APPENDIX 1
Public and Peer Review Panel Comments

Appendix 1-3
Authors Responses to Comments

Appendix 1-3c
Response to Peer Review Panel Draft Report and Author's Response to Other Comments on Chapter 3

Chapter 3: Ecological Needs of the Everglades

Unique Response to Peer Review Panel Draft Report

Prepared by: Grover G. Payne, Ph.D

October 16, 2000
Dr. Garth Redfield, PhD.
SFWMD
3301 Gun Club Road
West Palm Beach, FL 33406

SUBJECT: Comments on Draft Peer-Review Report for 2001 Everglades Consolidated Report

Dear Dr. Redfield:

The purpose of this letter is to provide a response to the Peer-Review Panel's draft report on Chapter 3 of the draft 2001 Everglades Consolidated Report.

Response to Chapter 3 Draft Peer-Review Report

Given the fact that Chapter 3 represents only a brief summary of a much more extensive effort by the DEP and SFWMD, the Peer-Review panel did a excellent job of digesting the information and providing pertinent questions and comments on the chapter. However, we hope that during the preparation of the final report the panel will consider the following thoughts.

Comment: The primary objective of the information presented in Chapter 3 is to provide a status update concerning the research being done to support the development of a phosphorus criterion that is protective of the remaining natural flora and fauna in the Everglades as directed by the Everglades Forever Act (EFA). Additionally, because the development of the P-criterion for the Everglades is potentially contentious, the DEP must rely on the highest quality and most technically and legally defensible data available to establish the criterion. While there is a lot of good research being conducted in the Everglades necessary to gather a complete understanding of how the system functions, all of the available data are not appropriate or necessary for development of a numeric P-criterion.

Comment: The discussion of the DUWC data in Chapter 3 was not intended to be defensive or dismissive. It should be noted that the DEP has conducted extensive evaluations of the DUWC data of which only a minor portion is discussed in the chapter. As the Department conducted the extensive analysis of the underlying DUWC data, a number of concerns were identified. In drafting Chapter 3, we felt that it was necessary to point out some of the concerns that we had about the DUWC data and explain why it was not utilized to a greater extent, however we did not feel it necessary to go into great detail regarding these concerns. The Department has requested from DUWC the data sets that were analyzed by CART to assist us in addressing our concerns; however, we have been told that "This was an extensive amount of work, and additional time and

effort will be required to reconstruct each of these data sets … [therefore] the information is not available at this time." Hence, the Department has been forced to state our concerns generically and has been unable to investigate in detail the effect that the data variability has on the results to the degree necessary to answer the questions raised by the peer-review panel (e.g. the use of geometric versus arithmetic means).

Comment: We agree that the DUWC "Threshold" approach is just as scientifically valid as the "Reference Site" approach that we employed and much can be learned about the system from the DUWC data. However, our major concerns about the DUWC dosing flume study arise from the phosphorus data upon which their analyses are based. The most significant problem with the data discussed in the report is the variability inherent in the data. As pointed out in Chapter 3, the biological changes observed in the flumes were paired with phosphorus measurements averaged over periods ranging from 2 to 6 months. Often these measurements range widely even in the flumes receiving the lowest P-dose. It is unclear how biological responses, such as measures of the periphyton community (which change relatively quickly to changes in P-concentration) can be reliably attributed to the simple average of numbers that vary so widely. Additionally, the average P-concentration at the 2 meter distance (where most of the biological measurements were collected) in the lowest dose flumes rarely falls below 15 µg/L which would prevent derivation of a threshold in the 10 µg/L range.

Comment: Regarding the Peer-Review panel recommendation to compare the DUWC data variability to the variability at the impacted transect, we feel that Dr. Richardson's comparison of the variability of the flume data to that of a highly impacted transect site near the canal is misleading. P-concentrations along the transects do increase and become more variable with decreasing distance to the inflow structures. It is to be expected that stations strongly influenced by inflows would reflect any changes in inflow volume or concentration. Being highly impacted by the canal inflows, these sites were designated as such and therefore, can not be used to derive a P-criterion that is protective of the native flora and fauna. Only transect sites designated as minimally impacted can be used to generate a criterion that is protective of the native flora and fauna.

The purpose of Figures 3-3 and 3-4 was to indicate the amount of variability in the data being used by each group to generate a criterion. With the degree of variability in the DUWC data, even at the lowest loading rate, the authors feel that other factors such as luxury uptake and sediment loading during periods of high P levels and recovery during extended non-dosing periods must also be considered when evaluating the data. These factors greatly complicate the use of the DUWC data and reduce the reliability of any conclusions reached. Dr. Richardson's comparison of the percent of time the flumes were dosed to the percent of time the WCA-2 inflows were pumping is also misleading. The P-doses in the flumes affected the entire length of the flume as evidenced by Dr. Richardson's comment that increased sediment levels were observed down the entire length of the flume. In contrast, the P-concentrations and biology at the transect reference sites, by definition, are not greatly influenced by canal inflows and therefore, are not subject to the same effects arising from intermittent dosing.

Comment: Additionally, the DUWC report also uses data collected along the nutrient gradient in WCA-2A in an attempt to support a "1.0 g m^{-2} yr^{-1}" P assimilative capacity rule developed from data contained in the North American Wetland Database (NAWDB) (as described in the literature provided to the panel). Richardson and Qian (1999) propose that natural freshwater wetlands can assimilate P loading up to 1.0 g m^{-2} yr^{-1} without significant ecological change. However, the development of the "one gram rule" and its application to WCA-2A data have been seriously questioned in the literature by one of the developers of the NAWDB (Kadlec, 1999a and 1999b). Closer evaluation indicates that the 1.0 g m^{-2} yr^{-1} loading rate does not correspond to

chemical or biological changes that are occurring along the gradient in WCA-2A. This conclusion is supported by Kadlec (1999a and 1999b) who also finds that the 1.0 g m^{-2} yr^{-1} loading rate is not a good predictor of the ecological gradient observed along the gradient in WCA-2A. Additionally, Kadlec utilizes data specifically from WCA-2A to suggest a much lower assimilative capacity between 0.2 and 0.4 g m^{-2} yr^{-1} above which increases in P concentrations and subsequent ecological changes will occur.

Comment: The authors agree that it is important to understand the relationship between sediment P and water column P. This relationship will be especially important in the recovery of areas already impacted by P-enrichment. There is currently research being conducted to improve this understanding as well as efforts to develop and calibrate a mathematical model to predict the effects of P-enriched sediments on water column concentrations and recovery of impacted areas once inputs are reduced. The authors also appreciate the comment concerning the role of iron and sulfate in P retention by the sediments and will attempt to investigate the importance of these factors on soil P availability in the Everglades.

Sincerely,

Grover G. Payne, Ph.D.
Florida Department of Environmental Protection
Everglades Technical Support Section

References

Kadlec, R.H., 1999a. The limits of phosphorus removal in wetlands. Wetlands Ecology and Management. 7:165-175.

Kadlec, R.H., 1999b. Response to the Richardson and Qian comments. Wetlands Ecology and Management. 7:239-265.

Richardson, C.J., and S.S. Qian, 1999. Long-term phosphorus assimilative capacity in freshwater wetlands: a new paradigm for sustaining ecosystem structure and function. Environmental Science and Technology. 33:1545-1551.

Chapter 3: Ecological Effects of Phosphorus Enrichment in the Everglades

Responses to Public and Peer Review Panel Comments

By Grover Payne, Temperince Bennett, and Kenneth Weaver

Peer Review Panel Comments and Authors' Responses

Comment: The chapter would benefit from an illustration of phosphorus variability at the impacted sites.

Response: The authors acknowledge the fact that the P-concentrations along the transects increase and become more variable with decreasing distance to the inflow structures. It is to be expected that stations strongly influenced by inflows would reflect any changes in inflow volume or concentration. Being highly impacted by the canal inflows, these sites were designated as such and therefore, can not be used to derive a P-criterion that is protective of the native flora and fauna. Only transect sites designated as minimally impacted can be used to generate a criterion that is protective of the native flora and fauna. The authors do not understand the need to understand or discuss the variability at the impacted transect sites.

Comment: Bioengineering can achieve much, but creating habitat (e.g., pond apple) requiring very different soils and hydrology than presently exist would make success costly and risky. Recognition of the value of a pond apple habitat would be better addressed by restoration at the original site.

Response: The authors agree with the Peer Review Panel's assessment of the information presented in the TetraTech report.

Comment: The SFWMD/DEP should continue efforts to reconcile DUWC and Department findings. Efforts should include calculation of DUWC geomeans and determination of lower confidence limits.

Response: Since the Department initiated the evaluation of the available data for WCA-2, we have made extensive efforts to resolve the concerns about the DUWC work. Most recently, the Department has requested from DUWC the data sets that were analyzed by CART to assist us in addressing our concerns about both the data going into the analyses and the way in which the CART analyses were performed. The response from DUWC was that "This was an extensive amount of work, and additional time and effort will be required to reconstruct each of these data sets … [therefore] the information is not available at this time." Hence, the Department was forced to state our concerns generically in the chapter and has been unable to reconcile our differences with the DUWC findings as recommended by the Peer-Review Panel.

Comment: The SFWMD/DEP might also reconsider USEPA Regional Monitoring and Assessment Project (REMAP) data.

Response: The original 1995-96 REMAP data generally consisted of a single sampling event meant to provide a regional overview of the water quality status in the Everglades. As with many data sources, the REMAP data does a good job in fulfilling the intended purpose of the study and provides much useful information but, the data is of limited use for the more intense purpose of P

criterion development, especially when more appropriate data is available. Additionally, in March 2000, the Department requested portions of the more recent 1998-99 REMAP data considered potentially useful for phosphorus criterion development. However, at the current time this data has not been provided. The Department intends to perform a complete evaluation of the requested REMAP data when it is provided.

Comment: The nature and implications of water column P temporal variability should be understood.

Response: The authors agree that an understanding of the source and magnitude of the natural variation in the P concentrations at the minimally impacted sites is important. In addition, the EFA requires that the P criterion take into account natural variation. Therefore, there is a continuing effort to gain a better understanding of this variation especially as it applies to the application of the P-criterion.

Comment: The relationship between sediment P and water column P should be determined so that sediment P front movement and system response to changing P loads can be predicted.

Response: The chapter authors agree that it is important to understand the relationship between sediment P and water column P. This relationship will be especially important in the recovery of areas already impacted by P-enrichment. There is currently research being conducted to improve this understanding as well as efforts to develop and calibrate a mathematical model to predict the effects of P-enriched sediments on water column concentrations and recovery of impacted areas once inputs are reduced.

Comment: The rate of expansion of the high P front is probably related to anoxic events or iron and sulfur dynamics in the system.

Response: The Everglades is a unique system that responds differently than most other water bodies. Much of the sediment in the northern Everglades marshes is largely organic and anoxic most of the time. Therefore, in contrast to aerobic systems, the movement of the P front in the Everglades is not believed to be greatly influenced by anoxic events. However, significant amounts of phosphorus can be released through oxidation of the organic sediments if the system is dried.

Additionally, research has shown that retention of phosphorus in the Everglades is largely controlled by the formation of calcium phosphates and biological assimilation and sediment accretion. Because of the anoxic nature of the organic sediments and their relatively low iron concentrations, as compared to calcium, the role of iron and sulfur in controlling the retention of P in the sediment or the movement of the P-enrichment front is probably limited.

Comment: The system should be evaluated for potential nitrogen limitation.

Response: The Department and SFWMD have performed an extensive number of limiting nutrient assays in the laboratory. The results of these assays indicate that the system is predominately phosphorus limited except at sites strongly influenced by P-enriched canal inflows where the occurrence of nitrogen limitation and nitrogen/phosphorus co-limitation increases. Additionally, the N:P ratios measured in periphyton samples collected along the transects support the results of the limiting nutrient assays. In the interior of the marsh (at reference sites), the N:P ratios generally average between 50 and 60 which is indicative of a highly phosphorus limited system. At sites closer to the canal inflows, the N:P ratio in the periphyton decreases to reflect the increasing influence from P-enriched canal inflows.

Dan Scheidt, U.S. Environmental Protection Agency, Comments and Author's Responses

Comment: Defining sediment phosphorus concentrations as indicators of phosphorus-impacted areas: determination of ‘threshold’ concentrations.

Response: The only purpose of the sediment phosphorus contour map in Chapter 3 was to demonstrate the existence of a phosphorus gradient in WCA-1. The 600 mg/kg contour was suggested as a general break-point between impacted and minimally impacted areas. This was not meant to be construed as a definitive delineation of impacted areas. The use of the 600 mg/kg contour in WCA-1 was primarily based on the evaluation of WCA-2 data along with other research. As the commenter states, the Department intends to assess the appropriateness of the 600 mg/kg threshold on an area by area basis. The assessments for WCA-3 and the Park will be performed as the Department continues its evaluation of these parts of the system.

As the commenter points out, the use of sediment phosphorus concentrations expressed per unit volume instead of mass can provide a significantly different contour map. However, using a more extensive data set for WCA-2 and the Refuge, the contours generated from sediment P data expressed as mg/kg corresponds more closely to observed biological changes than does data adjusted for bulk density. Similar comparisons will be performed for WCA-3 and the Park as the evaluation of these areas continues.

The use of bulk density measurements to adjust the sediment phosphorus levels may hold some merit under certain conditions, such as the comparison of data across regions. However, before bulk density adjusted sediment data are used to differentiate impacted and minimally impacted areas, other factors should be considered. Some of the factors that deserve more thought are provided below.

1) How is the bulk density being altered by the different accretion rates and vegetative communities between impacted and minimally impacted areas? Are changes in the bulk density masking or enhancing changes in sediment phosphorus concentration?
2) How much error does the use of bulk density add to the already variable measure of sediment phosphorus?
3) Given data with sufficient spatial coverage, does the use of the bulk density adjustment produce results that more significantly correspond to observed biological changes within a given area? Preliminary comparison of the sediment contours generated from the 1995-96 REMAP data to those provided in the chapter suggest that the sediment contours in the chapter better reflect known P inflows than do either set of REMAP contours. This is likely the result of the limited spatial coverage of the REMAP data compared to the more extensive data set utilized by the Department.
4) How is the floc layer, which is observed to have the highest P concentrations, incorporated into the measure of bulk density? Are changes in the thickness or P concentration of the floc layer taken into account? Since the floc layer was poured off the sediment samples collected during the REMAP study, how does that affect the comparison of the two measures of sediment P?

Comment: Chapter doesn't provide information on how compliance with the TP criterion will be determined. These technical details should be included in subsequent technical documents.

Response: Chapter 3 of the 2001 Everglades Consolidated Report represents a status update concerning the research being conducted in the Everglades to support the development of the P criterion. This chapter is not meant to propose a P-criterion or associated compliance method. As stated in the chapter, the information provided represents a brief summary of a much more extensive technical support document currently being prepared. Based on numerous discussions with USEPA representatives (including the commenter), the authors fully understand the need to provide adequate details concerning the application of the P criterion and the compliance measurement methodology in the final technical support document.

Comment: The discussion of the USEPA's approval of the Miccosukee Tribe of Indians 10 µg/L TP criterion was incorrect.

Response: The discussion of the Miccosukee's 10 µg/L TP criterion approval by the USEPA was corrected in the text.

Everglades Program Team, United States Department of the Interior, Comments and Authors' Responses

Comment: It would be helpful if Figure 3-2 included labeling to identify the order in which different indicators appear in the cumulative distribution of the change points. This would be a useful summary of the ecological results. Also, it is possible that the use of multiple, presumably correlated, indicators as distinct measures of the same ecological feature might overemphasize change points because of "redundancy" of the measures (i.e., 25%, 50%, and 75% percentiles of the DO distribution).

Response: Additional information on the location of specific change points and a more detailed graphic depicting their location and ordering can be found in the extensive draft technical documents (Payne et al., 1999 and Payne et al., 2000) on which this chapter is based. Although change point analyses were run on numerous indicators, care was taken to avoid "redundancy" of measures when compiling change points of various metrics. For instance, although four of the five change points run on dissolved oxygen data were located at the same distance (25%, 75%, median, and mean), only mean and minimum dissolved oxygen change points were incorporated into Figure 3-2.

Comment: The comparison provided by Figures 3-3 and 3-4 is not a convincing demonstration that the TP concentrations from the DUWC dosing study are significantly more variable than values from the WCA-2A gradient. Figure 3-3 plots the DUWC high-dose treatments, which are quite variable, on the same graph with the lower-dose treatment and controls, which are relatively invariant on the chosen scale.

Response: The purpose of Figures 3-3 and 3-4 was to indicate the amount of variability in the data being used by each group to generate a criterion. Therefore, the variation within the DUWC flumes was compared to the variation at the minimally impacted transect sites (Figure 3-4). It should be noted that all DUWC flume data were utilized in their calculations regardless of intended dosing concentration. With the degree of variability in the DUWC data, even at the lowest loading rate, the authors feel that other factors such as luxury uptake and sediment loading during periods of high P levels and recovery during extended non-dosing periods must also be considered when evaluating the data. The pairing of short term (two to six month) average P concentrations from the flumes with the measured biological responses further emphasize the significance of the variability in the DUWC flumes. An average P concentration computed from a small set of highly variable concentrations (*e.g.*, TP measurements of 2, 20.9, and 184.7 µg/L resulting in a mean of 69.2 µg/L) is not a faithful representation of the phosphorus regime to which the biota is responding. The degree of variability documented during the DUWC dosing study prevents the accurate determination of the relationship between phosphorus concentrations and biological response. This is an especially important consideration when the measures of biological response are highly sensitive to small changes in P levels, such as many of the measures of the periphyton community. These factors greatly complicate the use of the DUWC data and reduce the reliability of any conclusions reached.

The authors acknowledge the fact that the P-concentrations along the transects increase and become more variable with decreasing distance to the inflow structures. It is to be expected that stations strongly influenced by inflows would reflect any changes in inflow volume or concentration. Being highly impacted by the canal inflows, these sites were designated as such and therefore, can not be used to derive a P-criterion that is protective of the native flora and

fauna. Only transect sites designated as minimally impacted can be used to generate a criterion that is protective of the native flora and fauna.

Chapter 3 was revised to clarify the description of Figures 3-3 and 3-4 as well as the reasons for their inclusion. Additionally, Figure 3-3 was modified to remove the two highest P-dosing rates to emphasize the point being made.

Comment: The last sentence appears to set up an "either-or" situation in which the choice is between "small" impacts to the EPA marshes using only green technologies or undesirable "forced" chemical treatments.

Response: The statement is only meant to provide an interpretation of the current status of the supplemental technology research. As stated in the text, before a final decision can be made, the supplemental technology research currently being conducted will need to be thoroughly evaluated along with an assessment of the ecological implications resulting from a small zone of limited P-enrichment downstream of the STA inflows.

Comment: Utilization of DO concentration as an index of impairment resulting from nutrient loading is not widely applied because (1) both high and low DO may result from nutrient enrichment (Rast and Lee 1978; Rast and Marjorie 1988), and (2) low DO is often the result of allochthonous organic loading.

Response: During our evaluation of the changes in DO measured along the transect, we examined several measures of the DO regime including minimum, 25% and 75% percentiles, maximum, mean, and median values. During this evaluation we found that DO in the Everglades does not respond to nutrient loading the same way as the northern lakes and reservoirs described by the commenter's references. Dissolved oxygen production in lakes is phytoplankton dominated, in contrast to the Everglades where the DO regime is largely controlled by periphyton and submerged aquatic vegetation (P/SAV).

A clear relationship between P-enrichment and DO is evident in the Everglades marsh. The dampened DO regime exhibited in P-enriched areas is primarily due to a progressive reduction in water column production (photosynthesis) and increased oxygen demand. Phosphorus enrichment causes a loss of the native P/SAV community, which greatly reduces the photosynthetic production of oxygen in the water column (McCormick and Laing, in Review). In addition, shading effects in areas invaded by dense emergent vegetation cause further reductions in DO production (Brandenburg, 1996). Additionally, as phosphorus levels are increased productivity increases, as does organic matter accumulation in the water and sediments (*i.e.*, increased BOD and SOD). This increased demand for oxygen results in greater oxygen consumption in both the water column and sediments. It should be understood that the Everglades is a very low-flow wetland system in which there is an abundance of organic matter accumulated from autochthonous sources (*e.g.*, macrophyte detritus). Therefore, the effects of any allochthonous organic loading would likely be very limited. As discussed above and in the Chapter, reductions in the DO regime along the gradient are strongly associated with biological changes resulting from P-enrichment in the marsh. Additionally, the relationship between the observed changes in the DO regime and the effects of P-enrichment have been confirmed in P-dosing experiments conducted outside the influence of any allochthonous organic loading.

Literature Cited

McCormick, P.V., and J.A. Laing. In Review. Effects of increased phosphorus loading on dissolved oxygen in a subtropical wetland, the Florida Everglades.

Brandenburg, M.E. 1996. The Effect of Canopy Shading on Relative Primary Productivity of Periphyton in Water Conservation Area 2-A, Everglades. Masters Thesis. Florida Atlantic University, Boca Raton, FL.

Comment: Data collected from interior marsh sites in LNWR could be useful for criterion development.

Response: As stated in the comment, the data collected at these sites provide useful information on background conditions. In addition, the purpose of the Consent Decree monitoring, as implied in the comment, is to provide a long-term average concentration of approximately 7 ppb at interior marsh stations. The purpose of the numerical P criterion is to be protective of the natural flora and fauna throughout the system. The extensive evaluation of the biological and chemical data collected along the gradient transects in the Refuge indicates that background P concentrations (*i.e.*, 7 ppb) are not necessary to be protective of the natural flora and fauna. Therefore, the addition of the interior marsh sites to the reference sites would unnecessarily lower any criteria derived. Additionally, the data from the interior marsh sites referenced in the comments are primarily chemical data without the biological data required to allow a full evaluation of the usefulness of these sites. The data referenced in the comments may be of greater use during efforts to understand the sources and magnitude of natural variation in P concentrations within the minimally impacted areas of the marsh.

Comment: An increased emphasis on functional data, such as productivity, respiration, etc., would provide a better picture of the effects of elevated P on Everglades biota.

Response: Chapter 3 of the 2001 Everglades Consolidated Report represents a status update concerning the research being conducted in the Everglades to support the development of the P criterion. As stated in the chapter, the information provided represents a brief summary of a much more extensive support document that provides greater detail on functional data.

Comment: The last two references, FDEP 1999 and FDEP 2000, are important references for this chapter, but are not generally available.

Response: FDEP 2000 will be completed prior to the release of the 2001 Everglades Consolidated Report. At that time, draft versions of both documents will be available upon request.

William H. Green, Counsel for Sugar Cane Growers Cooperative of Florida

Comment: Florida's narrative nutrient rule needs to be interpreted in such a way that (a) remaining natural areas are protected from phosphorus induced imbalances of flora & fauna, and (b) "already impacted areas" can be utilized for gradient ecology purposes. If the numerical criterion set for natural areas is roughly in the 10ppb to 20ppb range, a higher range of values will need to be set for "gradient ecology areas."

Response: The EFA states that the phosphorus criterion be applied to "assure a net improvement in areas already impacted". This requirement of the EFA precludes the development of a separate phosphorus criterion for the impacted areas that would prevent this improvement. Additionally, there is evidence to suggest that if the already impacted areas continue to be loaded at rates that would maintain their current state of phosphorus enrichment, the phosphorus front will continue to expand into previously unimpacted areas causing an imbalance of the natural flora and fauna in these areas which is also prohibited under the EFA.

Comment: The Everglades Forever Act directs the South Florida Water Management District to evaluate the costs and benefits of further phosphorus reductions. However, no such analysis appears in the report.

Response: The requirement of the Everglades Forever Act is taken out of context and misinterpreted in the comment above. The EFA directs the South Florida Water Management District, in cooperation with the Department, to provide a summary of the available data and findings related to costs and benefits of phosphorus reduction alternatives (advanced treatment technologies). SFWMD and the Department acknowledge this mandate and have provided a

detailed update on the cost and benefit analysis of advanced treatment technologies in Chapter 8 of the report. This analysis was initiated with the development of a Standard of Comparison (STSOC) methodology designed to ensure that comparable information is obtained from each advanced treatment study. The standard of comparison provided for the development of a database for the advanced treatment technology projects and the design of an evaluation method to assess the performance of each technology, including initial cost estimates and benefits (See Chapter 8, this report). The initial cost estimates for implementation of the advanced treatment technologies were provided by the Desktop Evaluation conducted by PEER Consultants P.C./Brown and Caldwell in 1996. These initial cost estimates were extremely preliminary, however, through continuation and completion of the advanced treatment technology research, more substantial information on the costs and benefits associated with each technology can be obtained. This information will be provided to the legislature in the peer-reviewed report required by the EFA by January 1, 2002.