lake drawdown. In the single-layer simulation, on the other hand, drawdowns in the aquifer adjacent to a lake would be virtually equal to the drawdown of the lake.

The single layer approach also eliminates any representation of vertical head loss within the aquifer itself. The effect of these head losses would be to reduce drawdowns at the fish ponds relative to those calculated in a single-layer simulation, although the magnitude of the reduction would vary depending on the flow field. The report does make the point that the ponds themselves are not represented as surface water bodies in the simulation, but rather are treated as parts of the aquifer; and that where hardpan is present beneath the ponds the actual pond drawdown will be less than that calculated for the aquifer. While I have no experience with fish farm ponds, I assume that they would tend to accumulate low-permeability organic bottom deposits, as happens in almost all non-flowing or slow-flowing surface water bodies. If this is the case, aquifer drawdowns calculated at the pond locations will overpredict actual pond drawdowns, whether or not hardpan is present. So in summary, I believe there are several reasons that two-dimensional simulations will tend to overpredict drawdown in the ponds, and I believe these reasons should be emphasized in the report.

B. Editorial Comments -- Pages 1 through 10

Pg 2, third sentence -- the sentence says that land surface ranges in thickness from 20 feet to 270 feet; I believe the intent is to say that the surficial aquifer ranges in thickness from 20 feet to 270 feet.

Pg.2, Last paragraph - I suggest something like the following:

"Over the long term, the shallow aquifer system is at equilibrium -- i.e., average inflow to the aquifer is balanced by average outflow, and the water table at any given location tends to fluctuate about a mean position. Inflow consists primarily of recharge from infiltrating precipitation, while outflow occurs by seepage into lakes, streams and canals, by evapotranspiration, by downward leakage to the Floridan aquifer system, and by water use. On a short term basis, inflows and outflows are generally not in balance, and water alternately accumulates in the aquifer or drains from it, causing temporal fluctuation of the water table."

Pg 3, first paragraph - It would help to include some description of the areal extent of the fish ponds -- the size of a typical pond, the number of ponds at a typical fish farm, the density of areal coverage, or etc. The second sentence of the paragraph should read "They intersected the water table..." rather than "They intersected the top of the water table..."

Pg 3, fourth paragraph, second and third sentences - the paragraph would make more sense if the word "excess" were deleted, all three times that it appears.

Pg 4, first full paragraph - I recognize that this section is only reporting the results of an earlier study, but for the record, I fail to see the logic of the argument in the first two sentences of this paragraph. The idea seems to be that because the water table is higher at a point between Castelli Farms and the lake than it is at Castelli Farms -- i.e., that (apparently) a water table divide exists between Castelli Farms and the lake -- it follows that a change in water level at the lake can have no impact at Castelli Farms. But the presence of an intervening water table divide would not in itself preclude a water level change at Castelli Farms in response to a change in the level of Alligator Lake. Hydrogeologic stresses can and do propagate across water table divides, and need not eliminate the divide when they do so. If water levels on the divide are drawn down by a stress, water levels across the divide will be drawn down as well. I doubt that the water level at Castelli Farms (well 0SS68) was actually influenced by Alligator Lake, but that doesn't make me feel any better about the argument made in this paragraph. It seems to me that the logical way to address the matter at issue using the water level records would be to attempt a correlation between the level of Alligator Lake and the level in well 0SS68. If the results turned out to be negative, the case would be made.

Pgs 4 and 5 - general comment - The discussion on pages 4 and 5 seems to alternate between two issues -- the distance from Alligator Lake to which lake drawdown impacts might extend, and the effect which a severe drought could have on the fish farms. The first two sentences in the first full paragraph on page 4 deal with the areal extent of drawdown impacts. The third sentence deals with the possible impact of drought on the fish farms. The discussion through the rest of Page 4 also seems to be related primarily to the issue of drought impact. At the top of page 5, the discussion returns to the question of the distance to which drawdown impacts would extend; in the middle of page 5 it goes back to drought effects, and then in the last paragraph back to drawdown impacts. The discussion would be a lot easier to follow if it were reorganized, preferably under subheadings, so that the two subjects were considered separately.

Pg. 8 top -- The statement that the model "allows for three-dimensional flow in the surficial aquifer system, which was modeled as a single layer" will act as a lightning rod for negative comment from readers with an interest in criticizing the work. The MIKE SHE code indeed allows for three-dimensional flow simulation, but that capability was not applied to the surficial aquifer in this study -- it takes more than a single layer to represent three-dimensional flow. Actually, as discussed above, simulation of the surficial aquifer as a single layer is conservative for the purposes of this investigation; this is the point which should be emphasized, not the three-dimensional capabilities of the MIKE SHE code.

Page 8 - second paragraph - In general, slug tests are of limited reliability in materials of high permeability. The surficial aquifer seems to be generally high in permeability, and it's not surprising that the final calibrated values of hydraulic conductivity exceed the slug test estimates by an order of magnitude or more. But given this difference, is there any point in bringing up the slug tests or their results at all? The same final calibrated conductivities would presumably have been obtained if arbitrarily chosen initial conductivity values had been used. Including the slug test results does not add to the credibility of the final conductivity values, and may actually provide ammunition for unwarranted criticism of the study. If the slug test discussion must be included, it would help to point out that reliability drops off at high conductivities, and that the calibration exercise subsequently confirmed the prevalence of high conductivity materials in the study area.

Pgs 9-10 and, Figures 4 and 5 - The conclusion on page 10 is that the two hydrographs illustrate that no impacts were measured at any of the wells due to the aquifer tests. I'm sure this conclusion will be disputed when the report is released. Figure 4 does indeed show short term fluctuations in the Beekman well, presumably in response to precipitation or other stress, but these fluctuations are superimposed on a general decline in water level which appears to correlate well with the drop in lake level. The fact that the short term fluctuations are not apparent in the lake record doesn't mean a great deal. Many kinds of stress would be expected to produce much greater impacts on ground water levels than on surface water, since surface water bodies have high storage factors, and in general much higher rates of outflow in response to a small increase in water level. Figure 5 shows a long term, almost linear decline in the water level of the Chestnut Well following the stepwise reduction in lake level. The text makes the point that the water level in the well continues to decline while Lake Gentry remains at a constant level. But in fact this is the response one would expect to a stepwise head change along an aquifer boundary. Water levels within the aquifer should continue to decline while the boundary head remains at its new level, until such time as the aquifer has come to equilibrium with the new boundary condition. The Chestnut well is located between two boundaries, both of which were subjected to stepwise head change. One would therefore expect to see a superimposed effect of both boundary changes, which again should persist while the new lake levels remain constant. It is true that there are obviously other factors influencing the Chestnut well. The slope of the hydrograph following the lake drawdown is about the same as its slope during periods of decline prior to the lake drawdown. This suggests that the lake drawdown is not primarily responsible for the later period of water level decline, and rather that the hydrograph is simply showing the normal recession of water level after a peak due to recharge. But the text does not make this argument, nor, in any case, does the similarity of the hydrograph slopes totally preclude the change in lake level as a contributing factor to the water level decline.

C. Answers to Questions Posed in the Scope of Work

1. Have the ground water/surface water relations been reasonably characterized?

Yes, for the purposes of this investigation. If the model is to be used for other purposes, it may be necessary, or at least advisable, to provide for simulation of swamp lands as discrete features of the model. This could be done, for example, by using a separate model layer to represent the upper few feet of the saturated zone, and by using very high specific yield and hydraulic conductivity values in that layer within the swampy areas. Alternatively, it should be possible to use the surface water components of the MIKE SHE code to represent swamplands (although I am not sufficiently familiar with the code to be sure that this is feasible).

2. Is the MIKE SHE model an appropriate tool for analyzing ground water/surface water interactions?

Yes, insofar as I can tell from the documentation. I have not used the code myself, nor did I have an opportunity to test the software during this review.

3. Is the methodology and approach used in this assessment sound?

Yes, except for the concerns noted in the discussion in Section A. Specifically, a steady-state calibration should be implemented, both for general confirmation of the hydraulic conductivity distribution obtained in transient calibration, and as one approach to the specific yield question. A sensitivity analysis, in which the sensitivity of the report's conclusions to variation in specific yield, should also be implemented. If the model is to be used for other purposes in the future, it may be necessary to use three-dimensional simulation of the surficial aquifer and to represent the swamps as discrete hydrologic features; but for the purposes of this analysis the procedures followed appear to be conservative.

4. Has the method been appropriately applied?

Yes, in general, but see the comments in response to question 3, above, and in Section A.

5. Is the data collection network in proper locations, and is the data sufficient for analysis?

Yes, at least for the purposes of this investigation.. However, I believe there is more data available, beyond that provided through the network, and that this additional data could be used as the basis for a steady-state calibration. Examples would include water levels in excavations, flow characteristics of drains or small streams, crop types and their required root depths, and so on.

6. Are the conclusions reached reasonable, i.e., accurate and supported by the analysis?

Yes, subject to the qualifications in the discussion of Section A. The approach used, i.e., simulating the various scenarios with and without lake drawdown, is certainly valid, and the results are as good as the model that was used. The credibility of the model, in my mind and (I believe) in that of any reviewer or critic, would be reinforced if a steady-state calibration were implemented, if the sensitivity of the conclusions to variation in specific yield were tested, and if the report were strengthened by emphasizing those aspects of the calculation which can be considered conservative for the purposes of this study.

7. (a) Has the project taken advantage of available ground water/surface water interaction assessment techniques and methodologies?

Yes, to the extent required for purposes of the analysis. If the model developed in this project is to be used for purposes other than those of this investigation, additional techniques or methodologies, for example those discussed in the response to question 1 above, might be necessary.

7. (b) Suggestions for future improvements of assessments and design of data collection systems.

In general, an aquifer as thick and complex as the surficial aquifer should be represented using multiple model layers, to provide three-dimensional representation of the flow regime within the aquifer. For the purposes of the present study, use of a single layer is conservative, but this would not be true for most applications.

As a general principle, steady-state calibration, however approximate, should be implemented whenever a flow model is developed.

If a critical hydraulic parameter is specified arbitrarily in development of a model, the sensitivity of the conclusions of the study to variation in that parameter should be tested.

Data collection systems should, to the extent possible, address long term or average flow rates, as well as water levels. Even if the objectives are of a very general nature -- for example, characterizing certain stream reaches as perennially gaining or perennially losing, or setting limits on the flow rate into a drain -- the resulting data can be useful. Any information which can be developed on flows between the ground water and surface water regimes can reduce the uncertainties in a steady-state calibration.

The next item does not relate to data collection networks, but is certainly a data collection issue. In general, constant rate discharge or injection tests are much more reliable than slug tests for estimating hydraulic conductivity in materials of moderate to high hydraulic conductivity. I'm referring here to short duration, single-well tests involving low rates of discharge or injection, not to long term tests with observation well arrays. Slug tests have gained popularity in ground water contamination studies because of problems and restrictions regarding the disposal of pumped water, or the injection of water into a contaminated aquifer. In a regional hydrogeologic investigation these issues do not arise; moreover, the effort involved in a short term single well discharge test is not much greater than that involved in a slug test. In many cases, drawdown and flow measurements made during normal well purging prior to (or during) sampling can provide adequate data for a reliable estimate of hydraulic conductivity.

7.(c) Provide suggestions on the applications of such assessments in hydrologic - hydraulic modeling of alternative water management strategies for ecosystem restoration.

The objectives in the Alligator Chain drawdown investigation were relatively narrow. More commonly, the objective of simulation would be to test a variety of alternatives or strategies using simulation, and to determine which alternative will have overall hydrologic consequences which most favor the eco-system restoration objective, whatever that may be. In many cases, particularly where questions of cost effectiveness arise, close comparison of the results of various alternatives or strategies is necessary. In this situation, conservative assumptions may not be appropriate, since their impact on different alternatives may differ, and those differences may drive the entire comparison. My general suggestion is therefore to do the most thorough job of simulation that the project resources will allow, in every study or investigation. Models have a way of taking on a life of their own, and of being used sooner or later for purposes far removed from those for which they were built. The model developed for the Alligator Chain project, for example, is suited to the purposes of the study, but could fall seriously short in a more general application. Whenever an already-existing model is proposed for use in a new application, a careful review of the objectives and tasks should be made, and the ability of the model to handle those tasks and meet those objectives should be evaluated.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

Gordon D. Bennett
Senior Associate

GDB:mt

Review of:

"Analysis of Projected Impacts Of the Alligator Chain Drawdown Project On the Surrounding Water Table Aquifer", SFWMD, October 28, 1998.

By Henk Haitjema

January 15, 1999

Report organization

In general the report is a well organized and forms a professional documentation of a careful and thorough analysis of the impacts of the proposed lake drawdowns on the surrounding groundwater regime. The preliminary analysis followed by the comprehensive modeling study form a logical progression toward the presentation of the final detailed water table drawdown scenarios.

I found the graphical illustrations and presentations of the results clear and helpful. I was spoiled by the color graphics in appendix J showing the maximum drawdown distributions in the aquifer for the two scenarios under "typical conditions". I wish that similar color figures had been included in appendix K, and I as these figures may form the most effective presentation of the final study results.

The discussions of the "Results of Scenario Simulations" in the body of the report (page 11 through page 23) might benefit from some additions and reorganization. It took me a while before I realized the differences in the lake drawdown scenarios for the "wet winter", "typical" and "severe drought" conditions. These scenarios should be presented concisely, perhaps with composite lake stage graphs, at the start of the discussion in the main body of the report (page 11). Similarly, if full size color graphics would be provided in the appendices, smaller scale versions (gray scale would be fine) of the "projected impact" figures can be grouped on one page (or two opposite pages). This would greatly facilitate comparisons between the drawdown patterns for the wet, typical and dry conditions.

I would also recommend that differences between the wet, typical and dry scenarios be briefly explained. For instance, I believe these differences to be due, at least in part, to differences in the drawdown scenarios and differences in the surface water occurrences (groundwater boundary conditions) for the three cases. It is also recommended to explain some of the major differences in spatial distribution of drawdowns for each of the scenarios themselves. For instance, spatial variations in aquifer properties and different distances to surface waters (constant head boundaries) may help explain spatial variations in drawdown responses. Such explanations serve two purposes: (1) they increase confidence of the reader in the results and (2) they help anticipate local drawdowns under conditions not explicitly represented by the modeling scenarios in the report. Some additional modeling work may help to better understand the drawdown patterns (and thus better explain them in the report), see my recommendation on additional analyses.

In view of the fact that the bulk of the report consists of appendices, it may be helpful if a consistent page numbering scheme would be applied. For instance, numbering the appendices A1, A2,... B1, B2... etc. in the right bottom corner of the pages. During our phone conference on January 8, I had great difficulty finding my way through the appendices even though I was generally familiar with the organization of the report.

Study approach

The study, as presented, consisted of two phases: (1) a preliminary assessment based on (limited) field data and (2) a comprehensive computer modeling effort including saturated and unsaturated groundwater flow, surface water flow and interactions between surface waters, topography and groundwater. The simulations treated the various components of the hydrological cycle conjunctively and under transient conditions. The computer simulations, therefore, are of substantial complexity requiring many types input parameters, such as aquifer properties, rainfall and evapotranspiration data, surface water and terrain elevation data, soil composition data, etc. In addition, because of the transient nature of the simulations, initial conditions (e.g. water table elevations) needed to be specified.

While the preliminary study provided only a qualitative indication of the lake drawdown effects, the computer simulations are designed to provide a realistic quantitative assessment of the drawdown distributions in the aquifer surrounding the lakes. Data uncertainties and limited data resolution (and limited model resolution) will cause some discrepancies between observed and modeled groundwater elevations (see the model calibration results in appendix H). However, provided that the main characteristics of the hydrogeology and surface water hydrology are properly represented, at least on average, much more accurate results may be expected from the lake drawdown *impact* simulations. That is to say that the modeled differences between water level elevations, with and without the lake drawdowns, are more reliable than the absolute value of the modeled water levels. Consequently, the "Projected Impact of Lake Drawdown" figures (color floods) will be realistic, provided the main aquifer and surface water characteristics are properly represented in the model.

Additional analyses

In order to test the robustness of the complex MIKE SHE model I recommend that a single aquifer *steady state* groundwater analysis be performed. I suggest that the SFWMD construct a single aquifer (surficial aquifer) model with the same (approximately) hydraulic transmissivity distribution as used in the MIKE SHE model. The surface water features used in the MIKE SHE model may be introduced as head specified boundary conditions (constant head boundaries). It would be best to create three models using the surface water distributions from the *winter-wet*, *typical* and *severe-draught* conditions, respectively. The aquifer recharge rate may be taken constant over the model area, reflecting an average for each of the three conditions. The advantage of this basic model is that few input data are needed and that interpretation of the results is relatively simple. For instance, it is easier to understand why the drawdown in one area is lower than in another, when they result from the steady state groundwater model than when they are predicted by the transient MIKE SHE model. The downside of this simple model is that it can not be calibrated reliably, as the modeled groundwater regime does not really occur at any one time. However, as discussed for the MIKE SHE simulations, as long as the main aquifer characteristics are reasonably represented in the model, the impact of lake level reductions on the water table in the aquifer should be fairly accurate. Since the simulation is steady state, the water table reductions in the aquifer are expected to be larger than those predicted by the MIKE SHE model: The steady state impacts form an upper bound for the transient effects. The trends in the drawdown distributions, however, should be similar. This means, for instance, that if in the MIKE SHE model the drawdown in the Simmons2 well is much less than in the Beekman well, the same should be seen in the steady state simulations.

The proposed steady state simulations would bridge the gap between the very preliminary analysis discussed in the report and the very complex and sophisticated MIKE SHE simulations. The steady state analyses is important to help explain phenomena observed in the MIKE SHE model and to improve our confidence in its predictions.

Recommendations for future studies

Computer simulations are excellent quantitative tools to analyze the consequences of water resource management decisions, as seen in the current report. The realism of the simulations depend both on the sophistication of the model and the availability and reliability of the input data. Unfortunately, data availability and reliability becomes increasingly problematic with increasing complexity (sophistication) of the model. This circumstance tends to undo much of the gain that may be expected from a sophisticated model when compared to a simpler model. For instance, a single layer steady state groundwater flow model will necessarily fail to recognize the transient effects of changing surface waters. On the other hand, the data needed to parameterize a transient conjunctive surface water and groundwater model may well exceed the available information, at least the available *reliable* information. As a result it is uncertain whether or not the refinements due to the more complex model will provide meaningful extra information.

To overcome this impasse a stepwise modeling approach may be adopted. The idea is to gradually build up complexity in the modeling process until additional refinements do not provide further meaningful information. This approach has several important advantages over the "all at once" comprehensive modeling approach:

1. Initial quantitative results are obtained early on in the study at little expense.
2. The relative importance of various data becomes evident when gradually more data is being used.
3. The modeling process and data collection process may be aborted when no significant changes in the outcome occur between modeling steps, thus avoiding some of the most complex and expensive simulations.
4. The gradual convergence toward an end result provides confidence in those results.

For the case of this study a stepwise approach would have started with the preliminary analysis presented in the current SFWMD report, followed by a simple steady state model with uniform aquifer properties and average aquifer recharge. Variations in aquifer properties and (net) recharge rates could have been added, followed by a distinction between wet, typical and dry conditions. Next, a transient groundwater simulation may be conducted. Finally, the Mike She model could have been introduced, again, gradually increasing the complexity of its data structure. During this process the purpose of the study should be kept in mind: what are the maximum drawdowns in the aquifer near the fishponds? Perhaps, the answer would have been obvious before the MIKE SHE model would have been implemented in all of its complexity. Perhaps the answer would have been obtained even before the MIKE SHE model would have been used at all.

Conclusions

The analyses presented in the report appear technically sound. The predicted water table impacts (drawdowns) as presented in Figures 7, 9 and 14 seem reasonable. However, an additional steady state analysis could significantly increase our confidence in these predictions by forming an upper bound to the drawdowns and by helping to explain some of the differences in drawdowns, both spatially and between scenarios. The proposed report reorganizations are cosmetic.

9 Jan 99

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Peer Review of: Alligator Lake Drawdown Model

General Comments

1. Have the groundwater /surface relationships in the study area been reasonably characterized?

The answer depends on the intended purpose of the model. Suggestions made below are intended to promote confidence that the model can be suitable for assessing the impact of lake drawdown on fish ponds. However, even with the recommended changes, the model will not be suitable for future purpose of assessing 'the time scale of refilling the lake and the aquifer systems assuming different climatic scenarios' (page 1, paragraph 3 of Appendix L).

At this time, the reader does not know how well the model predicts areas of ponding. Ponded waters provide a buffer that reduces the impact of lake drawdowns. It is important that the model predicts ponding reasonably, or at least in the right locations. Suggestions under comment 3 address this.

The report should clearly specify which canals are modeled using 1D flow equations, (Blackwater and Russell)and that they and all surface water bodies are sinks.

2. Is the MIKE SHE modeling system an appropriate tool to use to analyze groundwater / surface interactions?

The MIKE SHE model can be appropriately used to model groundwater / surface interactions.

3. Is the methodology and approach used in this assessment sound?

The task of calibrating a model without knowing initial heads is challenging. The general approach is sound but relies on the accuracy of the groundwater model. To improve confidence in the model, the areas the model predicts as having ponding should be verified using field data, aerial photography or remote sensing. Steady-state simulation using representative boundary conditions should be used to verify that the model will not cause ponding in inappropriate locations. This will give more confidence in the employed conductivity values.

The report should mention whether any groundwater extraction wells exist in the area or are modeled.

4. Has the methodology been appropriately applied?

See above comment 3.

5. Is the data collection network in proper locations and is the data sufficient for the analysis?

The monitoring well network is reasonable. However, more water level information can be used than is provided by the wells. For sites such as this, one should verify locations of ponding (see comment 3).

It is also useful to use field crop evaluation to provide spatially distributed upper limits on acceptable water levels during calibration. Field observation of agricultural crop robustness can help identify areas having high water tables. When water levels intrude too much into the normal crop root zone, the plants do not grow normally and crop yields suffer. If crops are growing normally, the water levels are beneath the bottom of the root zone.

6. Are the conclusions reached reasonable (accurate?) And supported by the analysis?

The projected impacts of lake drawdown on water levels near fish farms should be adjusted to reflect the calibration error observed for those wells. The calibration was performed during a wet period, during which ponded water might ameliorate the drawdown due to lake drawdown. That might mean that if the model overpredicted head x feet during calibration, it might overpredicted head by more than x feet during normal or dry scenarios. For example, p 3 of Appendix H shows a 0.5 ft final over prediction at Blackwater well. Appendix K, p 5 predicts Blackwater levels as low as 69.1 ft to result from lake drawdown. Subtracting 0.5 ft from 69.1 yields a 68.6 ft head for Blackwater well. One can use that value to evaluate impact on the fish farm. (P 9 shows a 1 ft over prediction at Chestnut well. Applying the same process yields 64.7 - 1.0 or 63.7 feet.)

Using the error observed at the end of the calibration period (for the adjustment) is justifiable because SFWMD did not consider much early observed data to be valid, and calibration error would not necessarily be decreasing with time.

7. Has the project taken advantage of available groundwater / surface interaction assessment techniques / methodologies? Suggest future improvements of such assessments and design of data collecting systems. Suggest application of such assessments in hydrologic-hydraulic modeling of alternative water management strategies for ecosystem restoration.

Including ponding area, and in some cases ponding depth, is important. Evaluating depth to water by observing plant robustness is also useful. Both acts can be enhanced by aerial surveillance techniques. Evaluating ponding area is especially important when one is trying to predict impacts on nesting areas and endangered habitats.

Detailed Comments

Comments Concerning Report Body.

p1, para 1, last line. Replace 'drawdown project' with 'drawdown project and structure locations'. Better maps are needed in the body of the report. The best one in the document is that at the beginning of Appendix E. However, it does not identify the roads and the lake structures that are mentioned in the report.

P1, para 2, sentence 1. Please clarify how large a head drop is represented by the mentioned lowering.

P3, para 4, line 3. Shouldn't 'excess' be replaced with 'excessively' here and in other places in the report?

P3, para 5. The available map should show both wells and the highways.

p4, para 2. Rearrange this paragraph to initially indicate its intent of showing that Alligator Lake does not influence heads at Castelli Farms. As written, the reader was wondering why the well farthest from the lake had an intermediate head value. Later I realized that distance from the lake was not very important for that well.

p4, para 2. This reader is curious as to why OSS68 had intermediate head values. Are these heads possibly due to the wetlands near OSS68. Why are the wetlands not mentioned in the report? How are they represented in the MIKE SHE model? It would be helpful to know the relative ground surface elevation for these locations if that is what is impacting the relative head elevations of the two wells.

p4, para 2 and elsewhere. It would be very helpful to see assumed or simulated water table contour maps. I found none in the report. I realize data is sparse, but would rather see such maps than not. Similarly, ground surface elevation and depth to water maps for a representative scenario would help.

P4, para 2, line 7. Remove 'the' between 'during' and 'drought'.

P4, para 4. This paragraph would benefit by a lead-in. What is its relation to what preceded it? Please clarify what are the 'wet season' and dry season months.

P4, para 3-5. A table summarizing this information would be helpful. The same or similar table should be used to summarize the results of simulated scenarios.

P5, para 2. Please break this into more than one phrase and reword. If head difference during the severe drought (1980-81) were close to their long term averages, why was the head difference not 'average' when rainfall was far below normal in 1980? I though the definition of a drought was a period of very low rainfall.

p5, para 4. I could not find Lake Joel on any of the maps in the report body.

p5, para 4, line 4. Shouldn't you replace 'consistent' with 'similar'? If not, what does consistent mean here?

P5, para 5, lines 5-7. Please replace 'There are...important role...' with 'Many interacting parameters affect groundwater levels. Rainfall plays an especially important role...'.

P5, para 5, line 9. Does this mean all the fish would die at Blackwater Fishery unless supplemental water is provided?

P5, para 5, lines 9,10. Please replace 'up to an additional one foot lower' with 'as much as one foot lower'.

P5, para 5, lines 12,13. Please consider replacing 'Head...table).' with 'Head difference increases as groundwater levels rise in response to rainfall.'

P7, table, column 2. Consider replacing 'Water Body' with 'Nearby Water Body', and adding a table number.

P8, Fig 2. It would be helpful to have the roads labeled, and to know what the intermediately shaded areas are. I assume they are wetlands.

P8, para 1, line 3. This seems misleading. An Appendix indicates that the Floridan aquifer was also simulated in this study, and that flow between aquifers was simulated.

P9, para 2, line 1. Although the sentence is accurate, 'during the calibration period' left me wondering whether this was a computer simulated aquifer response test, or whether it was a field test that was conducted during the same period for which the model was being calibrated.

P9, para 2, line 3. The water level did not reach 62 feet according to Fig 3.

P9,. Para 2, line 8. Where is Structure S-60 located on a map?

P9, Fig 3. The lines need to be distinguishable in the final report. Also, please indicate in the legend that 'normal schedule;, 1 in 3 schedule' and 'actual stage' all refer to lake levels.

P9, para 3, sentence 1. Please consider replacing 'hydrographs show the relationship between the lowered lake' with 'hydrographs show the relative weakness of the relationship between the lowered lake'. Mention that rainfall affects well stage more immediately and probably significantly than lake level (when contrasting Figs 3 and 4). The well level rose almost 2 feet in response to a rainfall event.

P 10, Figures 4 and others. The figure titles and legends could be improved. Many look like they were prepared as slides or transparencies. For example, the title of Figure 4 should be something other than 'Well Stage'.

P12, para 2. It would help to mention the Figure 7 cell size, and whether those cells were what were used in the simulation model.

P 13, Figure 7 and others. What was the maximum drawdown? I don't think it should have exceeded the maximum lake drawdown, except possibly a very small bit due to computational roundoff. Showing 2-3' begs the question about how great the change really was.

P 14. It would be helpful to see a figure or table that shows both calibration error statistic(s) and predicted water level change. At this point, a reader is uncertain how to assess the predicted drawdowns for a well (for example a well at which the model might have consistently overpredicted head by 2').

P14, para 2, line 3. Replace 'projectted' with 'projected'.

P 17, para 1, last sentence. Please clarify. Does this mean that water levels actually dropped below pond bottom and that fish died?

P 23, para 3. Input Lake Gentry (LG) head values were supposedly lowered enough to permit canal flow from Lake Alligator (LA). Is there any lower limit on how much canal flow should occur between LA and LG? If so, were any hydraulic computations performed to assure that the head decline was sufficient to cause that flow.

p 23, para 4. Please clarify the time lag relationship between when a gate is set and the target lake level is achieved? Is it on the order of hours, days or weeks for the gate setting changes being invoked in these scenarios?

P 26, para 2, lines 2,3. Consider replacing 'those fish farms such as' with 'the fish farms:'.

Several pages and figures. Figures or text discussing predicted heads at wells should include discussion of calibration error and its significance on the conclusions. (See comment concerning Appendix I).

Comments Concerning Appendix B (Preliminary Hydrologic Analysis).

p1, para 4, line 4. Replace 'primarily' with 'primary'.

P1, para 5, line 1. Replace 'There are six fish farmers who' with 'Six fish farmers'.

P 2, para 5, line 8. Replace 'current' with 'the present'.

P2 and 3. It would help if you referred to a water table contour map that also shows the discussed wells, farms, and S60.

P5, para 1, line 2. Please insert 'be' between 'also' and 'caused'.

P 6, Fig 1. Why are there two p_A .

P 12, Fig 7. Please label the curves (and the precipitation). The figure title is misleading.

Comments on Appendix E (Data from Monitoring Wells).

p 1, Fig 1?. This was the most useful figure for my review. The reader should see such a figure earlier in the report.

P2, Fig 2. This is a useful drawing (especially so because there are currently no water level contour maps). It would help if the legend listed the wells in the same order as their lines begin (on the left and from top to bottom). It took me awhile to be sure that I could distinguish between Moonlight 2 and Chestnut, etc.

P 3, Fig 3. In the body of the report can you please refer to the upward gradients, and explain why they occur.

Comments on Appendix H (Model Calibration).

P1, para 1, lines 3 and 4. This says 3-D flow is modeled in the SAS and the SAS is modeled as a 1 layer system. Are you including the downward vadose zone flow to justify describing the SAS modeling as 3-D? That seems nonstandard.

P1. How might water levels change during a 24 hour period that does not experience precipitation or pumping. In other words, what is the maximum water level change that might occur during a single day due to ET (ask someone that has conducted a lysimeter study with a saturated zone). Mention whether ET can affect the calibration comparisons between simulated and observed values for the soils of the area?

P 1, para 3. Clarify which figures include the canal. If all simulation results in the report do so, please say that. This reader was left wondering whether some simulation results should not be regarded highly because they did not include the canal.

P1, para 3. Please clarify how the canal was included in the model and the ramifications thereof. Was it represented using specified-head cells, or in some other way? What were the input parameters and assumptions? Is this the Blackwater Creek referred to on p 2, para 2 of Appendix L? I don't think it is clearly stated in the report what channel flows are simulated as such in the model.

P 7 and 9, Figures of Moonlight 1 and Chestnut well. Please be sure the report discusses the reason that early data is unreliable.

P9, Figure of Chestnut well. I am unsure about how good the calibration is here. It looks like the error is increasing with time. It is hard to trust predictions for this well.

P 12, Figure of OS-181. The trend is not good here. Please justify stopping calibration.

Comments Concerning Appendix I (Wet Winter Scenario).

P 1, para 1. Please clarify that the wet winter condition scenario is the same as the calibration era. In that case, the head figures should have additional curve(s) showing the predicted heads adjusted by the known error.

P1, para 1, line 5 and subsequent figures. Line 5 states that the figures illustrate predicted heads, with and without lake drawdown. The figures declare one of the curves to be 'Actual 97-98'. Both statements cannot be true since simulated heads for that era do not equal actual observed heads. If both curves represent simulated heads, both curves should be corrected as mentioned in the previous comment.

P1 and report body. Discussions of scenario results should explain the ramifications of calibration error on the predicted impacts.

Comments Concerning Appendix J (Typical Condition Scenario).

P 1 and figures in Appendix J and in the Report Body. It would be good to mention the ramifications of any calibration error on the predictions.

P 5, Figure on Projected Impact of Drawdown..... Why is there drawdown just west of Exotic Acres? I do not understand the modeling feature that would have caused this. Is there ponding of surface water above the ground surface anyplace other than in lakes? Also, if both Lake Alligator and Lake Gentry are drawn down 2 ft, would not the canal cells connecting the two lakes also draw down 2 ft?

Comments Concerning Appendix K (Severe Drought Scenario).

P 16, Figure for OS-181. There is an unusual difference between simulated and actual heads beginning about May 30. Can you explain that?

p 20, and in report body. In the physical system, how long does it take for the model-specified Lake Gentry and Lake Alligator heads to be achieved? In the model the heads are achieved within one simulated day, I assume.

Comments Concerning Appendix L (Model Documentation).

P1, para 2, line 4. Insert 'be' between 'would' and held'.

P1, para 3, line 3. Do you mean 'time period' instead of 'time scale'.

P1, para 3, lines 3 and 4. This implies that the model simulates reservoir head response to management.

P1, para 3, line 6. Does 'current level' mean 'present' or do you envision changing the changing the model (in which case perhaps 'current level of development' would be better)?

P1, 2nd bullet below para 5, and ramifications on subsequent text. This indicates that 2D overland flow was simulated in the model. In that case, it would be good to show map(s) indicating that the area predicted by the model to be under water was indeed under water in real life.

P1, 3rd bullet below para 5 and ramifications on subsequent text. Somewhere you should mention that there was insufficient data to calibrate the 1D flow in the channels.

P 2, top bullet and ramifications on subsequent text. To the extent possible, one should use depth to water beneath fields as a calibration parameter, even if there is no monitoring well. Crops and native plants have different rooting depths and their tolerance to saturated conditions within their root zone varies. For example, if the water table were within 3 feet of the ground surface beneath corn, one would expect an adverse affect on the crop and its yield. By field observation one can estimate a reasonable upper limit on the water table beneath cropped areas (and possibly beneath some native vegetation). It would be good to know whether the calibrated heads are beneath those upper limits.

P2, para 3, line 2. Unless there are cliffs or levees, topographic watershed boundaries normally to not lie on stream banks. Please confirm in text that the northern boundary follows sub-basin boundaries or revise the statement.

p3, para 1, line 2. Cell size seems reasonable. To better evaluate the calibration, it would be helpful if we knew how much change in head there in between cell centers in the vicinity of the monitoring wells. We need water table contour maps (including the model grid on one would be helpful) to get a feel for this.

P7, para 1, line 1. What is the vertical conductivity between layers 1 and 2 and 2 and 3.

P7, para 1. Where are the storativity values provided?

P 8, para 1. We recognize the difficulty in determining initial heads without more observation locations and with so many surface waters. There should be more checks on the suitability of the initial heads than merely a close match at OS-181. I would prefer to know that the initial heads include consideration of ponding depths and areas and depth to water based upon field and crop observation. For example, do simulated heads cause water levels that lie beneath the bottom of the agricultural root zones in the areas shown in Fig 15, p 15?

p 8, para 1. What do simulated steady-state heads resulting from mean boundary conditions look like? Please justify not presenting those.

P 8, para 2. I missed the discussion of what a T2 filename is. If it does not precede this text, it should be clarified.

P 8, para 3. Why not mention the northwestern and northeastern boundary conditions?

P 8, para 3, lie 4. Please insert 'peripheral' before 'cells'.

P 8, para 4, line 2. Please insert 'specified' before 'variable'.

P8 para 5, line 6. It would be helpful to see a gridded map showing where drainage water is routed to. Where was water east of Gentry Lake routed to?

P 9, Fig 7. I would use 'specified variable' instead of just 'variable' in the legend.

P 9, Fig 7. Is the effect of the eastern no flow boundary on the head at OS-181 insignificant?

p 14. It would be good to present the reported accuracy of the employed ET method in SFWMD. Might not head decline in some areas be due more to ET than to horizontal groundwater flow?

p 17, para 2, line 1. Clarify whether sub-regional head boundaries are specified and time-varying?

P 17, para 2, line 10. Please replace 'feature that is' with 'feature than is'.

p 17 para 2, next to last line. Please clarify whether the hardpan is used to represent layer 2 in the model, and the deep well is used to represent the Floridan Aquifer.

p 19, Figures here and in subsequent figures. The legend should indicate which line is from regional and which is from sub-regional model.

P 19, para 2, lines 1 and 2. Please clarify. Does this mean that matching deep well heads was considered more important than matching shallow well heads?

P 20, Table 4, wells 1 and 2. What are the entries in the right hand column?

P 22, para 1, line 6. Please replace 'that portrayed' with 'than portrayed'.

P 24, para 1. Please clarify that this covers the same time period as the dry condition scenario. What are any ramifications of that?

Appendix N. Model Verification - Spring 1999

Model Verification - Spring 1999

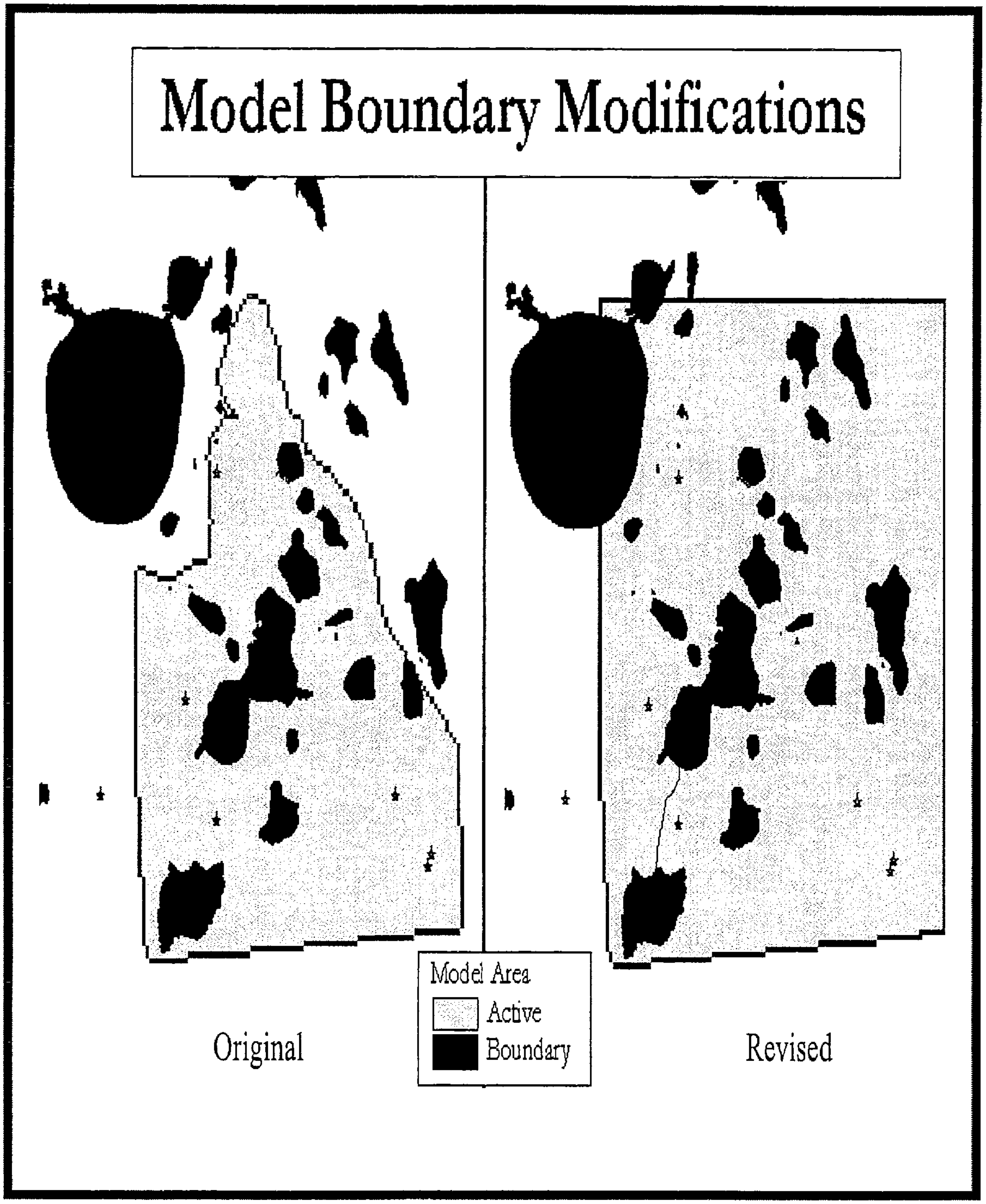
In Spring 1999, the model was modified and a model verification run was made to compare model predictions to actual water levels in the monitoring wells. A simulated drawdown analysis was performed using the modified model to estimate the potential impact of the drawdown if it had taken place in 1997-98. This simulation used weather patterns as actually experienced and used the "hold Gentry" alternative for lake stages in Lake Gentry.

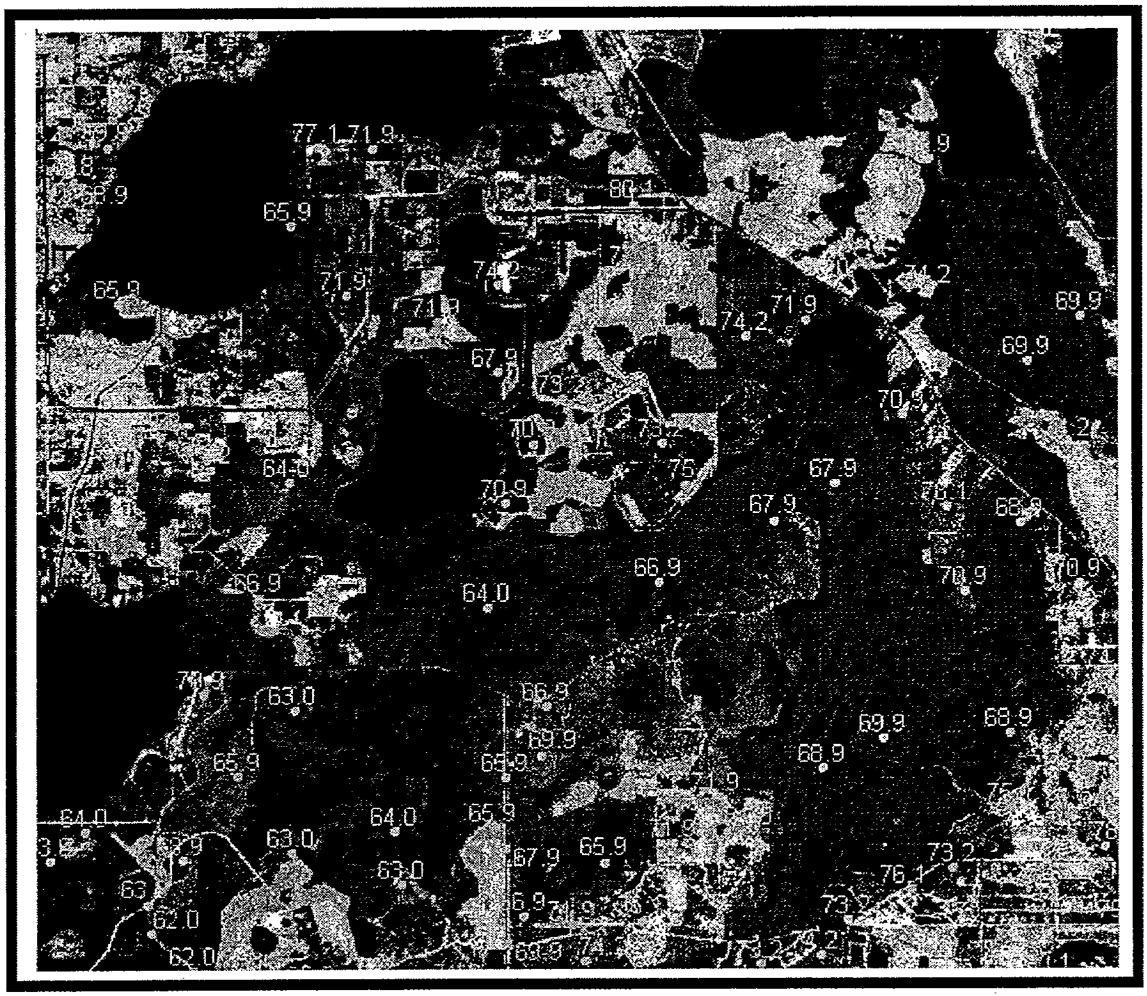
One of the model changes was to the boundary conditions. The boundary for the original model was based on surface water basin divides. In order to allay concerns that this boundary might lead to boundary effects in the groundwater at some areas of interest, the model has been expanded both to the east and west. Another model change was to the topography used in the model. Soft data, SPOT imagery and NWI wetland classifications were used in combination with the USGS point elevations to improve the representation of topography within the Big Bend Swamp.

An additional analysis was conducted to estimate the effect of placing a structure in the Blackwater Ditch. This had been identified as a potential way to address the potential impacts to the aquifer at Blackwater Farms identified by the modeling under certain scenarios.

The appendix contains the following:

- Graphics of model changes
- Monitoring well location map
- Graphs of lake stages used for scenario
- Graph of rainfall used for scenario
- Graphs showing predicted water levels in monitoring wells compared to actual levels
- Map showing area of impact
- Graphs showing predicted water levels in monitoring wells with and without drawdown
- Graphs showing predicted water levels in monitoring wells with and without drawdown with weir placed in Blackwater ditch


Model Boundary Modifications
Model Area
Active
Boundary
Original
Revised



77.1
71.9
80.1
65.9
65.9
71.9
74.2
71.9
74.2
71.9
69.9
67.9
69.9
73.2
70.9
64.0
67.9
70.9
67.9
68.9
66.9
64.0
66.9
70.9
70.9
63.0
66.9
69.9
69.9
68.9
65.9
68.9
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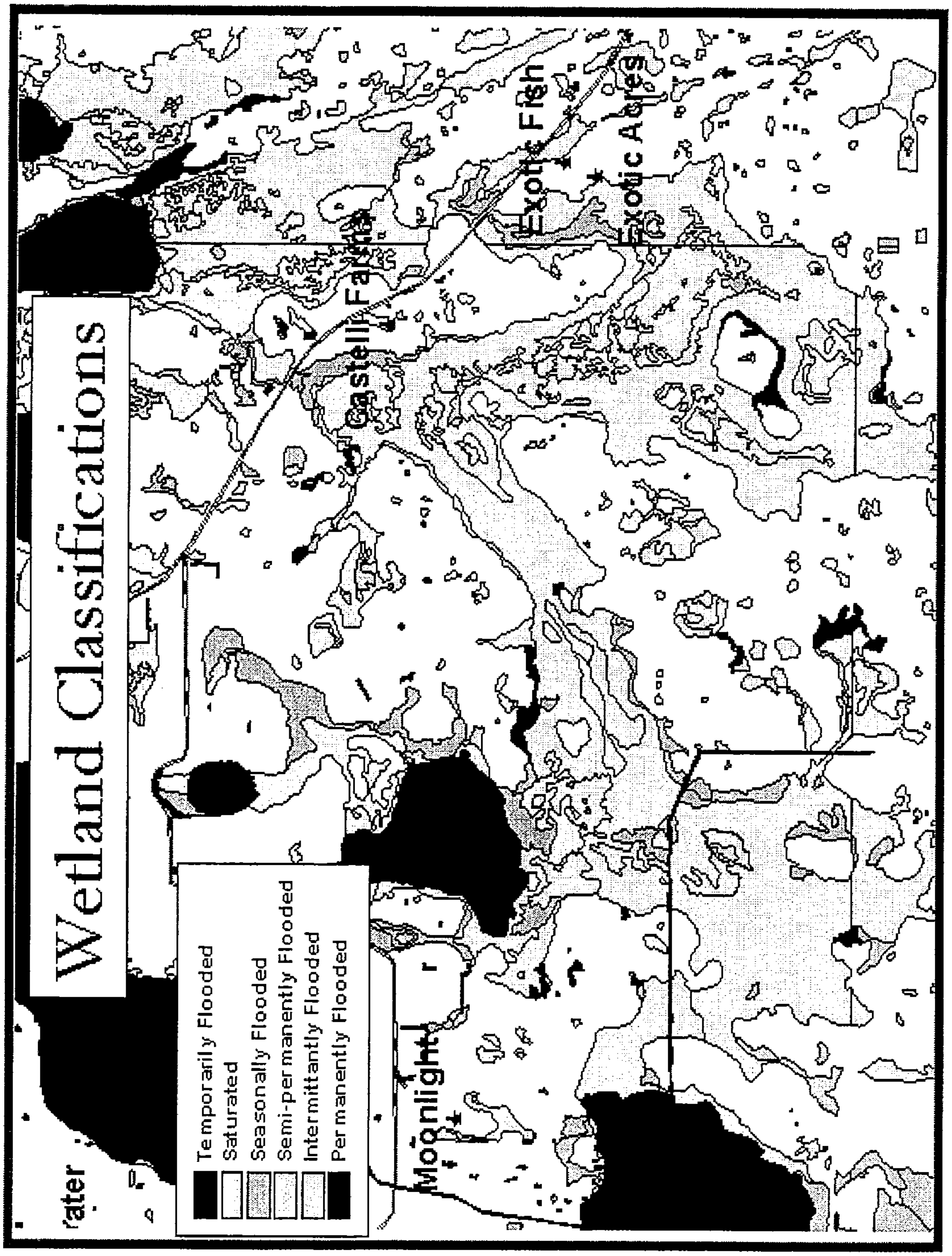
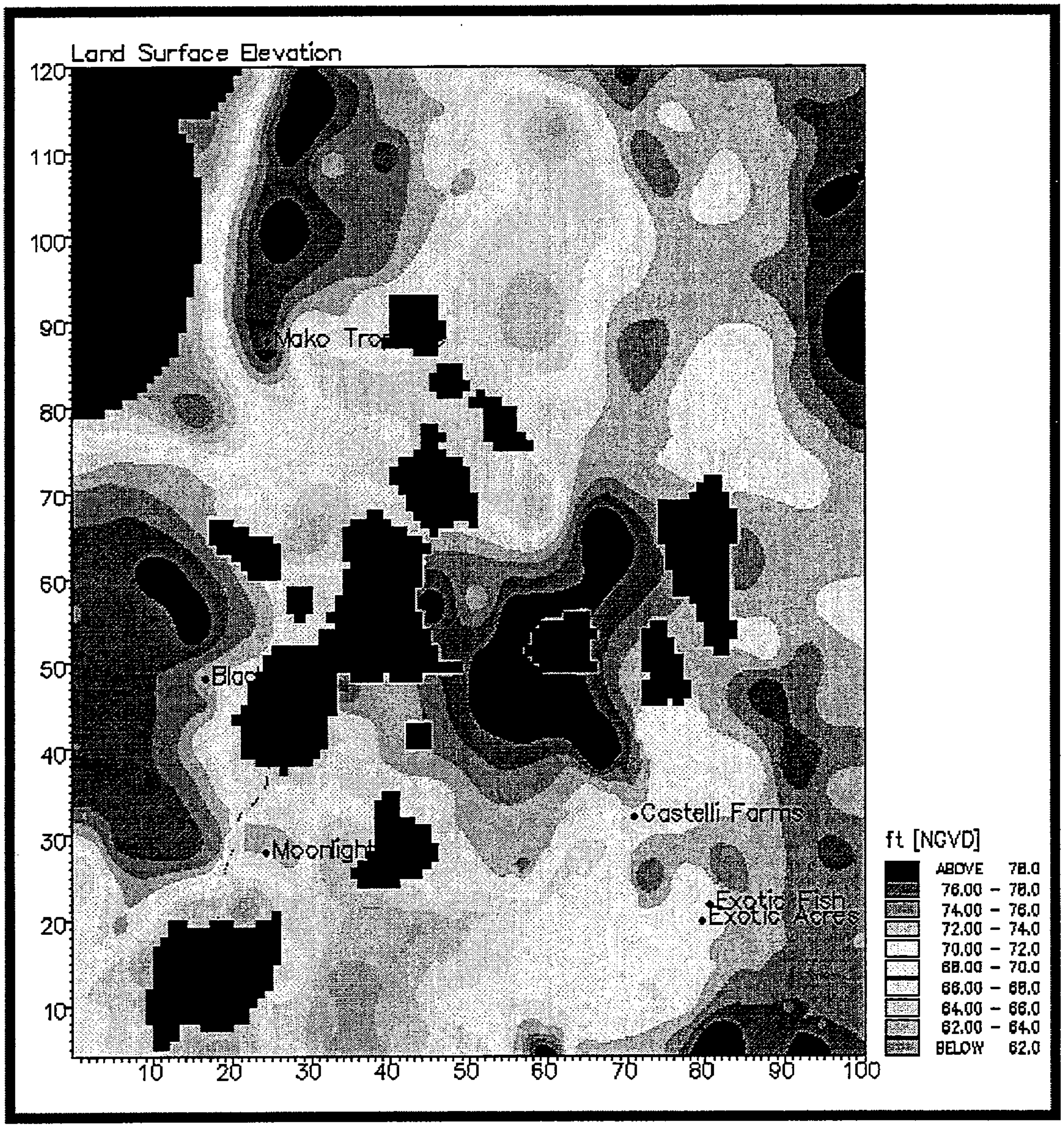
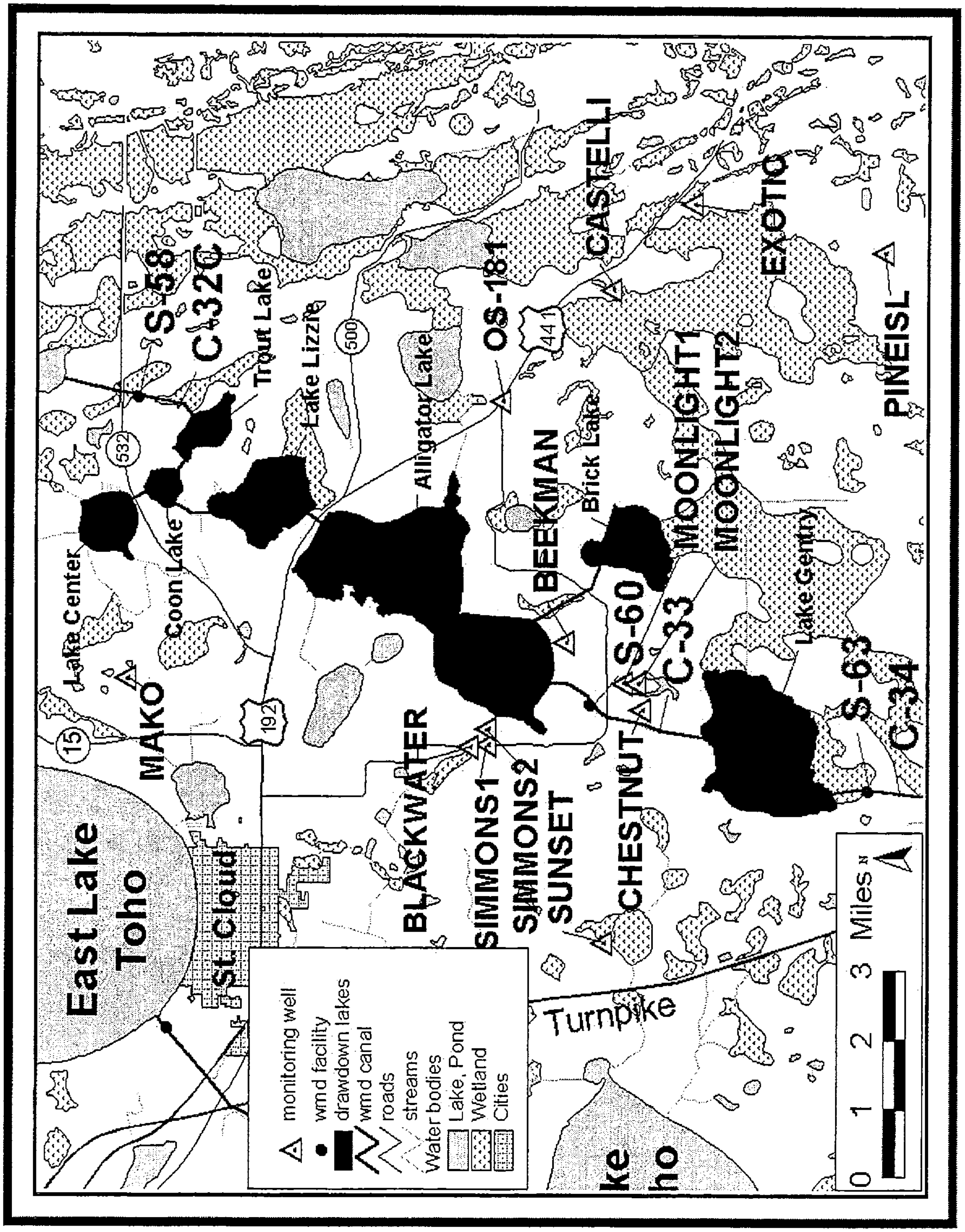
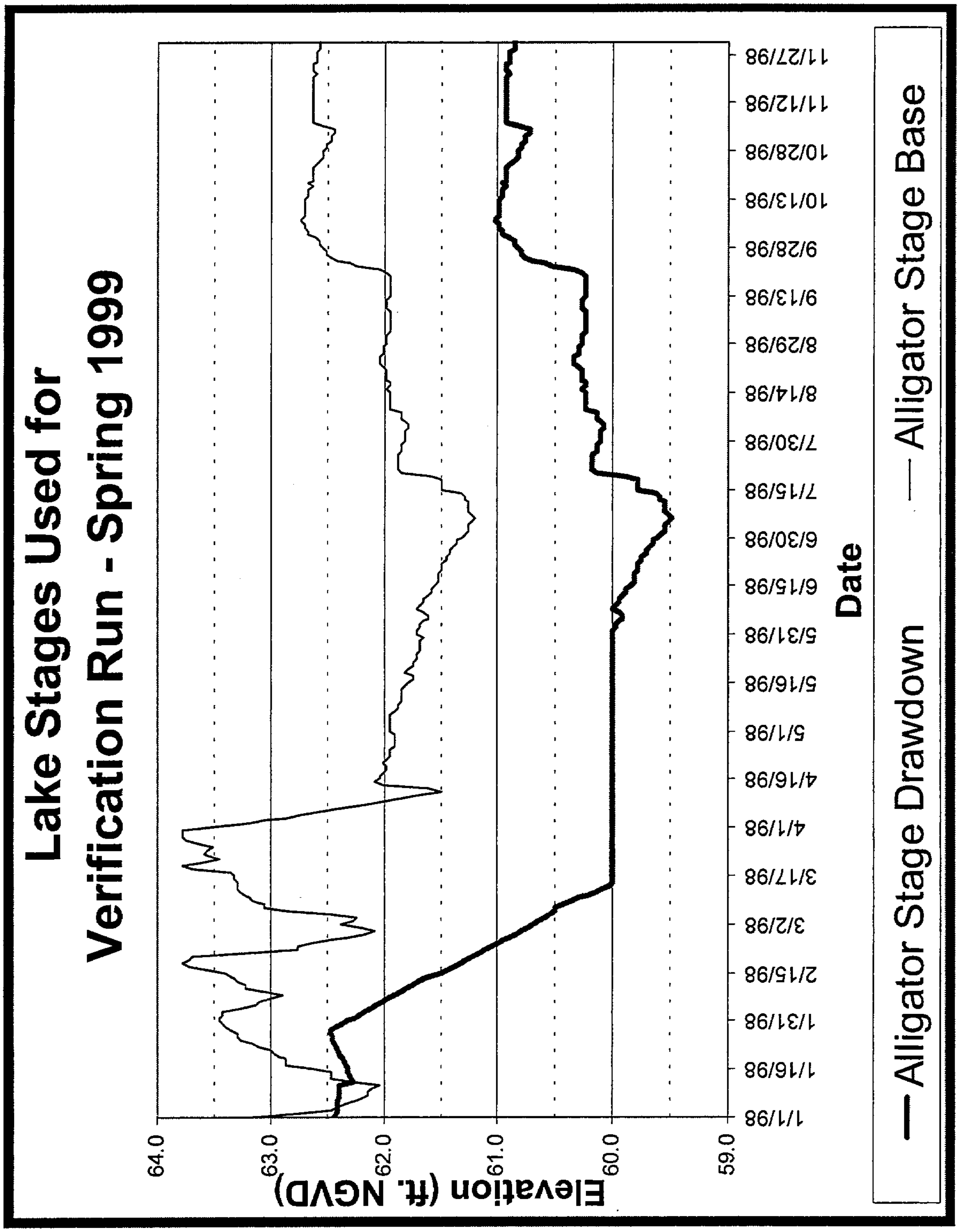
62.0
73.2
62.0


Wetland Classifications
Temporarily Flooded
Saturated
Seasonally Flooded
Semi-permanently Flooded
Intermittantly Flooded
Permanently Flooded
Castelli
Exotic Fish
Exotic Acres
Moonlight



Land Surface Elevation
120
110
100
90
80
70
60
50
40
30
20
10
10
20
30
40
50
60
70
80
90
100
Mako Tro
Blac
Moonligh
Castelli Farms
Exotic Fish
Exotic Acres
ft [NGVD]
ABOVE 78.0
76.00 - 78.0
74.00 - 76.0
72.00 - 74.0
70.00 - 72.0
68.00 - 70.0
66.00 - 68.0
64.00 - 66.0
62.00 - 64.0
BELOW 62.0


East Lake Toho
St. Cloud
ke
ho
MAKO
Lake Center
Coon Lake
S-58
C-32C
Trout Lake
Lake Lizzie
Alligator Lake
OS-181
CASTELLI
EXOTIC
BEEKMAN
Brick Lake
MOONLIGHT1
MOONLIGHT2
PINEISL
Lake Gentry
S-60
C-33
S-63
C-34
BLACKWATER
SIMMONS1
SIMMONS2
SUNSET
CHESTNUT
Turnpike
15
192
532
500
441
monitoring well
wmd facility
drawdown lakes
wmd canal
roads
streams
Water bodies
Lake, Pond
Wetland
Cities
0 1 2 3 Miles
N


Lake Stages Used for
Verification Run - Spring 1999
Elevation (ft. NGVD)
64.0
63.0
62.0
61.0
60.0
59.0
1/1/98
1/16/98
1/31/98
2/15/98
3/2/98
3/17/98
4/1/98
4/16/98
5/1/98
5/16/98
5/31/98
6/15/98
6/30/98
7/15/98
7/30/98
8/14/98
8/29/98
9/13/98
9/28/98
10/13/98
10/28/98
11/12/98
11/27/98
Date
Alligator Stage Drawdown
Alligator Stage Base