APPENDIX V

FINAL ENVIRONMENTAL IMPACT STATEMENT

ANALYSIS OF PROJECTED IMPACTS OF THE ALLIGATOR CHAIN DRAWDOWN PROJECT ON THE SURROUNDING WATER TABLE AQUIFER

Analysis of Projected Impacts Of the Alligator Chain Drawdown Project On the Surrounding Water Table Aquifer

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June 1999

Analysis of Projected Impacts of the Alligator Chain Drawdown Project on the Surrounding Water Table Aquifer

Update Notes

October 1998

The original July 1998 document was modified in the following ways:

- *Appendix E* was revised by reformatting the graphs from point data to lines in order to substantially reduce the file size of the electronic version this document.
- *Appendix G* was updated by including more recent print outs of the DHI website pages.
- *Appendix L* was added. This appendix incorporates the previously stand alone document *Alligator Lake Drawdown Study Model Documentation - August 26, 1998.*

June 1999

The document was modified in the following ways:

- *Appendix M* was added. This appendix contains the comments received from the outside peer review on the October 1998 version of the document.
- *Appendix N* was added. This appendix contains an explanation of changes to the model and the results of the model verification run completed in spring 1999. It also presents a new modeling scenario analysis under 1997-98 weather conditions.
- Numerous editorial changes were made throughout the document to address suggestions from the peer reviewers and others. Information about the spring 1999 verification efforts was included. The appendices were reordered. Graphics were modified to improve their readability.

Analysis of Projected Impacts of the Alligator Chain Drawdown Project on the Surrounding Water Table Aquifer

An extreme drawdown of the Alligator Chain of Lakes and Lake Gentry has been proposed. The project purpose is to reverse the decline of aquatic habitat associated with years of lake level stabilization. The project area is located southeast of St. Cloud in Osceola County, Florida. During the drawdown, bottom sediments will be exposed, simulating the historic cycle of flood and drought which maintained the lakes' ecological balance. Also associated with the drawdown will be the removal of organic material (muck) from the lake bottom. This habitat enhancement project was initiated by public concerns for protection of their resource. The prospect of cleaner shorelines, less nuisance vegetation and organic material, and an improved sport fishery has engendered a great deal of support for this project from homeowners and other area residents who utilize these lakes (see Appendix A for more detailed overview of the proposed drawdown project).

Background

The proposed plan would temporarily modify the lake regulation schedules for the Alligator Chain of Lakes and Lake Gentry, lowering the lake level to 60.0 feet, and 56.5 feet NGVD[1], respectively, between November and March. These levels would be maintained through May while in-lake restoration work takes place. The Alligator Chain's normal regulatory lake level schedule varies from 64.0 feet to 62.0 feet. Lake Gentry's normal regulatory lake level schedule varies from 61.5 feet to 59.5 feet.

Modification to the lake regulation schedules is a Federal action, requiring National Environmental Policy Act documentation. A Draft Environmental Assessment was prepared for this action, and distributed for public review and comment on August 4, 1997. Concerns were raised by the aquaculture community regarding possible impacts to their operations by the proposed drawdown. The concern is that declines in lake levels could influence ground water level in the immediate area, and adversely impact their operations. Farm locations are shown in Figure 1 on page 2.

1. Elevations refer to the National Geodetic Vertical Datum of 1929 or NGVD.

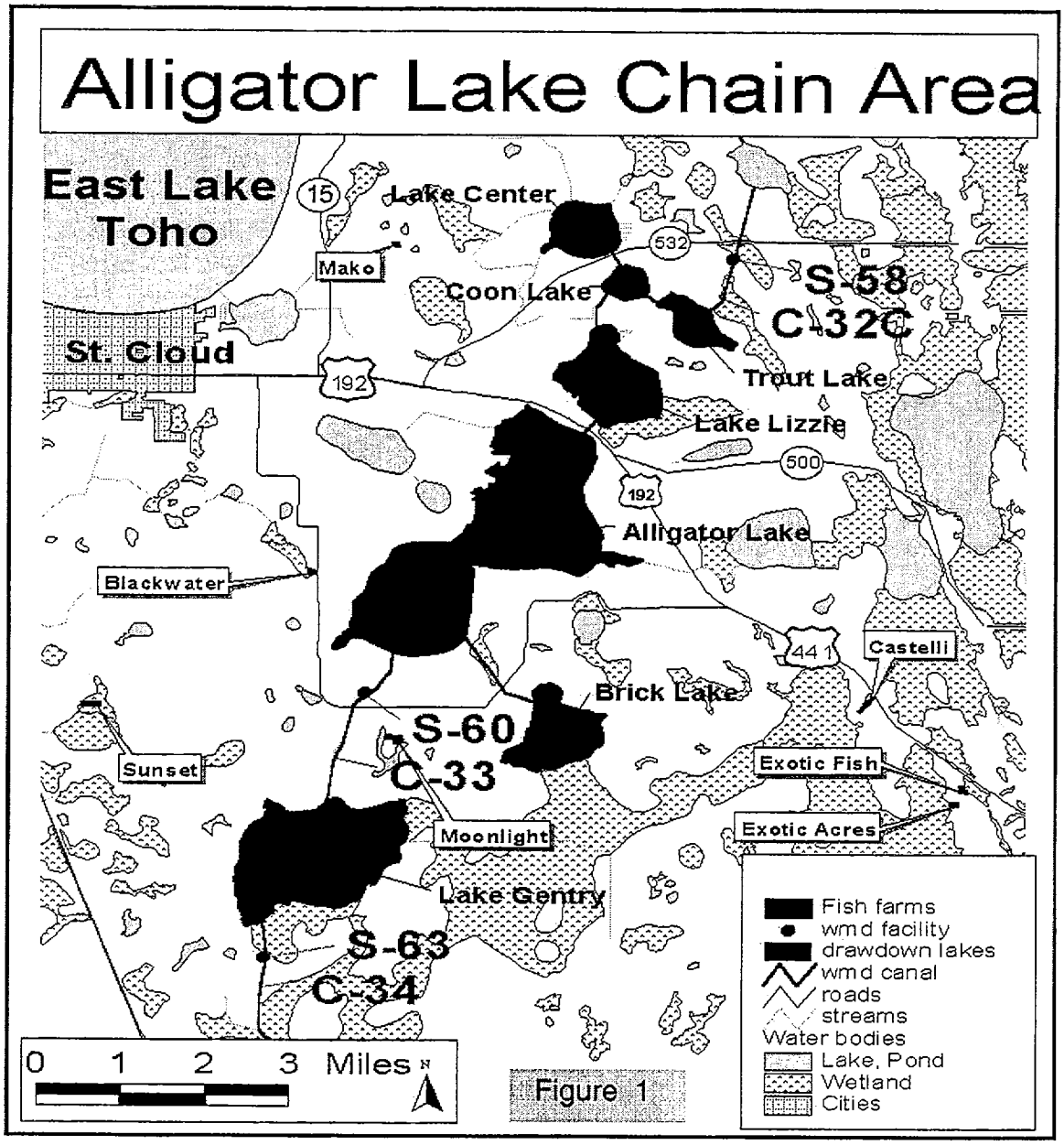

Alligator Lake Chain Area
East Lake Toho
St. Cloud
Mako
Lake Center
Coon Lake
S-58
C-32C
Trout Lake
Lake Lizzie
Alligator Lake
Blackwater
Brick Lake
S-60
C-33
Sunset
Moonlight
Lake Gentry
S-63
C-34
Castelli
Exotic Fish
Exotic Acres
15
532
192
500
441
0 1 2 3 Miles
N
Fish farms
wmd facility
drawdown lakes
wmd canal
roads
streams
Water bodies
Lake, Pond
Wetland
Cities

Figure 1

The ground water system in the project area is complicated. There are two major ground water systems (surficial and Floridan) and one Intermediate Confining Unit in the area. The Surficial Aquifer System consists of the water table aquifer and is located at the land surface, which ranges in thickness from 20 feet up to 270 feet. Hard pan layers are present in the Surficial Aquifer System at certain locations. Below the Surficial Aquifer System is the Intermediate Confining Unit. The Intermediate Confining Unit consists mainly of silts and clays of the Hawthorn Group and can be one foot to 370 feet thick. Underlying the Intermediate Confining Unit is the Floridan Aquifer System, which ranges in thickness of 100 feet to 2,100 feet. The Surficial Aquifer System is of primary concern in this issue.

Over the long term, the surficial aquifer system tends to be at equilibrium. 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. Outflow consists primarily of evapotranspiration, downward leakage to the Floridan aquifer system, and by water use. On a short term basis, inflow 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.

The fish farms consist of unlined ponds dug into the ground, generally five to six feet deep (pond sizes vary). They intersect the surficial aquifer under normal to wet conditions. Generally, the levels in the ponds fluctuate with water table elevation changes. Some ponds sit above a hardpan layer that somewhat isolates them from the regional aquifer. Some fish farms have water supply wells and pumps to help maintain water levels in their ponds.

The South Florida Water Management District conducted analyses of the potential impacts on three occasions. A preliminary analysis was performed in September 1997. A more detailed analysis was conducted in the spring 1998. A follow-up analysis was conducted in the spring 1999. The following sections report the results of these analyses.

Preliminary Analysis

The concerns of the aquaculture community were investigated and a preliminary analysis of the potential impact was prepared in September 1997[2]. This section contains a summary of the preliminary analysis (see Appendix B for the complete preliminary analysis).

The South Florida Water Management District operates the water management system in the Kissimmee Chain of Lakes and maintains

desirable water levels in the lake system except during drought periods. The water level data for the preliminary analysis was limited. The influence of a surface water body on the surrounding water table and the potential impact of lake level drawdown on the fish ponds depends on the interaction of many factors such as soil conditions (textures, structures permeability, etc.), lake operations for flood control, rainfall, water withdrawals, and evapotranspiration processes and distances to the regulated lakes.

Preliminary Well Data Analysis

The preliminary analysis indicated that the drawdown of Alligator Lake will not likely have direct impact on the fish ponds in Castelli Farms. The water table readings at Castelli Farms consistently ranged between water levels in Alligator Lake and at OS-181 Well (which is located between Alligator Lake and Castelli Farms). In addition, there was a poor correlation between Alligator Lake stage level and the water table readings at Castelli Farms.

The preliminary analysis indicated that it would be difficult to maintain a water depth of five to six feet in fish ponds during drought conditions similar to those experienced in 1970s and 1980s due to significant rainfall deficit and lower regional water table levels. The water table at Castelli Farms fluctuates approximately two feet within a month but fluctuates much more from month to month and year to year. For example, the water table fluctuated over five feet during 1974. The water table dropped to 71.2 feet NGVD during 1981.

Most of the fish farms in the project area did not exist prior to 1985. The water tables have been relatively higher since 1986 as compared to 1970 through 1982. The only fish farm known to have existed and experienced the 1980-81 drought is Blackwater Fishery. It has been reported that, at that time, fish ponds in Blackwater Fishery had virtually no water. However, the fish farmer managed to keep enough water in some ponds to save some stock. The rainfall during 1981 in the area of the Kissimmee Chain of Lakes was approximately 70 percent of average annual rainfall. In some months, the monthly rainfall during 1980-81 was less than 10 percent of normal.

2. The preliminary analysis was based on limited data and the conclusions of this analysis were tentative. The subsequent analysis and modeling was done to address uncertainties identified. The preliminary analysis is presented to provide perspective to the need and basis for the subsequent detailed analysis. The reader is cautioned to the tentative nature of the conclusions.

Preliminary Analysis Conclusions

The following conclusions were reached in the September 1997 preliminary analysis:

- Based on the wide range of water table fluctuations (5 to 6 feet) at the OS-181 Well, fish farm ponds in the project area, with five to six foot depths, are at risk of not being able to maintain adequate water levels in them under natural conditions. This condition exists without any artificial drawdown of Alligator Lake.
- The proposed Alligator Chain of Lakes drawdown may impact water levels in fish ponds at Blackwater Fishery and Moonlight Fisheries, which are near Alligator Lake. However, negative impacts could also be caused by rainfall deficit and water use in the area.
- Influence on the water table aquifer by the drawdown of Alligator Lake is not projected to extend beyond the OS-181 Well site. The available data indicate that the proposed lake drawdown will not have a measurable negative impact to the water levels in fish farms beyond OS-181, such as Castelli Farms, Sunset Tropicals, Mako Tropicals, Exotic Fish, and Exotic Acres because their locations are beyond the cone of influence.
- The decline of the water table aquifer in the project area depends on a number of factors, including seepage into lakes, streams, and canals; evapotranspiration; water usage; and downward leakage to the Floridan Aquifer System. Rainfall is the primarily recharge to the Surficial Aquifer System, and ground water inflows from outside the project area are minor.
- Additional water table and rainfall data would help better define the ground water table response to local rainfall under different soil types, and the water table decline in relation to lake level drop.

Spring 1998 Analysis

Based on the results and recommendations of the September 1997 Preliminary Analysis, it was determined that further investigation was warranted. The investigation of possible impacts to fish farm ponds involved frequent meetings, site visits, analysis of existing surface and groundwater data (both short and long term), installation of groundwater monitoring wells at the fish farms and other locations, and groundwater modeling.

The preliminary analysis concluded that additional data analyzed with hydrologic computer models would provide better answers to the concerns raised. Groundwater monitoring wells were installed at six fish farms, and four additional locations between the farms and the lakes to gather

additional data on water table elevations (see Appendix C for discussion of well construction). Rain gauge monitoring sites were established to gather additional rainfall data. From November 1997 to February 1998, groundwater level observations were collected manually on an approximately bi-weekly basis. Starting in mid-February 1998, continuous water-level recordings became available due to automatic recording units being installed in each well (see Appendix D for discussion of monitoring equipment). Long-term monitoring well OS-181 was also used since it has long term daily water level readings. Distances from the wells to selected water bodies in the area are shown in Table 1 on page 6. A map showing the

Table 1: Distances to Nearby Water Bodies

Well	Water Body	Distance (miles)
Beekman	Alligator	0.2
Moonlight 1	Alligator	1.0
	C-33 Canal	0.5
	Gentry	1.2
Moonlight 2	Alligator	1.2
	C-33 Canal	0.5
	Gentry	1.0
Chestnut	Alligator	1.4
	C-33 Canal	0.2
	Gentry	0.9
Blackwater	Alligator	0.6
Simmons 1	Alligator	0.4
Simmons 2	Alligator	0.2
Mako	Center	1.7
	East Lake Toho	1.6
	Runnymede	1.5

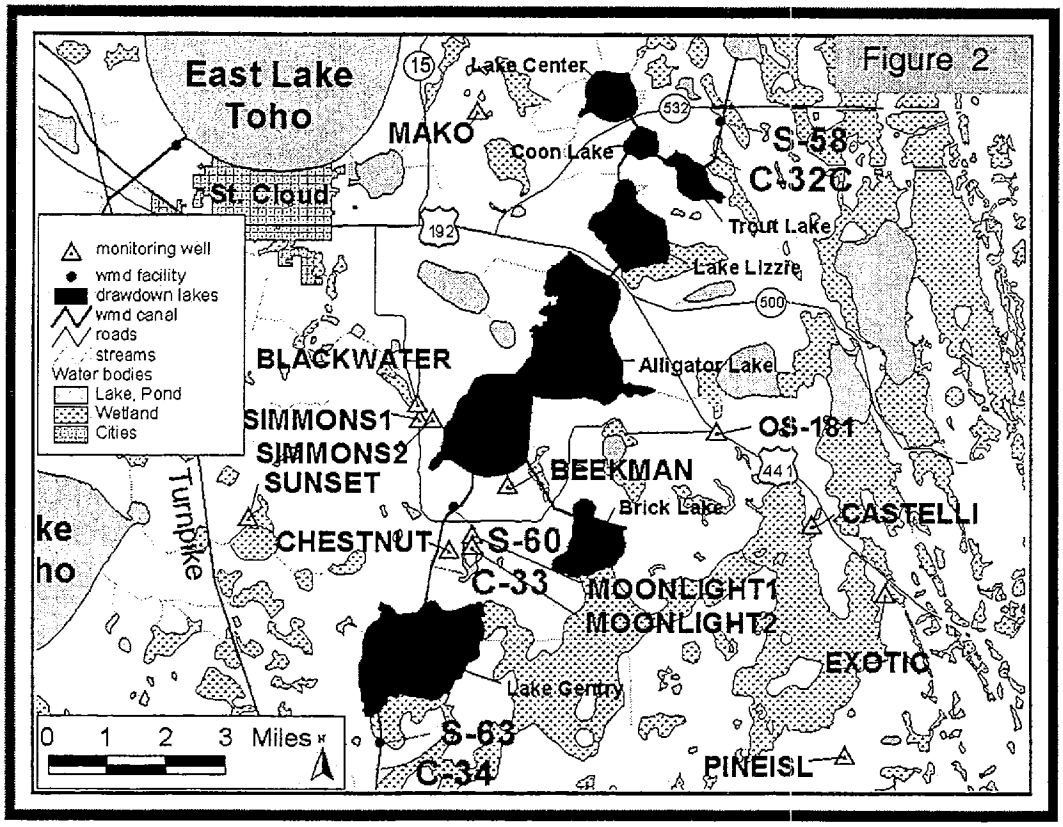
Table 1: Distances to Nearby Water Bodies

Well	Water Body	Distance (miles)
Sunset	Toho	1.7
	Alligator	3.1
	Gentry	2.6
Castelli	Alligator	3.5
	Brick	3.1
	Cat	0.2
	Big Bend Swamp	adjacent
	Gentry	5.7
Exotic	Alligator	5.2
	Brick	4.4
	Big Bend Swamp	adjacent
	Gentry	6.8
OS-181	Alligator	1.3
	Brick	2.2

relationship of the monitoring well and the lakes is included (see Figure 2 on page 8). Graphs of the data collected by the monitoring equipment is included in Appendix E. Rainfall information is included in Appendix F.

Computer Model

A computer model was constructed encompassing the area around the Alligator Lake Chain and Lake Gentry (including Mako, Blackwater, Moonlight, Castelli, Exotic, and Exotic Acres fish farms). The model was constructed using the MIKE SHE code. MIKE SHE is a generalized physically based modeling system and may be applied to a variety of hydrological studies and to a large range of spatial and temporal modeling scales. MIKE SHE encompasses a number of components describing the



flow within different parts of the hydrological cycle. They can be combined depending on the scope of the study. In this application, the surficial aquifer system was modeled as a single layer with one-dimensional flow (downward) in the unsaturated zone. All lakes (Alligator Chain & Gentry) were input into the model as head boundaries. Lake level stage was varied daily according to measured stage readings for lakes Alligator and Gentry (see Appendix G for overview of MIKESHE model.)

Soil-water retention curves necessary to perform the unsaturated zone budget were based on information provided in the *Osceola County Soil Survey* (generalized soil map). Hydraulic conductivities were refined during calibration based on observed water levels from November 1997 to June 1998, a period which ranged from abnormally wet to abnormally dry (see Appendix H for a more detailed explanation of the model setup).

The results of the calibration are shown via comparison of observed and projected (modeled) water levels (see Appendix I). Review of hydrographs shows the model reasonably replicates the pattern of observed water table fluctuations. The mean difference between observed and projected water-levels was generally within half a foot at all locations. Based on the

hydrographic results, the model was deemed sufficiently reliable for use in predictive simulations.

Scenario Simulations

To test the potential impacts of the proposed drawdown, three predictive simulations were run using the computer model. Results of each simulation run are shown via comparison of projected water levels for each well site without the lake drawdown (base condition) and with the drawdown (drawdown condition). Hydrographs are presented for each modeling scenario. The difference between base and drawdown lines at any point in time can be viewed as the change due to the proposed drawdown.

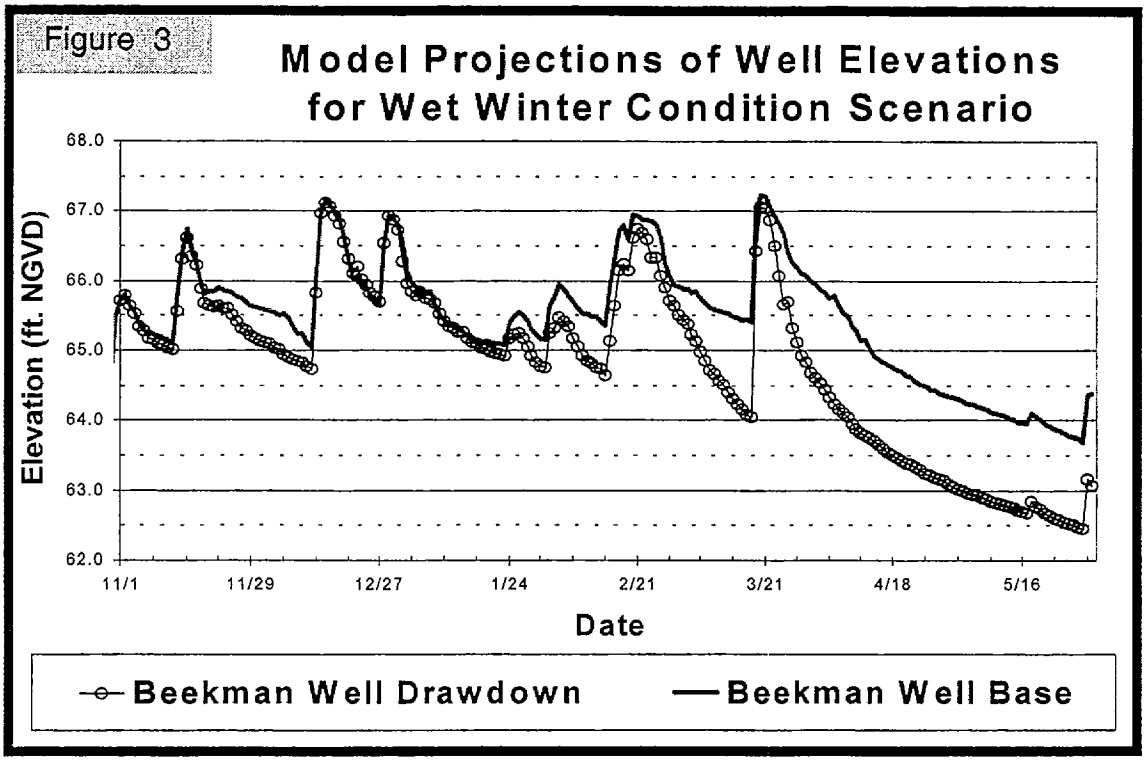
The first scenario (Wet Winter Condition) uses the rainfall pattern experienced in 1997-98. The second scenario (Typical Condition) uses a rainfall pattern based on rainfall experienced in the area in 1988-89. Both of these scenarios use a time period from August to the following June. The third scenario (Severe Drought Condition) uses the rainfall pattern experienced in the area during the 1980-81 drought. This scenario assumes the drawdown occurs in the first year of the two year drought. This scenario uses a longer time period from January to August of the following year.

Hydrographs of each scenario are shown in the Appendices. Simulated water levels with and without the test drawdown, near the end of the simulation period, were subtracted from each other to depict the cumulative effect of the scenario drawdown over the simulation period. Maps for each scenario show the extent of projected changes to the water table due to the proposed drawdown.

Wet Winter Condition Scenario Results

The hydrographs in Appendix J show the projected well stage, with and without a drawdown for the Wet Winter Condition Scenario. The difference between the two lines is the projected change due to the drawdown. Results showed no difference in water table elevation at any fish farm for the Wet Winter Condition Scenario. The hydrograph for the Beekman Well (Figure 3 on page 10) shows that there is a change projected at that site. The Beekman Well is the closest well to Alligator Lake (0.2 miles) and will be the most influenced. The projected changes in the water table are shown in Figure 4 on page 11. The map illustrates that the projected zone of influence does not extend out to any of the fish farms. This scenario assumes Brick Lake would

Figure 3



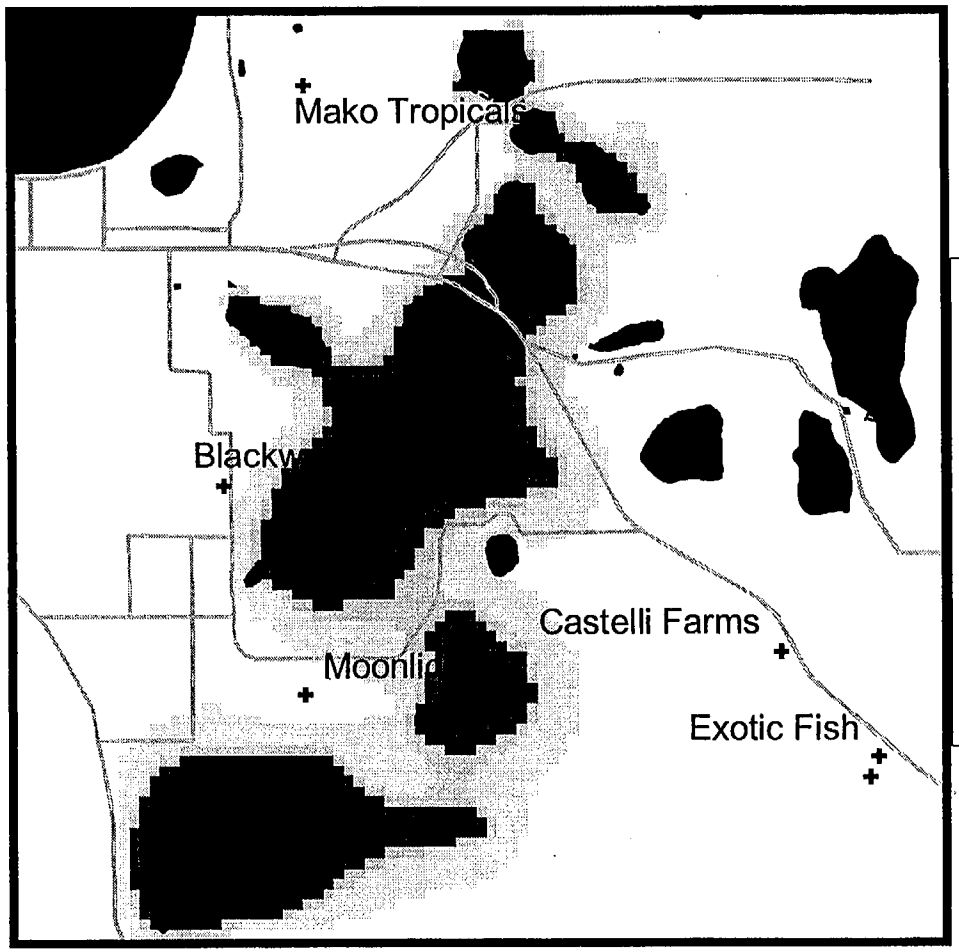
be drawn down with Alligator Lake. If Brick Lake is held at a higher stage, the zone of influence around Brick would be smaller.

These model projections also confirm that there were no changes at any of the fish farms due to lowering lake stages in Alligator Lake and Lake Gentry in the spring of 1998. The hydrographs of well stages help illustrate that the groundwater levels respond more to rainfall than lake stages (see Figure 5 on page 12). The hydrograph of stages for the wells between Alligator Lake and Lake Gentry shows the well stage elevations for the Beekman, Moonlight 1, Moonlight 2, and Chestnut wells. It also shows the stage for lakes Alligator and Gentry and rainfall from a nearby rainfall monitoring site.

Typical Condition Scenario Results

The hydrographs in Appendix K show the projected well stage, with and without a drawdown for the Typical Condition Scenario. The difference between the two lines is the projected change in the aquifer level due to the drawdown. Results show a difference in water table elevation at two fish farms for the Typical Condition Scenario. No change is projected for any

Projected Impact of Lake Drawdown on the Water Table Aquifer



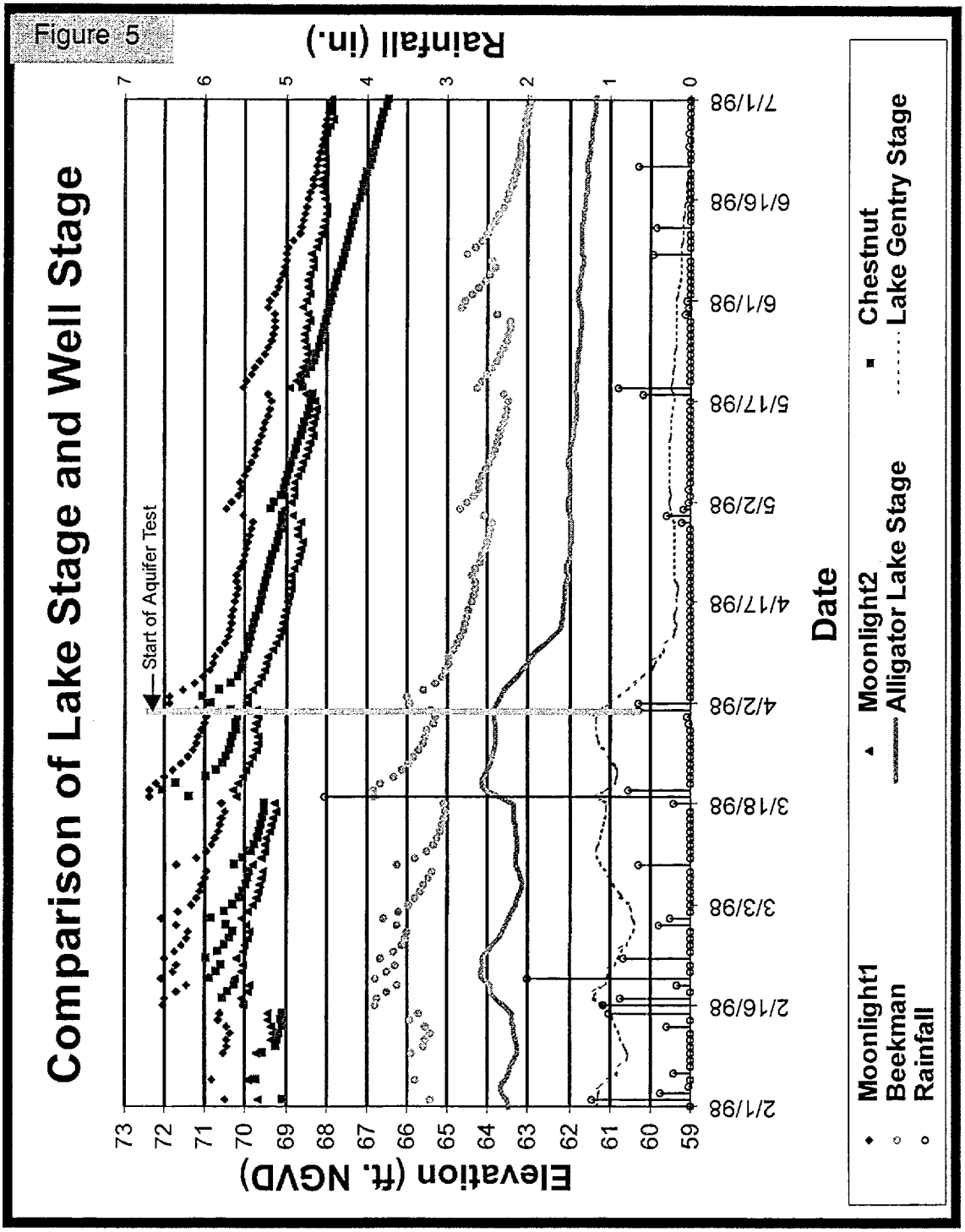
Wet Winter Condition Scenario

Drawdown [ft]

- < 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 3.00

Figure 4

Figure 5

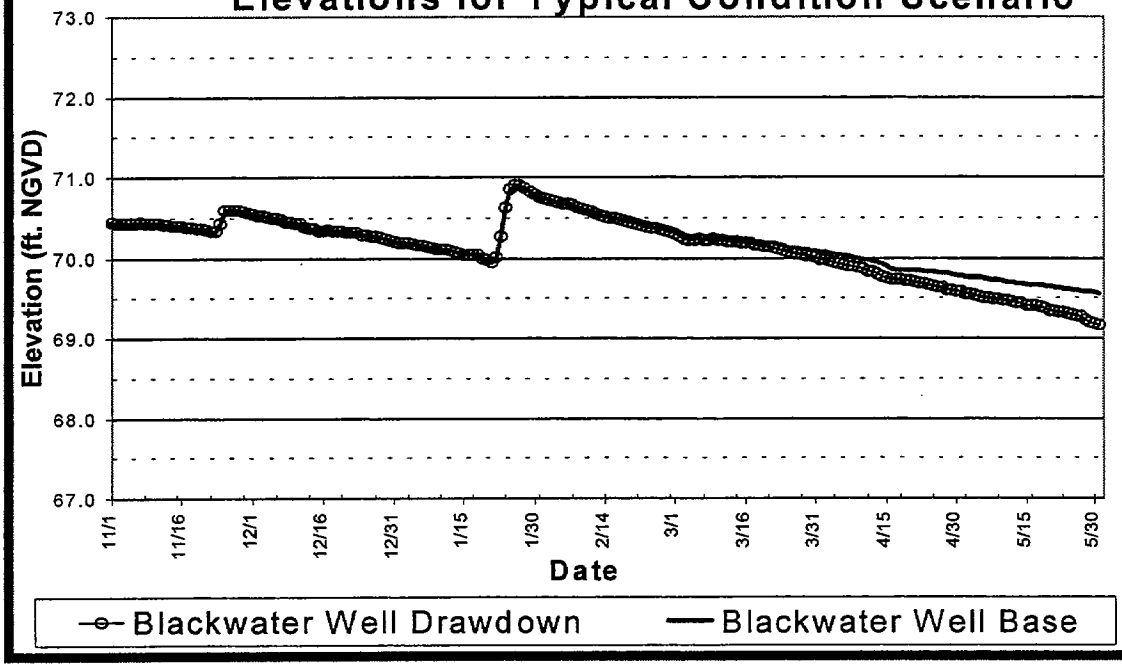

Comparison of Lake Stage and Well Stage
Elevation (ft. NGVD)
Rainfall (in.)
Start of Aquifer Test
Date
2/1/98
2/16/98
3/3/98
3/18/98
4/2/98
4/17/98
5/2/98
5/17/98
6/1/98
6/16/98
7/1/98
Moonlight1
Beekman
Rainfall
Moonlight2
Alligator Lake Stage
Chestnut
Lake Gentry Stage

other fish farm. Hydrographs for Blackwater and Moonlight wells show the extent of projected changes during the simulation period. The map illustrates the extent of the zone of influence (see Figure 6 on page 14). This scenario assumes Brick Lake would be drawn down with Alligator Lake. If Brick Lake is held at a higher stage, the zone of influence around Brick would be smaller.

The hydrograph for the Blackwater Well (Figure 7 on page 13) shows that a change to the aquifer level at this site is projected. The change at Blackwater under typical conditions is projected to be less than 0.4 feet.

Figure 7

Model Projections of Groundwater Elevations for Typical Condition Scenario



The hydrograph for the Moonlight 2 Well (Figure 8 on page 15) shows that there is a slight projected change at this site. The change at Moonlight under typical conditions is projected to be less than 0.25 feet.

A change to the aquifer level is projected at Moonlight Fisheries. Actual change to fish pond water levels at the farm may be less, depending on the extent of isolation of the ponds from the water table. The hard pan soils below most of the ponds helps isolate the ponds from the underlying aquifer. Detailed information on the extent, thickness, and integrity of the hard pan is not available. However, several pieces of information indicate changes to the pond water levels will be less than changes to aquifer levels. From spring

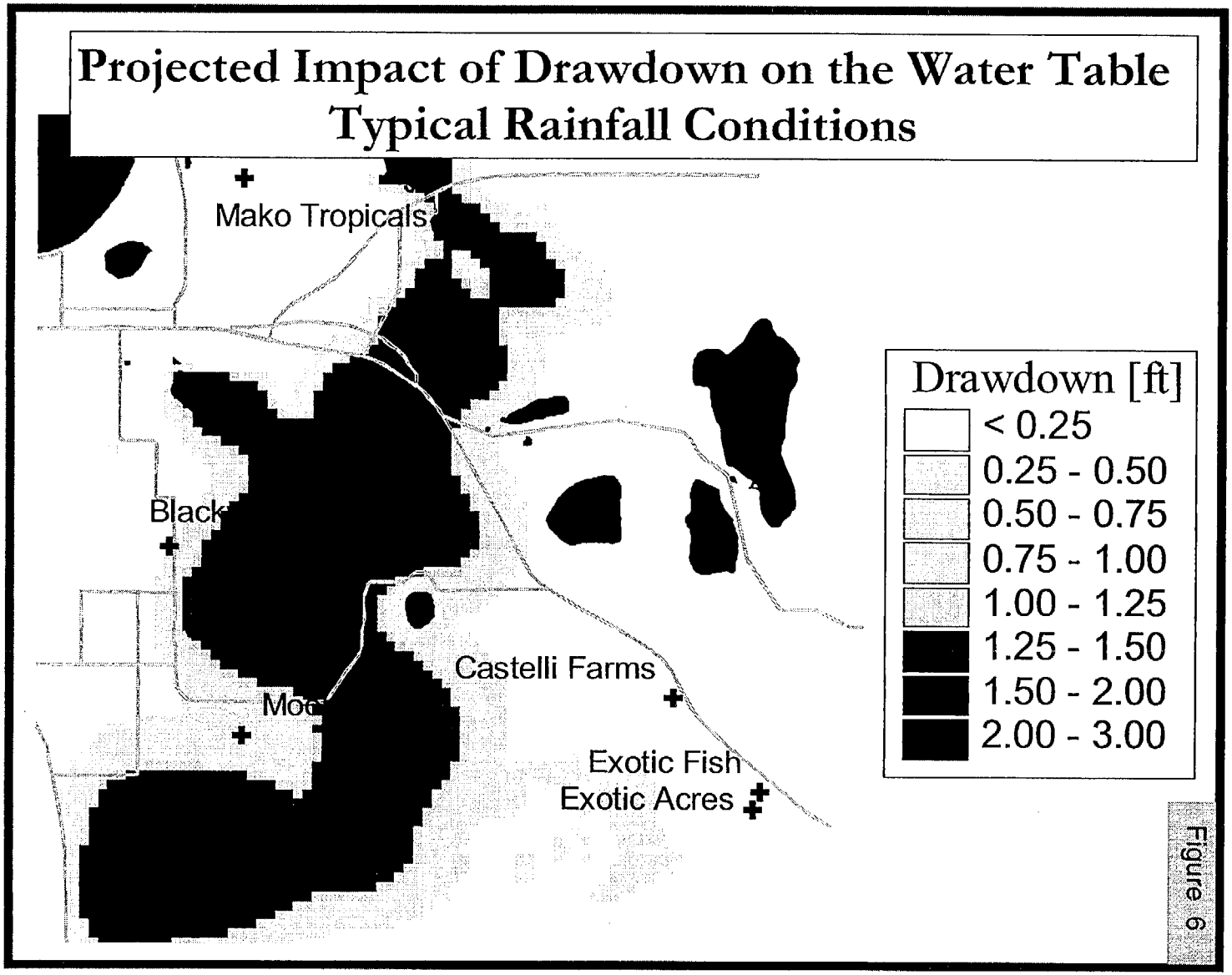
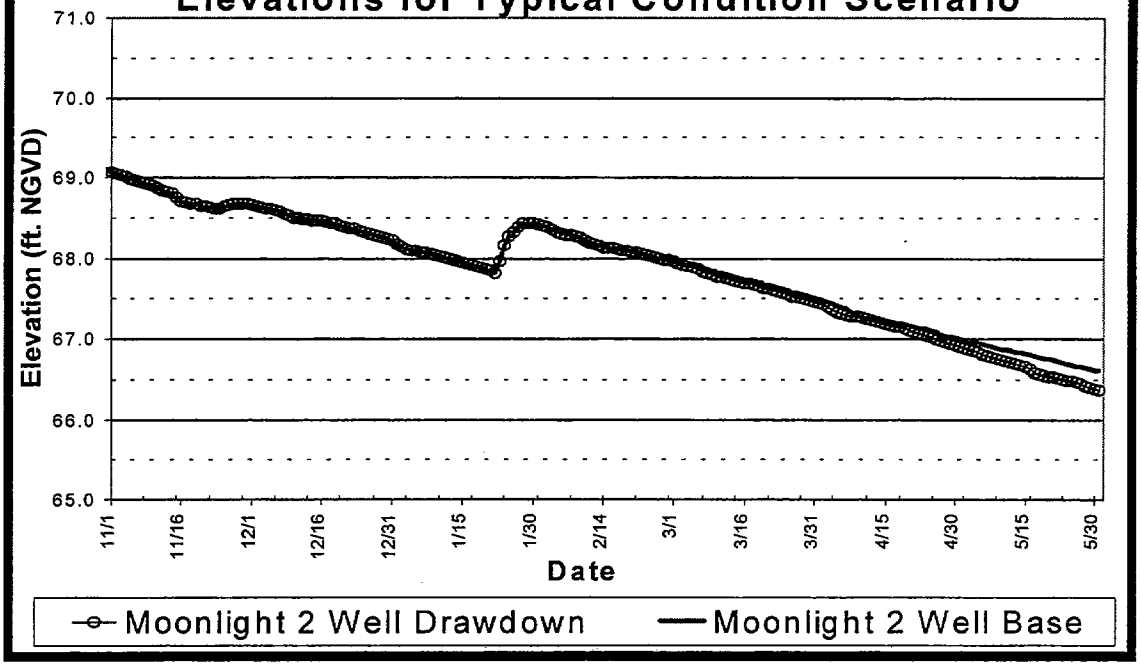

Projected Impact of Drawdown on the Water Table
Typical Rainfall Conditions
Mako Tropicals
Black
Castelli Farms
Exotic Fish
Exotic Acres
Drawdown [ft]
< 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 1.00
1.00 - 1.25
1.25 - 1.50
1.50 - 2.00
2.00 - 3.00

Figure 6

Figure 8 **Model Projections of Groundwater Elevations for Typical Condition Scenario**

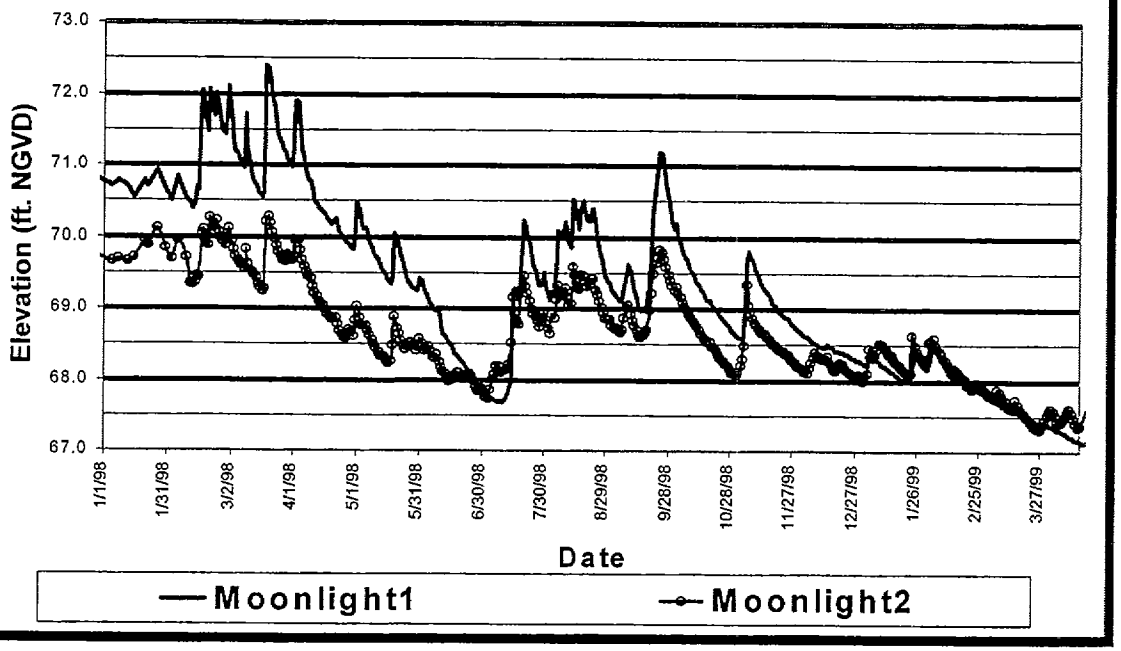


of 1998 to spring of 1999, well stage elevations at the Moonlight 1 well varied over five feet (about 72 feet to 67 feet). Well stage elevations at the Moonlight 2 well (closest to the ponds) varied only three feet (70.3 to 67.3 feet). Figure 9 on page 16 compares the water levels from the two wells. Survey information from the *Master Stormwater Management Plan for St. Cloud Manor Pilot Drainage Program* indicates that pond bottom elevations at Moonlight Fisheries range from about 68 to 69 feet. Ponds at Moonlight Fisheries should have been dry or almost dry during spring 1998 and winter/spring 1999 if they were not isolated from the underlying aquifer. Adding supplemental water to the ponds can offset some water level drops in ponds to some extent.

The aquifer levels at Moonlight 2 Well for the Typical Condition Scenario are projected to fall below 67 feet during the spring without a drawdown. This level is below pond bottom elevations. This is an elevation that is projected to be experienced at Moonlight Fisheries routinely. The fish farm has been in operation several years and has undoubtedly experienced conditions such as these.

An alternative to the Typical Condition Scenario was prepared and analyzed. This alternative would only lower Lake Gentry to 59.0 feet in order to allow

Figure 9



flows out of Alligator Lake, but would not lower Gentry to its drawdown level of 56.5 feet (see Figure 10 on page 17). Under this scenario, the Lake Gentry drawdown and habitat enhancement work would occur in a subsequent year, separately from the Alligator Lake work. Under these conditions the hydraulic head differences between the aquifer at Moonlight Fisheries and the C-33 Canal and Lake Gentry would be greatly reduced. This reduced head difference would lower the rate of flow in the aquifer, lessening the changes in the aquifer levels at Moonlight Fisheries.

The modified hydrograph for the Moonlight Well (Figure 11 on page 17) shows the projected change in aquifer levels due to the drawdown at this site would be reduced. The changes at Moonlight under typical conditions, while not doing a Lake Gentry drawdown, is projected to be about 0.1 feet.

Severe Drought Condition Scenario Results

The hydrographs in Appendix L show the projected well stage, with and without a drawdown for the Severe Drought Condition Scenario. The difference between the two lines is the projected change due to the drawdown. Results show a difference in water table elevation at two fish

Figure 10

Lake Stages for Typical Condition Scenario - Hold Gentry Alternative

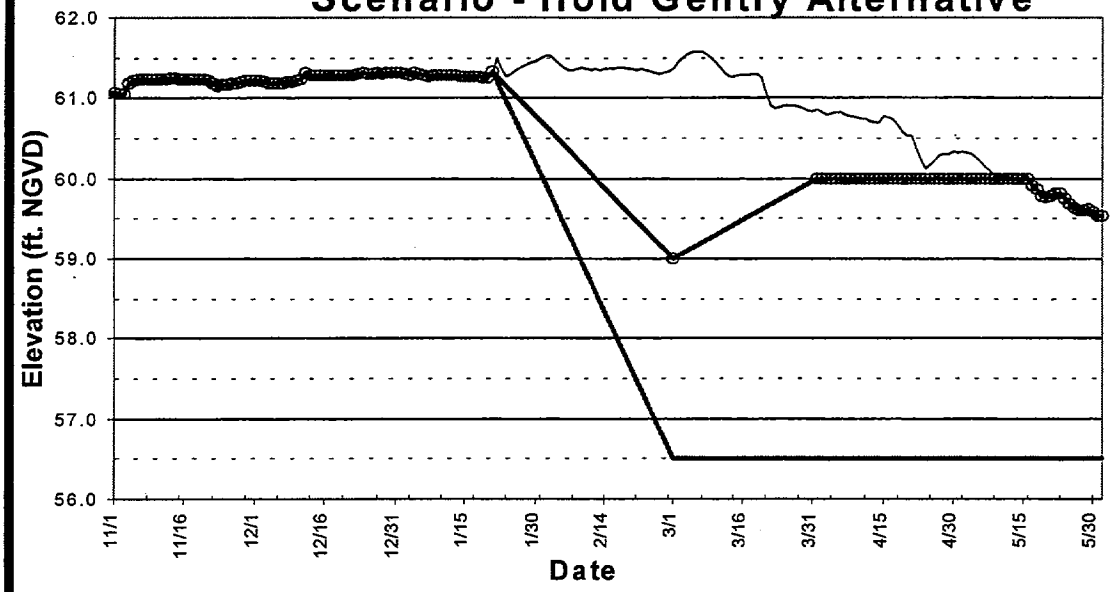
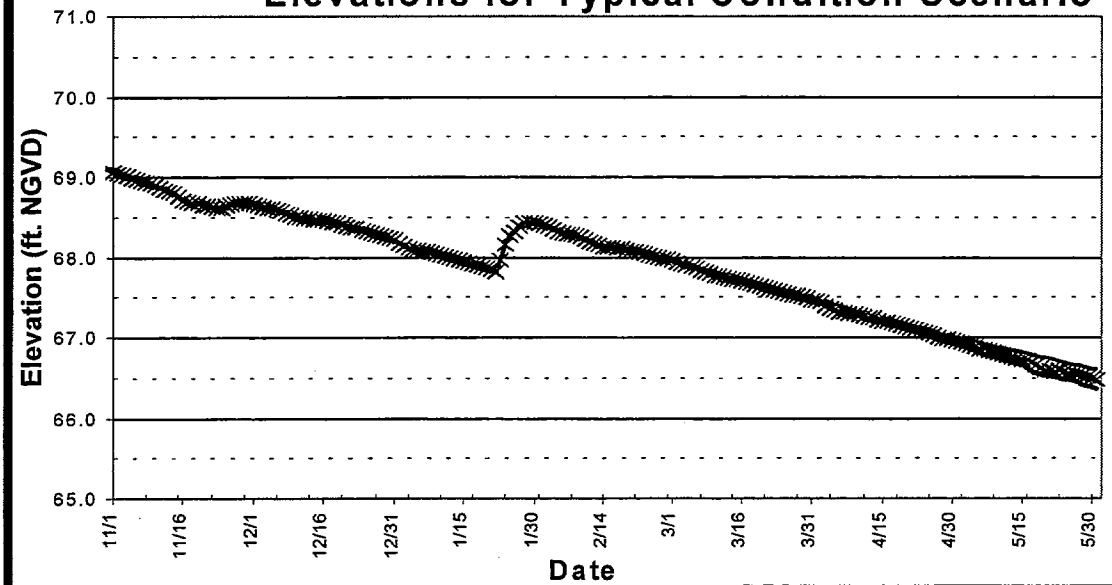


Figure 11

Model Projections of Groundwater Elevations for Typical Condition Scenario

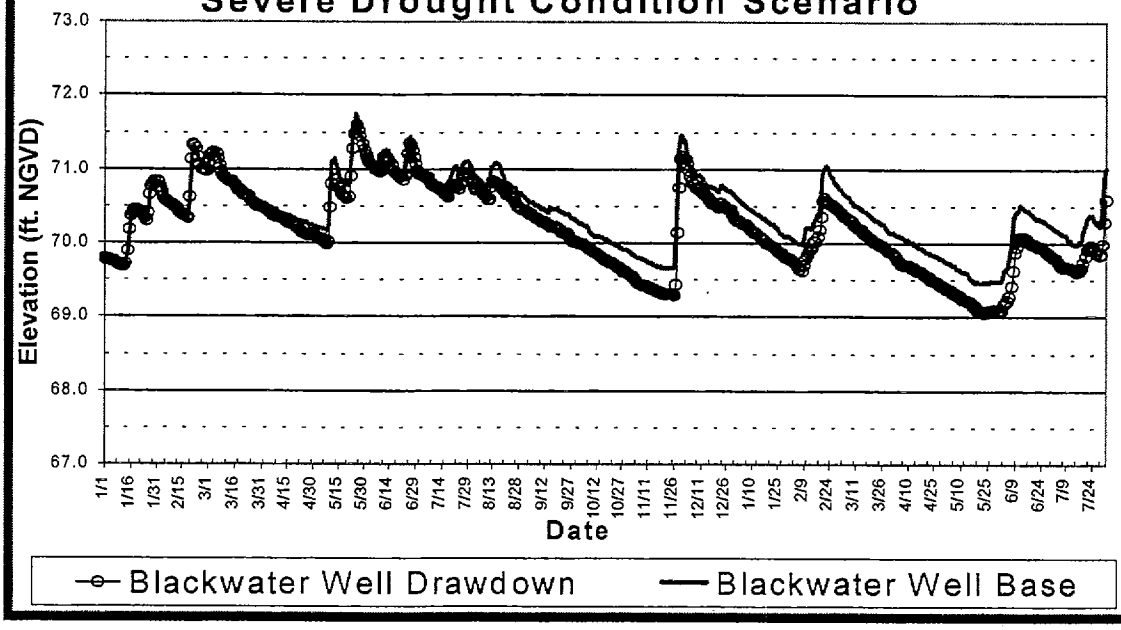


farms for the Severe Drought Condition Scenario. The map for the Severe Drought Condition (Figure 12 on page 19) shows projected changes due to the drawdown extending to Blackwater Fishery and Moonlight Fisheries farms. The map illustrates that the zone of influence is not projected to extend out to any other fish farm under these conditions. This scenario assumes Brick Lake would be drawn down with Alligator Lake. If Brick Lake is held at a higher stage, the zone of influence around Brick would be smaller.

The hydrograph for Blackwater Well (Figure 13 on page 18) shows the extent of projected changes to aquifer levels during the simulation period. The drawdown is projected to lower the water table an average of 0.1 feet during the first year of the drought and by an average of 0.4 feet during the second year. Maximum change during the drought is projected to be 0.7 feet.

Figure 13

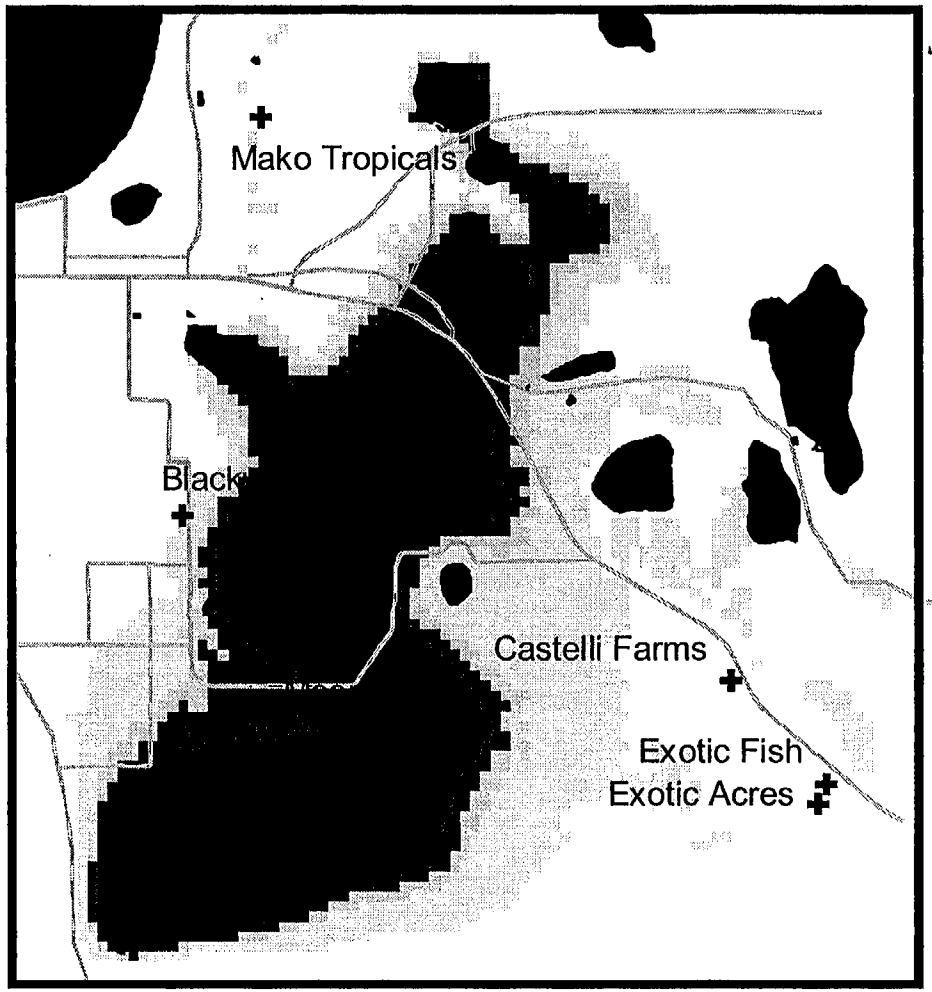
Model Projections of Groundwater Elevations for Severe Drought Condition Scenario



The water table at Blackwater Well for the Severe Drought Condition Scenario is projected to fall to about 69.7 feet during the first year of the drought without a drawdown and to 69.5 feet during the second year. Pond bottom elevations at Blackwater Fishery are about 68-69 feet. There is a drainage canal running through Blackwater Fishery which passes through culverts under Hickory Tree Road just downstream from Blackwater

Projected Impact of Lake Drawdown on the Water Table Aquifer

Severe Drought Run



Drawdown [ft]

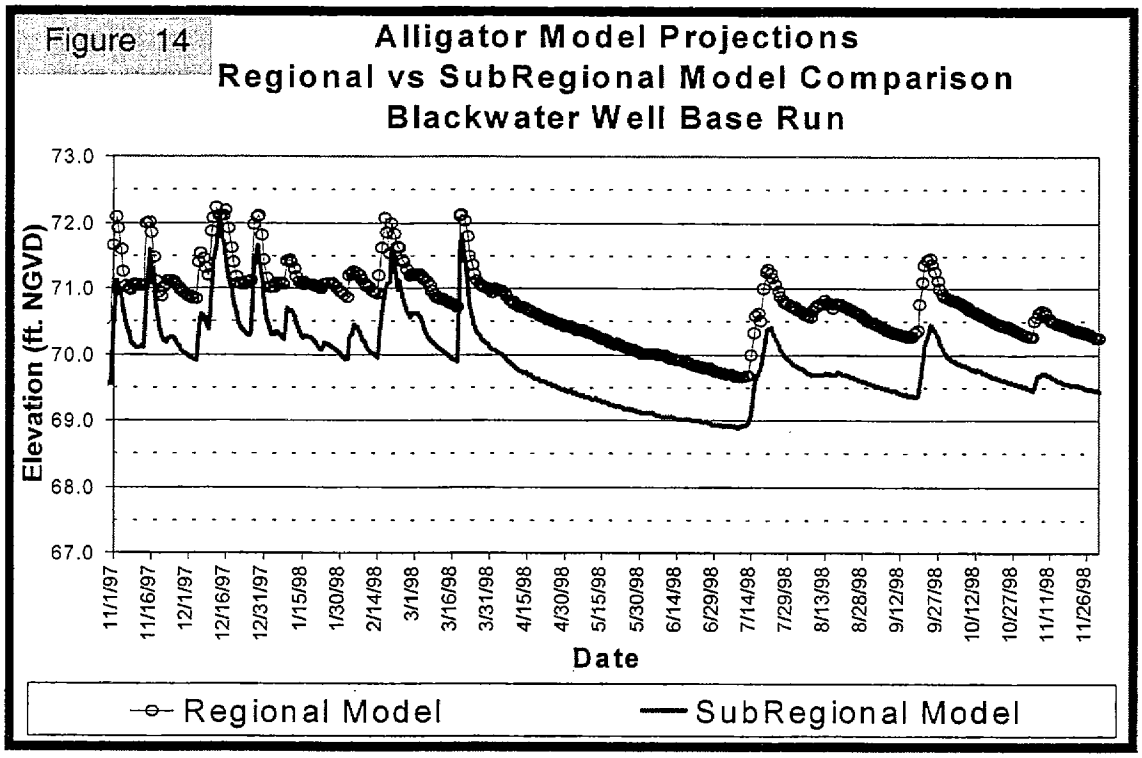
- < 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 3.00

Figure 12

Fishery. The controlling elevation of the culverts is 68.1 feet. During drought conditions the water elevations in the canal can be expected to fall to 68.1 feet.

The drainage canal has a major influence on the surficial aquifer in the areas immediately adjacent to it (including Blackwater Fishery).The impact of the canal can be seen by comparing hydrographs of the projected well levels from the regional scale model versus the subregional scale model (see Figure 14 on page 20). The regional model projections are generally 0.8 feet higher than the sub-regional model projections. This difference shows that the canal has a major influence, especially as water levels decline.

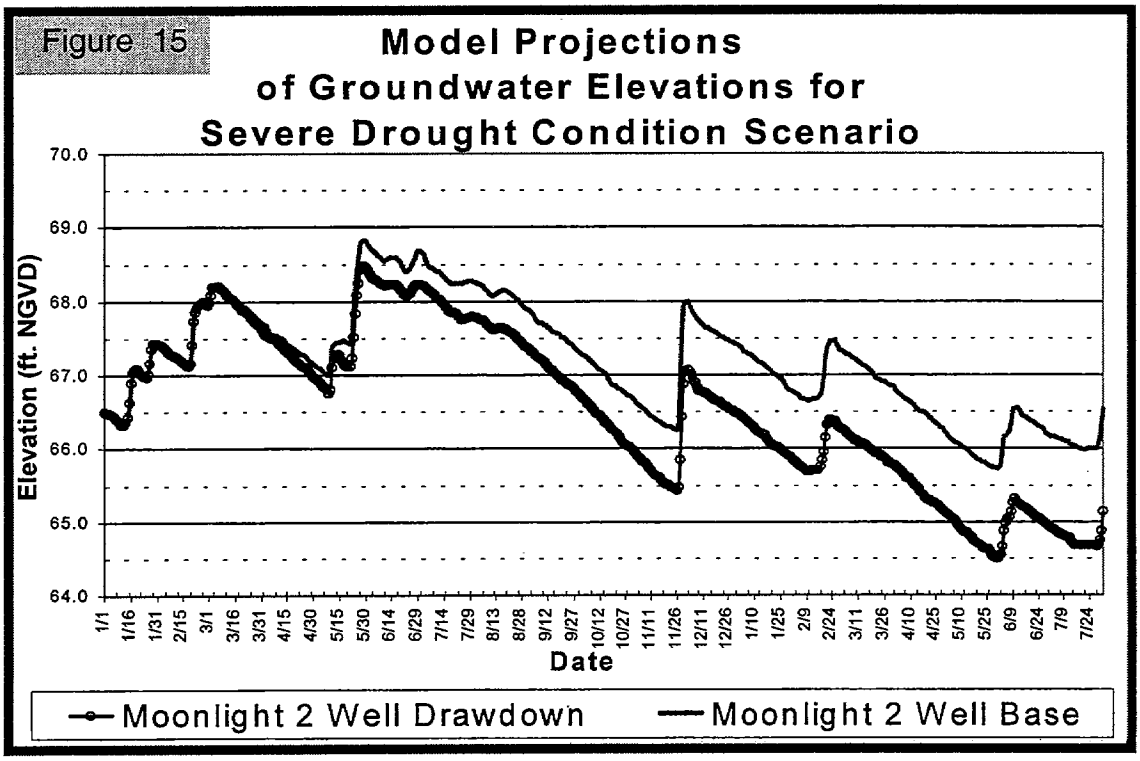
Figure 14



Surficial aquifer levels will be close to pond bottom elevations during a severe drought. The drainage ditch is a major controlling influence on pond water levels. Water levels in the ponds can be expected to fall to extremely low levels (or completely dry) during severe drought conditions without a drawdown. Supplemental water can be added to the ponds to offset some of the drought impacts, but probably not completely offset them (due to the proximity of the drainage canal). If the drought is severe enough, the ponds at Blackwater Fishery can be expected to go dry or almost dry.

The hydrograph for Moonlight Well (Figure 15 on page 21) shows the extent of projected changes to aquifer levels during the simulation period. The drawdown is projected to lower the water table an average of 0.4 feet during the first year of the drought and by an average of 1.1 feet during the second year. Maximum changes are projected to be 1.0 feet in the first year and 1.5 feet the second year.

Figure 15



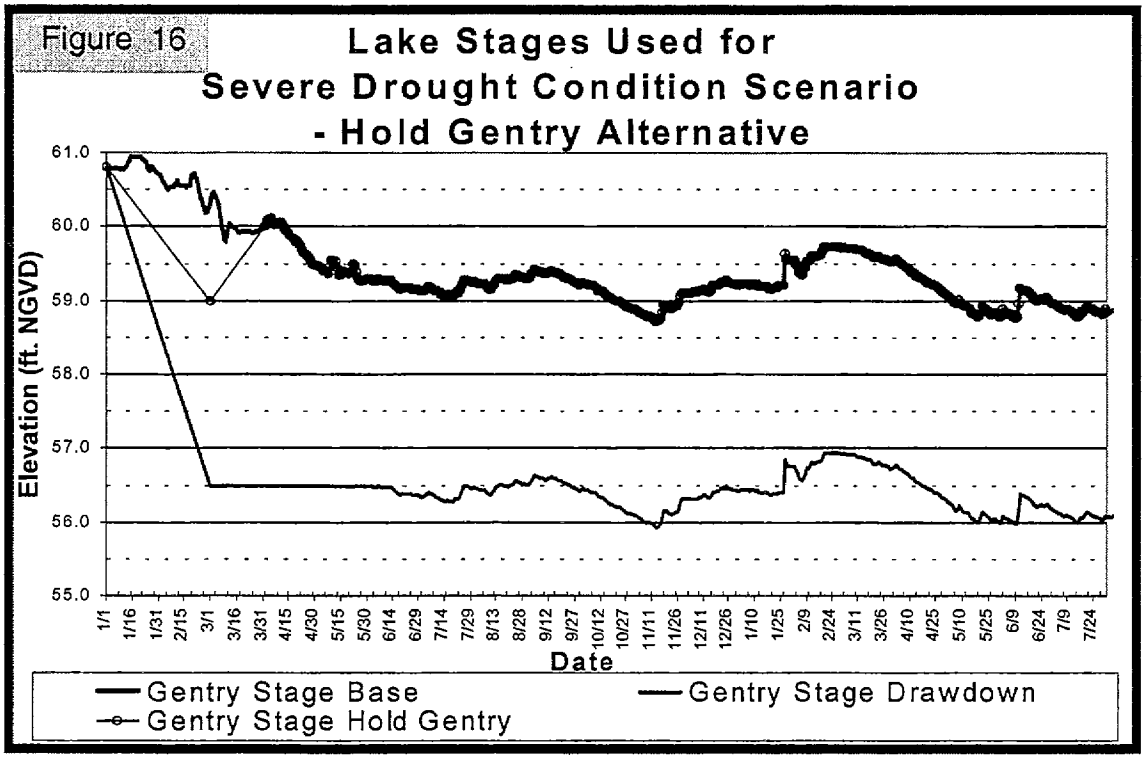
The water table at Moonlight 2 Well for the Severe Drought Condition Scenario is projected to fall to about 66.3 feet during the first year of the drought without a drawdown. Levels are projected to fall to about 65.8 feet during the second year of the drought. These levels are below pond bottom elevations of about 68 feet. The drawdown is projected to lower the aquifer levels an average of 0.4 feet below base levels during the first year of the drought and by an average of 1.1 feet during the second year. Maximum changes during the first year of the drought are projected to be 1.1 feet and 1.5 feet during the second year. For any given aquifer level, the levels are projected to be experienced about four weeks sooner during the first year of the drought with a drawdown as compared to base conditions.

Changes to fish pond stage elevations at Moonlight Fisheries are expected to be less than projected changes to the water table. The ponds appear to be

somewhat isolated from the aquifer by the hard pan under the ponds (see discussion under Typical Condition Results section).

An alternative to the Severe Drought Condition Scenario was prepared and analyzed. This alternative would only lower Lake Gentry to 59.0 feet in order to allow flows out of Alligator Lake, but would not lower Gentry to its proposed drawdown level of 56.5 feet (see Figure 16 on page 22). Under this scenario, the Lake Gentry drawdown and habitat enhancement work would occur in a subsequent year, separately from the Alligator Lake work. Under these conditions the hydraulic head differences between the aquifer at Moonlight Fisheries and the C-33 Canal and Lake Gentry would be reduced. This reduced head difference would lower the rate of flow in the aquifer, lessening the changes to the aquifer levels at Moonlight Fisheries.

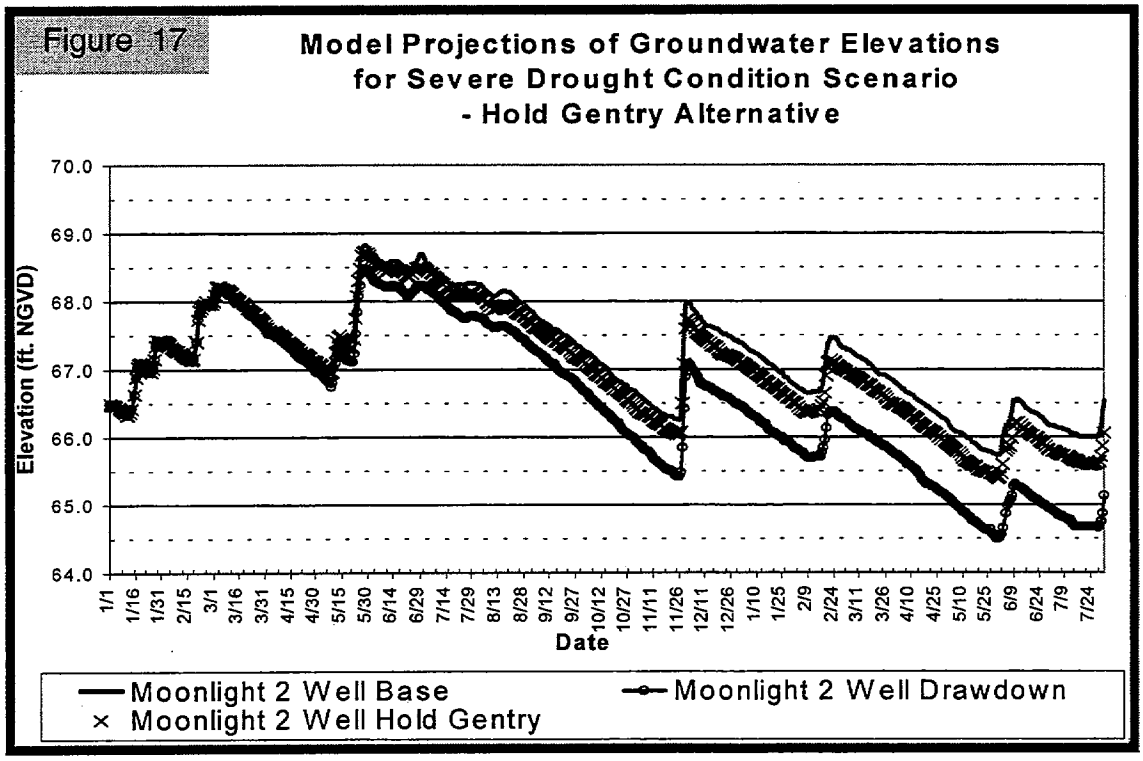
Figure 16



The modified hydrograph for the Moonlight 2 Well (Figure 17 on page 23) shows the change due to the drawdown at this site is projected to be reduced. The drawdown is projected to lower the water table an average of 0.1 feet during the first year of the drought and by an average of 0.3 feet during the second year. Maximum change during the drought is projected to be 0.4 feet in the first year and 0.5 feet the second. The changes to the aquifer levels due to the Alligator Lake drawdown at Moonlight Fisheries under severe

drought conditions, while not doing a Lake Gentry drawdown, is projected to be less than 0.5 feet as compared to 1.5 feet with a Lake Gentry drawdown.

Figure 17



Under the alternative scenario, the water table at Moonlight 2 Well for the Severe Drought Condition Scenario is projected to fall to about 66.3 feet during the first year of the drought without a drawdown. Levels are projected to fall to about 65.8 feet during the second year of the drought. These levels are below pond bottom elevations of about 68 feet. The drawdown is projected to lower the aquifer levels by about 0.1 feet during the first of the drought and by about 0.3 feet during the second year.

Another alternative to offset the changes projected at Moonlight Fisheries would involve supplemental pumping and minor surface drainage changes. The water levels in the perimeter drainage ditch at the farm are controlled by a culvert structure. This culvert could be blocked, raising the controlling elevation about one to two feet.This would reduce the rate of drop in aquifer levels at this site. In addition, supplemental pumping of groundwater from deep wells to the perimeter ditch or ponds would also help to offset the projected changes to the aquifer water levels.

Model Verification - Spring 1999

The *Analysis of Projected Impacts of the Alligator Chain Drawdown Project on the Surrounding Water Table Aquifer - July 28, 1998* and the *Alligator Lake Drawdown Study Model Documentation - August 26, 1998* were submitted to peer review[3]. Three experts in hydrologic modeling were selected and sent the reports in December 1998.

The experts were asked to review the documents and provide comments. It was requested that their review specifically address questions pertinent to the theme of the study (see Appendix M for complete comments from the peer review panel). Additional work was undertaken in response to comments received from the outside peer review panel and others.

Since the Spring 1998 Analysis was done, the region has continued to experience below normal rainfall, and both groundwater levels and the levels in the fish farmers' ponds continued to decline. Given this prolonged drought, concerns with potential boundary effects, particularly in the northwest quadrant of the model emerged.

Model Changes

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 address 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 (Figure 18 on page 25). 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 (Figure 19 on page 26). The C-33 Canal was added as a river using the model's river package to better estimate water levels in the area between Alligator Lake and Lake Gentry.

Model Verification

After making the model modifications, the calibration period (8/97 - 6/98) was re-run to verify that the model was still working correctly, and a verification simulation was run (6/98 - 12/98) to assess model performance

3. To increase the ease of the peer review, these two documents were combined in October 1998. The documentation report was included as Appendix L.

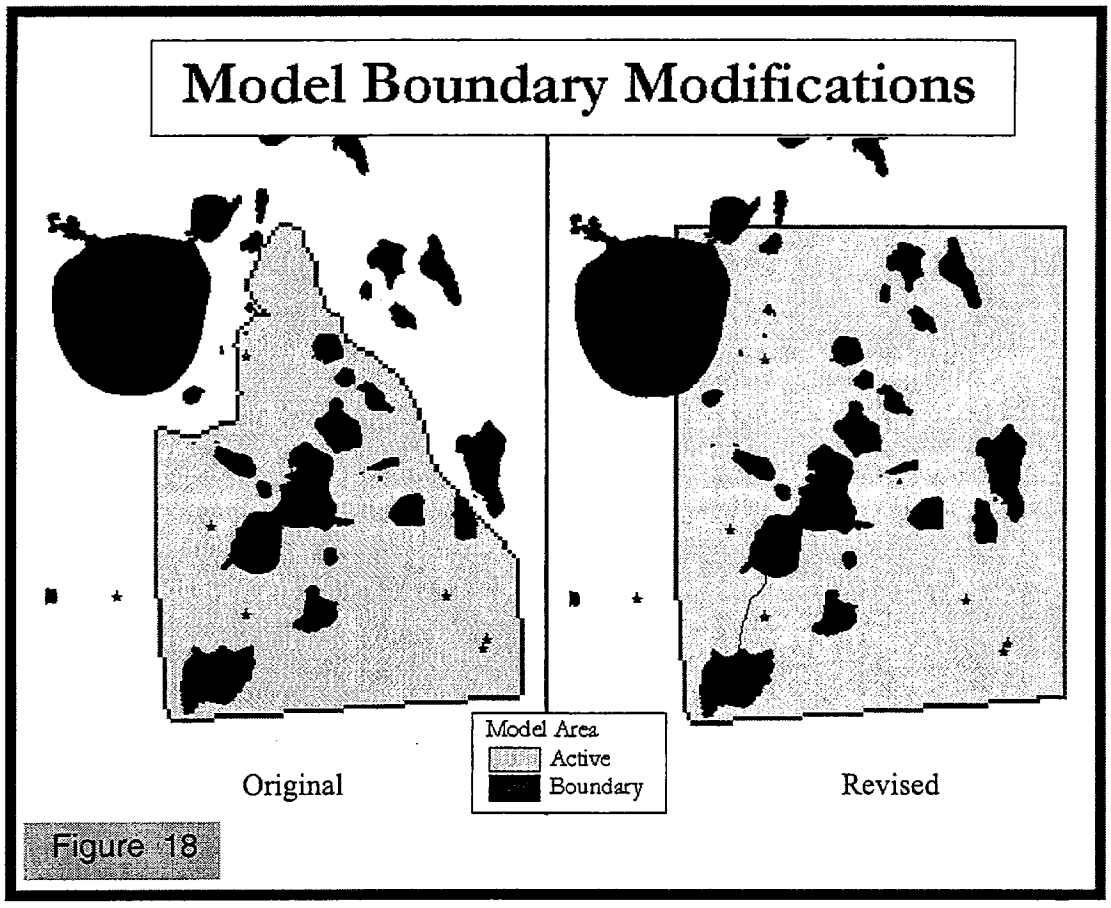
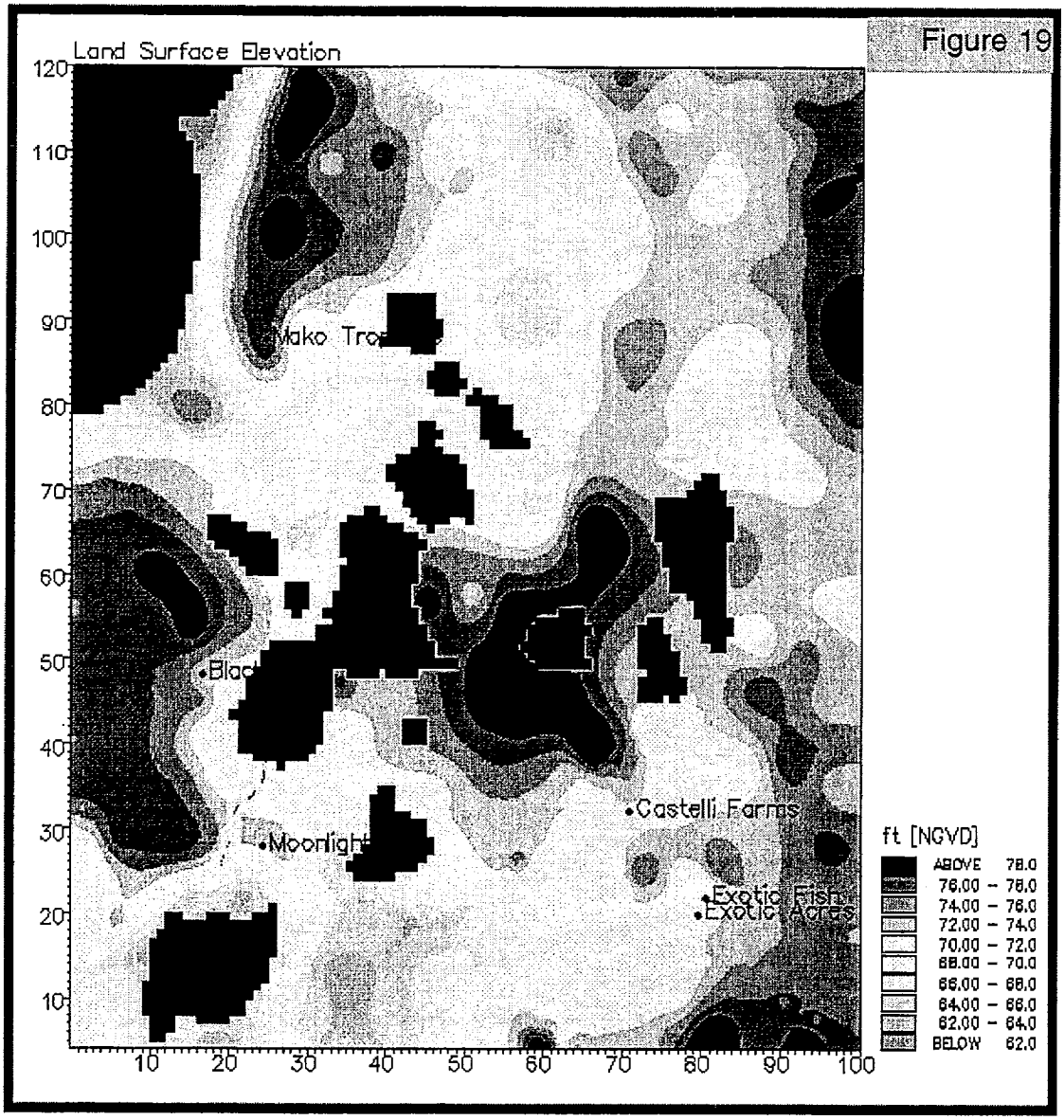


Figure 18

through the prolonged dry period. The model verification run was made to compare model predictions to actual water levels in the monitoring wells. In both cases no significant deviation from the calibration response was observed (see Appendix N for more details).

The most common suggestion from the expert reviewers was the application of soft data to test the reasonableness of the model. In other words, if there is a wetland in a particular location, does the model predict that it gets wet there, and does it stay dry where it is supposed to be dry. An analysis of the model was performed to address this question.

For example, in the southern portion of the model, encompassing Big Bend Swamp, the model predicts ponding of water on the surface in the wetlands and it stays dry outside of them. It may also be noted that although the wetlands fill up after a rain, they do not stay wet as long as they would in the real world. It was necessary when using the overland flow component of the



model to specify the elevation to which water is allowed to flow. It was specified that it be allowed to flow right down to ground surface. In reality, much of the water in the swamp would probably be restricted to isolated ponds long before this, but limited topographic data was available on which to base controlling elevations. Given the need to assess the effects of dropping swamp elevations on the fish farms, land surface was determined to be the most appropriate assumption.