AN EXAMPLE OF MODEL UTILIZATION FOR WATER MANAGEMENT DECISIONS IN MISSISSIPPI

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Introduction

Intense development since the early 1940's has increased the demand for freshwater along Mississippi's Gulf Coast (Map 1). This development has been in the form of tourism, industry, and agricultural growth. Within many wells near the coast there has been a steady water level decline of two feet or more per year in the principal freshwater layers of the Miocene aquifer system.

In the Gulf Coast area, 60 million gallons per day (MGD) of freshwater is withdrawn from the Miocene aquifer system. With the exception of about 100.0 MGD of surface water withdrawn from the Pascagoula River for the Bayou Cassotte Industrial Area, the Gulf Coast area of Mississippi depends entirely on the Miocene aquifer system for freshwater. The Miocene aquifer system consists of, in ascending order, the Cataholula Sandstone, the Hattiesburg Formation, the Pascagoula Formation, the Graham Ferry Formation, and the Citronelle Formation. (The validity of these formation names has not been established, but they are useful in defining the position of water-bearing zones within the aquifer system).

In response to concern for the aquifer system's ability to continue to meet ever increasing demands for freshwater, the United States Geological Survey (U.S.G.S.) constructed a three dimensional numerical grid model. The model has been used to project the withdrawal effects on the different layers within the Miocene aquifer system up to and including the year 2005. There are a total of eight (8) layers within the Miocene aquifer system. The deepest, Layers 1 and 2, are saline in the coastal area.

Purpose and Scope

Model simulations were utilized to evaluate the effects of large withdrawals of water from Layer 2 on overlying and underlying model layers. Model-projected potentiometric surfaces for Layers 1 through 6 were simulated at two sites near Ocean Springs, MS. Although Ocean Springs at the present time withdraws freshwater from Layers 4 and 6, Layer 3 may be considered a potable water source for future use.

Methods and Results

Water in Layer 2 in the Miocene aquifer system in the coastal area surpasses the maximum dissolved solids (500 mg/l) as established by the Environmental Protection Agency (EPA) for potable water. Although Layer 2 does not contain potable water, it is useful for aquaculture along Mississippi's Gulf Coast. There have been several business interests studying the area for potential fish culture. These potential operations would require large quantities of higher chloride water from Layer 2. Large withdrawals from Layer 2 may induce significant drawdown in overlying freshwater Layers 3, 4, and 5 and is of concern to the Office of Land and Water Resources (O.L.W.R.) for the protection of existing freshwater.

The O.L.W.R., to establish a maximum withdrawal rate for Layer 2 in the Ocean Springs area, proposed two hypothetical locations for the aquaculture facilities. Each location was chosen on the basis of freshwater demand from Layer 3 near the hypothetical withdrawal site. The farther from major pumping centers (i.e. Ocean Springs, Biloxi, etc.), the greater a withdrawal rate from Layer 2 can be maintained.

Aquaculture operations near the Ocean Springs, MS, area have been proposed to the O.L.W.R. Hypothetical locations and pumping rates near the Ocean Springs area were selected to examine the drawdown impact on the freshwater layers. Projections using the Miocene quasi three-dimensional numerical model by the O.L.W.R. predicted future drawdowns in aquifer Layers 1 through 5 which would result from withdrawal of high chloride water from Layer 2.

Two (2) site specific locations for the aquaculture facilities were selected (Map 2). Each site was assigned two (2) specified withdrawal rates (MGD). On the basis of model calibration, a 30-foot drawdown limit was established in a freshwater layer. A 30-foot drawdown, or greater if allowed, would draw potable water into saline water, rendering the freshwater non-potable. (The larger withdrawal rate at each site may induce a 30-foot or greater drawdown within any overlying freshwater layer). State Water Laws of Mississippi mandate the O.L.W.R. to prevent the

degradation of freshwater within the State's surface water and groundwater systems. The lower withdrawal rate represents the maximum withdrawal of saline water from Layer 2 in order to remain within the 30 foot drawdown limit of any freshwater layer.

Cypress Creek #1

The first site evaluated was near the town of Cypress Creek, MS, located four (4) miles northwest of Ocean Springs, MS. Site specific Run 412 was simulated at the rate of 11.0 MGD withdrawal from Layer 2. This withdrawal rate induced a drawdown of 792.72 feet within Layer 2 by the year 2005. A drawdown of this magnitude in Layer 2 induced a drawdown in the overlying freshwater Layer 3 of 30.25 feet. Although it is near the 30-foot limit, the drawdown exceeds the limit established by the O.L.W.R.

The Ocean Springs area was also affected by the Cypress Creek site withdrawal. Freshwater Layer 3 had a drawdown of 24.20 feet. This drawdown in Layer 3 is within the established 30-foot limit.

Cypress Creek #2

A second site specific Miocene Model run (Run 406) was simulated at the Cypress Creek location. The withdrawal rate of 10.0 MGD induced a drawdown of 632.01 feet in Layer 2; the drawdown in Layer 3 was 27.50 feet at the Cypress Creek site. Ocean Springs had a drawdown in Layer 3 of 20.21 feet. Both sites had significant drawdown in freshwater Layer 3 but remained within the 30-foot limit.

Latimer

Site specific Miocene Model Run 411 near Latimer, MS, located nine (9) miles north-northwest of Ocean Springs, MS, simulated a withdrawal of 12.0 MGD. Within saline Layer 2, the drawdown was 659.77 feet. This withdrawal induced a drawdown of 30.64 feet in Layer 3. Again, the drawdown in Layer 3 exceeds the 30-foot limit established by the O.L.W.R. The drawdown at Ocean Springs in Layer 3 was predicted to be 12.55 feet, well within the 30-foot limit.

The withdrawal rate of site specific Miocene Model Run 413 at the Latimer site in Layer 2 was reduced to 11.0 MGD. This withdrawal rate induced a drawdown in Layer 2 of 604.77 feet at the site. Drawdown within Layer 3 was 28.09 feet near Latimer and 11.50 feet at Ocean Springs. The drawdowns at both locations are within the 30-foot drawdown limit established by the O.L.W.R.

Conclusion

Intense development since the 1940's along Mississippi's Gulf Coast has stressed the Miocene aquifer's freshwater layers. Many wells along the coast have experienced a 2-foot decline in water levels per year since the 1940's. The United States Geological Survey, in response to concerns about the aquifer's ability to continue to meet demands for freshwater, constructed a quasi three-dimensional numerical grid model. The model will project the withdrawal effects on the layers of the Miocene aquifer system through the year 2005.

Several business interests have studied the coast as a potential aquaculture facility area. Aquacultures of this size would require vast amounts of high chloride water from Layer 2. Such large withdrawals would induce drawdowns within the overlying freshwater Layers 3, 4, and 5. The Office of Land and Water Resources is greatly concerned with the drawdown of freshwater layers since it is mandated by State Water Law to not allow the degradation of freshwater.

Potential aquaculture operations near the Ocean Springs, MS, area were proposed to the O.L.W.R. Cypress Creek and Latimer, MS, were selected as potential sites. A thirty (30) foot drawdown limit within any freshwater layer of the Miocene system was established for this evaluation based upon previous model calibration

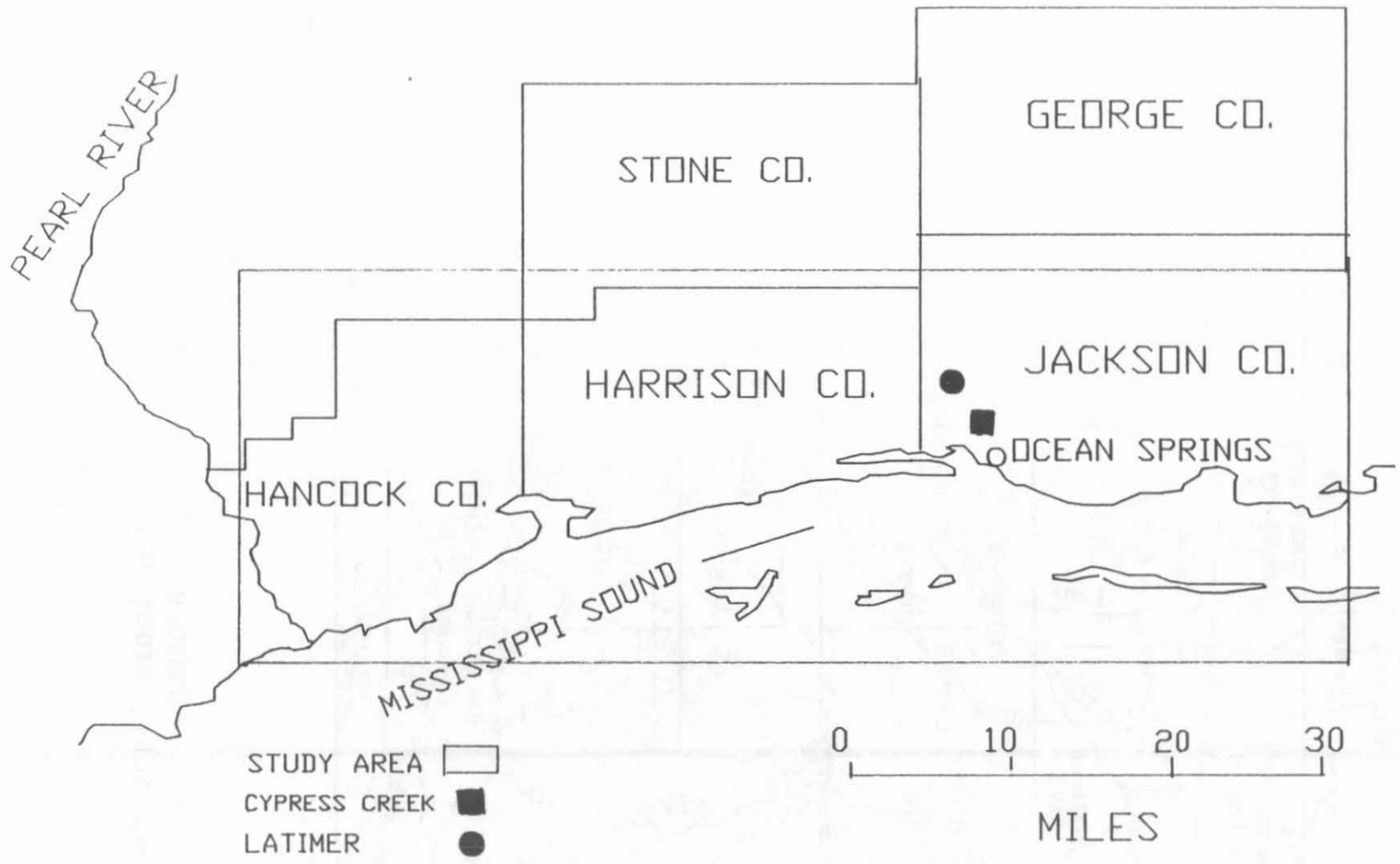
At the Cypress Creek site, withdrawal of 11.0 MGD from Layer 2 induced a drawdown in Layer 3 greater than the 30-foot limit, while a withdrawal of 10.0 MGD induced a drawdown less than the 30-foot drawdown limit (Fig. 1). At the Latimer site, a withdrawal of 12.0 MGD from Layer 2 induced an unacceptable drawdown within freshwater Layer 3. The withdrawal of 11.0 MGD from Layer 2 induced a drawdown within Layer 3 (Fig. 2) less than the 30-foot limit established by the Office of Land and Water Resources. Significant reductions in these projected drawdowns may be accomplished by using appropriate well spacing rather than a site specific or theoretical single-well withdrawal site.

References

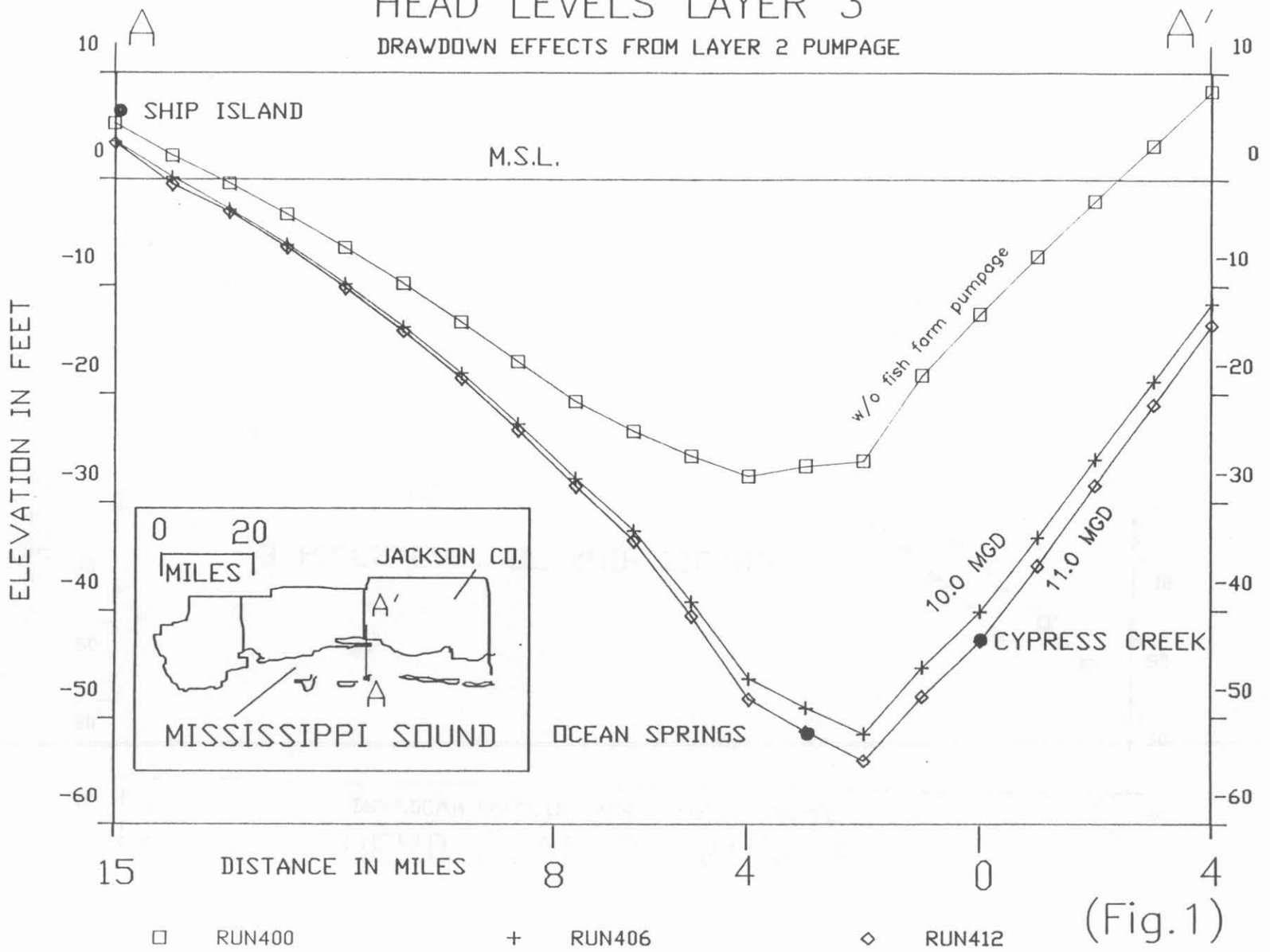
Sumner, D.M., B.E. Wasson, and S.J. Kalkhoff. Geohydrology and simulated effects of withdrawals on the Miocene aquifer system in the Mississippi Gulf Coast Area. U.S. Geological Survey, Water-Resources Investigation Report 87-4172. Revised 1989.

Map 1.--Culture and drainage of the primary and secondary study areas in southeast Mississippi.

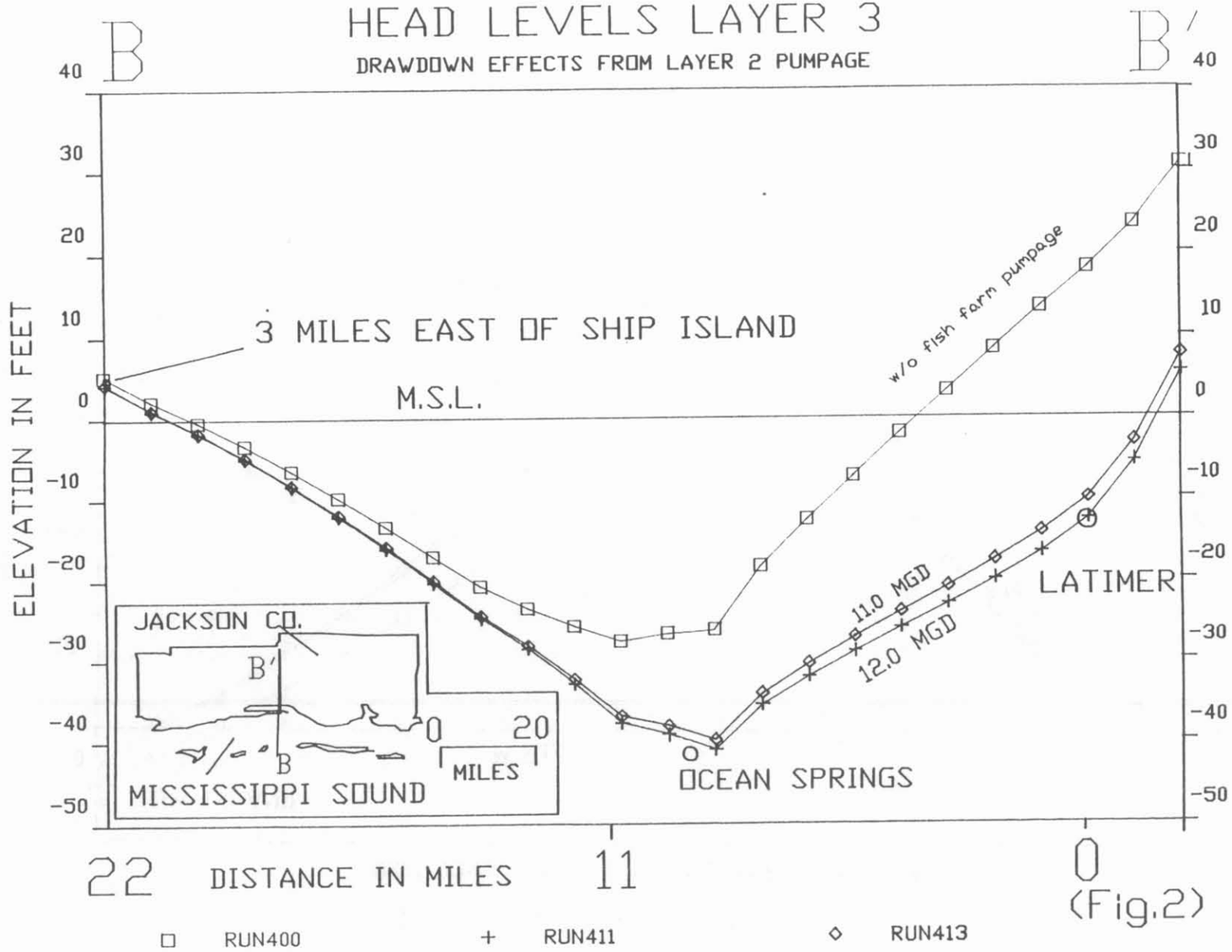
(Sumner and others, 1989)



Map 2- Site Location of Hypothetical Fish Farms


HEAD LEVELS LAYER 3
DRAWDOWN EFFECTS FROM LAYER 2 PUMPAGE
A
A'
SHIP ISLAND
M.S.L.
w/o fish farm pumpage
10.0 MGD
11.0 MGD
CYPRESS CREEK
OCEAN SPRINGS
ELEVATION IN FEET
10
0
-10
-20
-30
-40
-50
-60
0 20
MILES
JACKSON CO.
MISSISSIPPI SOUND
15
DISTANCE IN MILES
8
4
0
4
RUN400
RUN406
RUN412

(Fig.1)


HEAD LEVELS LAYER 3
DRAWDOWN EFFECTS FROM LAYER 2 PUMPAGE
B
B'
ELEVATION IN FEET
40
30
20
10
0
-10
-20
-30
-40
-50
3 MILES EAST OF SHIP ISLAND
M.S.L.
w/o fish farm pumpage
11.0 MGD
12.0 MGD
LATIMER
OCEAN SPRINGS
JACKSON CO.
B'
B
0
20
MILES
MISSISSIPPI SOUND
22
DISTANCE IN MILES
11
0
RUN400
RUN411
RUN413

(Fig.2)