LAKE JESUP AQUATIC ENHANCEMENT PROJECT
SEMINOLE COUNTY, FLORIDA

PRELIMINARY DESIGN REPORT

October 2002

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State Project No. FWC 01/02-17

CERTIFICATION

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EXECUTIVE SUMMARY

Background

Lake Jesup is a large, crescent-shaped, shallow lake located in central Seminole County along the middle basin of the St. Johns River. Lake Jesup and its flood plain encompass a total area of approximately 16,000 acres, including about 7,500 to 10,000 acres of open water area depending on lake level. The lake receives surface drainage from 13 subbasins covering a total watershed area of approximately 156 square miles (99,800 acres). Lake Jesup's configuration, location, and narrow connection to the St Johns River, as well as other factors, have contributed to the lake's limited circulation and dilution patterns and the uneven distribution of sediment within the lake. The hydrologic residence time of Lake Jesup is estimated at 3 to 12 months, but the residence time within the western embayment of the lake may be much longer due to the poor circulation and mixing.

Before the 1960s, Lake Jesup was a thriving water body, attracting thousands of recreational boaters and anglers each year. Over the years, bald eagles, manatees, ibises, wood storks, and sandhill cranes have made Lake Jesup their home. However, the water quality of the lake has deteriorated over the past half century, and Lake Jesup has become one of the most eutrophic bodies of water in Central Florida. This water quality decline is attributed to wastewater effluent discharges directly into the lake; untreated stormwater discharges from surrounding tributaries; unregulated agricultural runoff; construction of berms that separated the lake from parts of its flood plain limiting the lake's ability to cleanse itself; and construction of the State Route 46 bridge and causeway over the lake's confluence with the St. Johns River, which reduced its hydraulic connection with the river and its flushing time. All of these factors have taken a significant toll on the sensitive ecosystem and have caused a significant increase in nutrient loading to the lake. The increased nutrient loading has left a legacy of algae and nuisance vegetation growth that deprived the lake's aquatic habitats of oxygen, deteriorated its water quality, caused frequent fish kills and degradation of sportfish populations, and created a nutrient-rich layer of unconsolidated sediment on the bottom of the lake that could be easily resuspended by wind activities.

Concerned with the health of Lake Jesup, the St. Johns River Water Management District (SJRWMD) and the Florida Department of Environmental Protection (FDEP), together with several local governments, were able to end major direct effluent discharges into the lake by 1983, but the damage to the lake's health remained as a result of the other water-quality deteriorating factors. In 1994, the Florida Legislature passed the Lake Jesup Act, which created the Friends of Lake Jesup, a group of state agencies, environmental groups, and homeowners organizations charged with developing a sound restoration and management plan for the lake. The Act also provided funding for the collection of data, initiation of diagnostic studies, and conductance of demonstration projects. By law, this Act ended in 1998, but residents and representatives from state, regional, county and city governments, environmental advocacy groups and homeowner associations still actively work toward the lake's restoration.

Several restoration alternatives have been identified for the lake, including replacement of the existing SR 46 bridge and/or causeway to increase the lake's hydraulic connection with

the St. Johns River. Increased riverine flows in Lake Jesup could potentially increase sediment resuspension and export to the river. The northern third of the lake is the area most likely to contribute the sediment discharges to the river. To reduce downstream impacts from sediment export and to reduce internal nutrient loading from lake-bottom sediment, hydraulic dredging of the lake appears to be one of the most promising restoration alternatives.

Project Objective

In 2001, the Florida Fish and Wildlife Conservation Commission (FWC) received State funding for the Lake Jesup Aquatic Enhancement Project (the Project). In March 2002 the FWC retained PB Water, a division of Parsons Brinckerhoff Quade & Douglas, Inc., to provide professional engineering services for the Project, which mainly includes hydraulic dredging and upland disposal of the uppermost unconsolidated nutrient-rich sediment layer existing within the open water area of the lake. The main objective of the Project is to reduce the lake's sediment resuspension and internal nutrient loading and to subsequently improve the water quality and the aquatic habitats of the lake.

Data Collection

As a part of the data collection effort for the Project, a hydrographic survey was conducted in May 2002 to determine the spatial and vertical distributions of the different types of sediment existing within the open water area of Lake Jesup. The survey included measurement of the top elevations of the uppermost unconsolidated sediment layer the underlying consolidated sediment layer, and the lake's hard bottom. A boundary survey of the lake's shoreline vegetation was also conducted in May 2002 to delineate the open water area of the lake and to determine the lateral extents of dredging. In addition, sediment sampling and laboratory testing programs were conducted to determine the physical, chemical, and beneficial use characteristics of the unconsolidated sediment layer. A total of 30 sediment coring locations were sampled and analyzed, covering a range of sediment types, thicknesses, and water depths representative of the entire lake.

Unconsolidated Sediment Characteristics

The results of the sediment sampling and testing programs indicated that Lake Jesup sediment consists mainly of an upper layer of unconsolidated sediment underlain by consolidated sediments. The unconsolidated sediment mainly consists of black to brown, very loose organic matter (muck), which contains small quantities of shell fragments, sand, and plant fiber in some places. The unconsolidated sediment is highly prone to erosion and resuspension, with subsequent movement, deposition, and export. In contrast, the consolidated sediment layer consists mainly of highly plastic clay that generally contains smaller quantities of black decomposed organic matter, except for small areas within the lake where sand, thin layers of pink/tan carbonate (marl), and/or soft brown/black fibrous organic deposits exist.

The results also indicated that the unconsolidated sediment contains approximately 5 to 15 percent by dry weight of coarse material (shell fragments, sand, and/or plant fiber) and 85 to 95 percent of fine material (clay, silt, and/or decomposed organic matter). The fine material consists of approximately 63 to 75 percent by dry weight of clay size particles and 25 to 37 percent of silt size particles. The average in-situ solids content of the unconsolidated

sediment increased with depth from 8.3 percent (by weight) at 0.25 feet to 18.5 percent (by weight) at 3.5 feet. Assuming an average dredging depth of 1.5 feet, average in-situ solids and organic contents of 14.2 percent and 26.0 percent by weight, respectively, were estimated for the unconsolidated sediment layer (from the sediment core data collected in this study) and subsequently used in the preliminary sizing analysis of the disposal area. Also, an estimated total of 0.44 million tons of organic matter would be removed from the entire lake at that depth. The average specific gravity of the solids was measured at 1.63 for the unconsolidated sediment. The results of the beneficial use testing indicated that the unconsolidated sediment is not contaminated and is suitable for Class III landfill disposal.

Based on analysis of data from a previous study performed by the University of Florida (UF) (Cable et al., 1997), the cumulative storage of organic matter in Lake Jesup unconsolidated sediment was estimated at 0.29, 0.44, 0.55, and 0.67 million tons at 1, 1.5, 2, and 3 feet, respectively. Also, the cumulative storage of total phosphorous (TP) in the lake's unconsolidated sediment was estimated at 890, 1,220, 1,560, and 1,870 tons at 1, 1.5, 2, and 3 feet, respectively. The cumulative storage of total nitrogen (TN) in the unconsolidated sediment was estimated at 13,000, 19,000, 23,000, and 27,000 tons at 1, 1.5, 2, and 3 feet, respectively.

Unconsolidated Sediment Volume

Based on the measured distribution of unconsolidated sediment and considering lake hydrology, geomorphology, prevailing wind direction, and circulation patterns, the Lake Jesup unconsolidated sediment layer was divided into seven zones. The zones were characterized as depositional, transitional, or scour depending on their depositional patterns. Using the results of the hydrographic survey, the volume and average thickness of unconsolidated sediment that would be removed from each of the seven zones were estimated as a function of potential maximum dredging depth. The total in-situ volume of unconsolidated sediment within the open water area of the lake was estimated at 10.6, 14.5, 17.1, and 20.3 million cubic yards at maximum dredging depths of 1, 1.5, 2, and 6 feet, respectively. The average thickness of unconsolidated sediment across the lake bottom was measured at 1.62 feet.

Prioritization of Dredging Zones

The seven zones were ranked with respect to dredging priority based upon their depositional classification, estimated in-situ unconsolidated sediment volumes, and estimated TP storages. The ranking results indicated that the eastern end (leading to the St. Johns River outlet) and southern shoreline of the lake have the highest ranking and should be dredged first. Given available Project funding, the FWC may also elect to dredge the upper 1 to 2 feet of highly nutrient-rich sediments that have been accumulating since 1900 within the remaining open area of the lake, with the exception of the central lake region, which is a scour zone with little deposited sediment.

Disposal Site Assessment

As a part of its conservation program, the SJRWMD has purchased several properties around Lake Jesup since the 1980s. One of the properties, formerly known as the Cameron/Little Ranch (Cameron) Site, includes areas at higher topographic elevations than many other areas surrounding the lake. Based on an agreement with the SJRWMD, the FWC has identified this

property as a potential sediment disposal site for the Project. A preliminary assessment was performed of the Cameron Site regarding its suitability for sediment disposal. The assessment included reviewing available geospatial data, conducting subsurface exploration and laboratory testing programs, performing a survey of available open pasture areas, and performing cultural resources and protected species surveys, plus other miscellaneous data and field reviews.

The assessment identified two adjacent land parcels occupying 100 and 290 acres that are most suitable for the construction of a confined disposal facility (CDF) on the Cameron Site. The two areas are located within the cleared pastureland portion of the site, outside the densely wooded area and above the +3.0-foot-NGVD contour, which corresponds to the upper limit of the sovereign submerged land on the site.

Confined Disposal Facility

To improve the operation of the CDF and facilitate final restoration, the 290-acre area was divided into two gravity-settling cells. As a result, the proposed CDF will include three settling cells, contained by earthen embankments, and one final polishing pond. The CDF will receive dredged sediment slurry from the dredge(s) via discharge pipelines. The coarse-grained sediment fractions, such as shells and sand, are anticipated to fall out of suspension and settle near the discharge locations of the pipeline(s), forming mounds. The fine-grained sediment fractions, such as silt and clay, are expected to gradually settle at greater distances and eventually fall out of suspension within the settling cells. The clarified supernatant water accumulating at the far end of the settling cells will be released into the polishing pond via overflow weirs, where it will be retained for further clarification and additional water quality treatment, if necessary. The supernatant water will be released into the marshland adjacent to Lake Jesup when the turbidity and water quality requirements of the project are met. Using the effective areas of the three settling cells and assuming a minimum 3-foot freeboard, the storage capacities of the CDF were estimated for different embankment and sediment heights.

Recommendations

Based on the data and analyses performed herein, the following recommendations are provided for future phases of the Project.

- Dredging of the following maximum thicknesses would result in removal of 15 MCY of unconsolidated sediment, which is approximately 75 percent of the total volume present in the lake, and approximately 96 percent of the total volume present in the priority East, South, and Northeast Zones:
  - Uppermost 2.0 feet within the East Zone (2.01 MCY);
  - Uppermost 2.0 feet within the South Zone (2.84 MCY);
  - Uppermost 2.0 feet within the Northeast Zone (2.11 MCY);
  - Uppermost 2.0 feet within the Northwest Zone (3.07 MCY);
  - Uppermost 1.5 feet within the West Zone (2.62 MCY); and
  - Uppermost 1.5 feet within the West Central Zone (2.30 MCY).

- During dredging, minimum setbacks of 50 feet from highway bridge piers, 10 feet from boat ramps and docks, and 20 feet from sea walls are recommended.

- A peak slurry production rate of approximately 4,000 gpm is recommended during dredging. This rate may be achieved by the use of two 8 to 10-inch auger-head dredges operating simultaneously, or an equivalent alternative. With this peak slurry production rate, and assuming 7-percent slurry solids content by weight, 24-hour/7-day per week operation, and 75 percent efficiency, a minimum production rate of 3.84 MCY per year is anticipated for removal of in-situ sediment. At this rate, approximately 4 years would be required to dredge the 15 MCY of sediment recommended above (1.5-2.0 feet within six zones).

- Settling cell embankment heights on the Cameron Site should not exceed a maximum reasonable height of approximately 15 to 20 feet (taller berms would require excavation within the storage area to a depth that could breach the existing natural clay liner). To avoid potential inundation, minimum settling cell and polishing pond embankment crest elevations should be set higher than the estimated 10-year flood elevation of 7.15 feet NGVD.

- The following minimum setbacks are recommended for locating the outer toe of settling cell embankments: 25 feet from property boundary; 25 feet from existing tree line; and at or above the existing 3-foot-NGVD ground surface contour.

- The recommended 15 MCY of unconsolidated sediment dredging from Lake Jesup likely will not fit within the identified Cameron Site disposal areas at the embankment height limits listed above. It is recommended that the FWC continue to investigate possibilities for additional disposal areas.

- The final polishing pond should be sized for a minimum of 7 days of retention. At a peak slurry production rate of 4,000 gpm, approximately 200,000 CY of storage volume would be required.

- For the Cameron Disposal Site, it is recommended that the FWC investigate the feasibility of long-term restoration alternatives, which would be able to return the site to a healthy ecological condition following dredging and disposal.

- Considering the current disposal area and budget limitations for the Project, the following minimum plan is recommended:
  - Construct the Cameron Site CDF (including three settling cells at a total storage height of 15 feet and one polishing pond at a total height of approximately 8 feet), at a probable construction cost of about $2.9 million.
  - Dredge the uppermost 2.0 feet of unconsolidated sediment from the East, South, and Northeast Zones (total of 7.0 MCY), at a probable cost of about $12.7 million. This volume of sediment is anticipated to fit within the CDF size recommended above.
  - If additional disposal volume remains within the Cameron CDF or additional disposal sites are located, and sufficient budget remains, the FWC may continue to dredge as much of the remainder of the lake as is feasible.

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K Laboratory Investigation Results for Cameron/Little Ranch Soil Samples, M3S Laboratories, August 2002

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1 INTRODUCTION

1.1 Background

Lake Jesup is a large, crescent-shaped, shallow lake located in central Seminole County along the middle basin of the St. Johns River (Figure 1.1). The lake is hydraulically connected to the St. Johns River at its northern end by a narrow outlet channel that was constricted in the early 1900s by the State Route (SR) 46 bridge and causeway. In addition, the SR 417 bridge, which was completed in 1993, crosses the lake near its western end. The lake has a small island, known as Bird Island, located near its center.

Lake Jesup and its flood plain encompass a total area of approximately 16,000 acres, including about 7,500 to 10,000 acres of open water area depending on lake stage. The limits of shoreline vegetation surrounding Lake Jesup (Figure 1.2) were delineated in May 2002 by the Florida Fish and Wildlife Conservation Commission (FWC) when the water level was at about 0.6 feet above the 1929 National Geodetic Vertical Datum (NGVD). This shoreline vegetation line encompasses an open water area of 7,800 acres at that elevation. Also shown on Figure 1.2 are the locations of properties that have been acquired by the St. Johns River Water Management District (SJRWMD) as part of the ongoing restoration effort for Lake Jesup (Futch property was recently obtained from the Expressway Authority).

As depicted in Figure 1.3, the lake receives surface drainage from 13 subbasins within its defined watershed, which has a total area of approximately 156 square miles (99,800 acres) (USGS, 1996; Adamus et al., 1997). Major tributaries include Howell Creek, Gee Creek, Soliders Creek, Six Mile Creek, Chub Creek, Salt Creek, and Sweetwater Creek. The lake also receives minimal discharge from the Clifton and Lake Jesup Springs, located near the southwestern end of the lake.

Two United States Geological Survey (USGS) stage and discharge gaging stations are located in the vicinity of Lake Jesup (Figure 1.4). Measurements at the stage-only gage (Station 02234434) on the southern edge of the lake were discontinued in September 1997 and replaced by stage measurements at the outlet gage (Station 02234435). The outlet gage near SR 46 also measures discharge into the St. Johns River. Analysis of the USGS stage data at the confluence with the St. Johns River indicates that the water level of Lake Jesup is mainly dependent on the river's stage and not the lake's watershed hydrology and hydrodynamics. Figure 1.5 shows the historic water level of Lake Jesup during the period from October 1977 to July 2002. As shown, the daily average water level of the lake varied between 0.00 feet NGVD and 7.29 feet NGVD during this period, with an average value of 2.21 feet NGVD. The historic low and high water levels of the lake during the available period of record are -0.63 feet NGVD and 9.13 feet NGVD, respectively (CDM, 2001). According to information from a former Sanford City Engineer, Lake Monroe (the next lake downstream of Lake Jesup along the St. Johns River) was observed at a maximum elevation of 13.28 feet above sea level in the fall of 1880 (USGS, 1996). For permitting, the Florida Department of Environmental Protection (FDEP) estimates the mean high water level of the lake at no more than 3.0 feet NGVD. Based on an unpublished report by the SJRWMD, the 100-year 1-day high elevation for the lake is estimated at 9.98 feet NGVD (reported in CDM, 2001).

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SOURCE: SJRWMD

Figure 1.1	Lake Jesup Aquatic Enhancement Project Location Map	PB Water A Division of Parsons Brinckerhoff Quade & Douglas, Inc. 100 East Pine Street, Suite 500 Orlando, FL 32801 407-587-7800 Certificate of Authorization Number: 00001462

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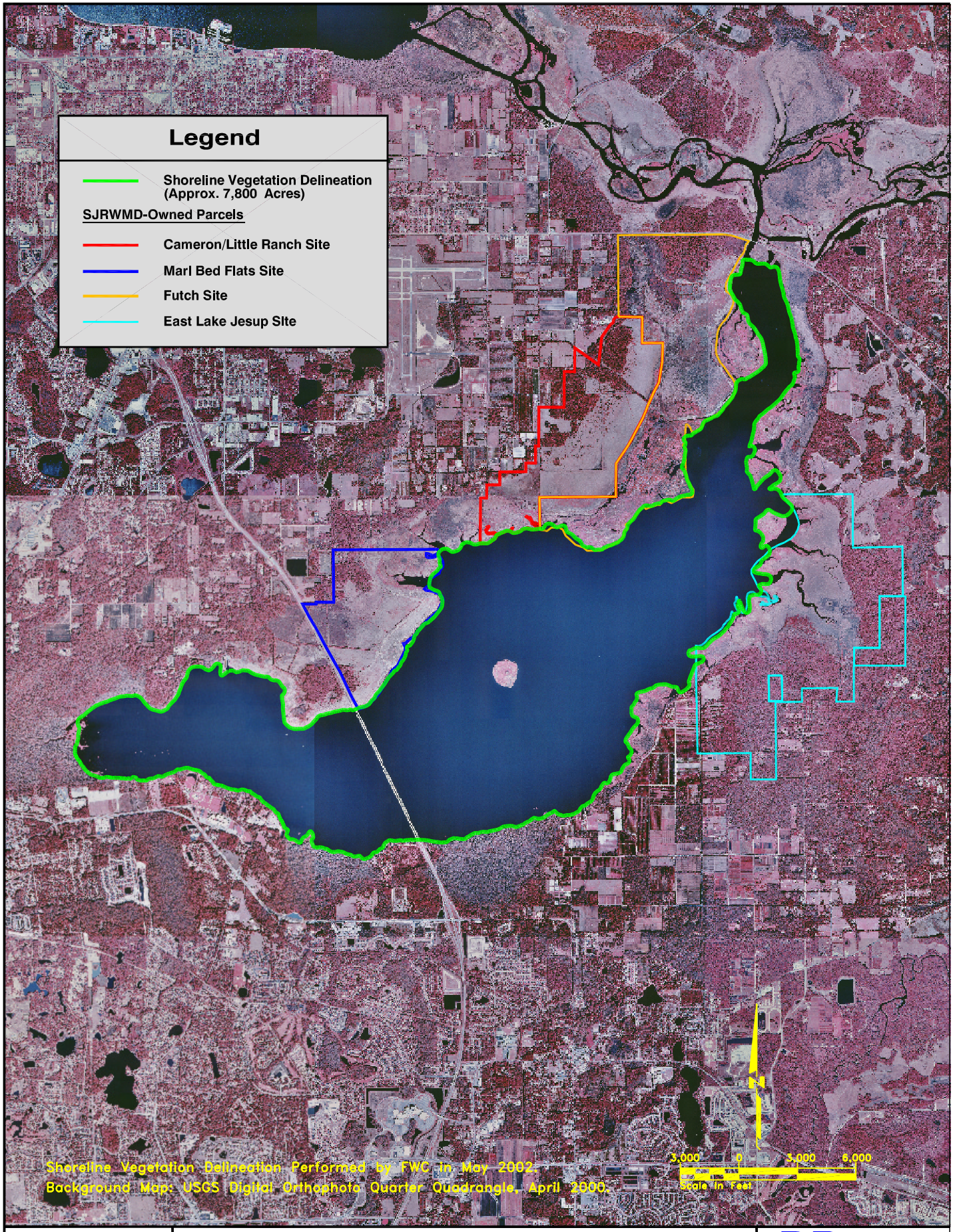

Figure 1.2	Lake Jesup Shoreline Vegetation Delineation and District Owned Parcels	PB Water A Division of Parsons Brinckerhoff Quade & Douglas, Inc. 100 East Pine Street, Suite 500 Orlando, FL 32801 407-587-7800 Certificate of Authorization Number: 00001462

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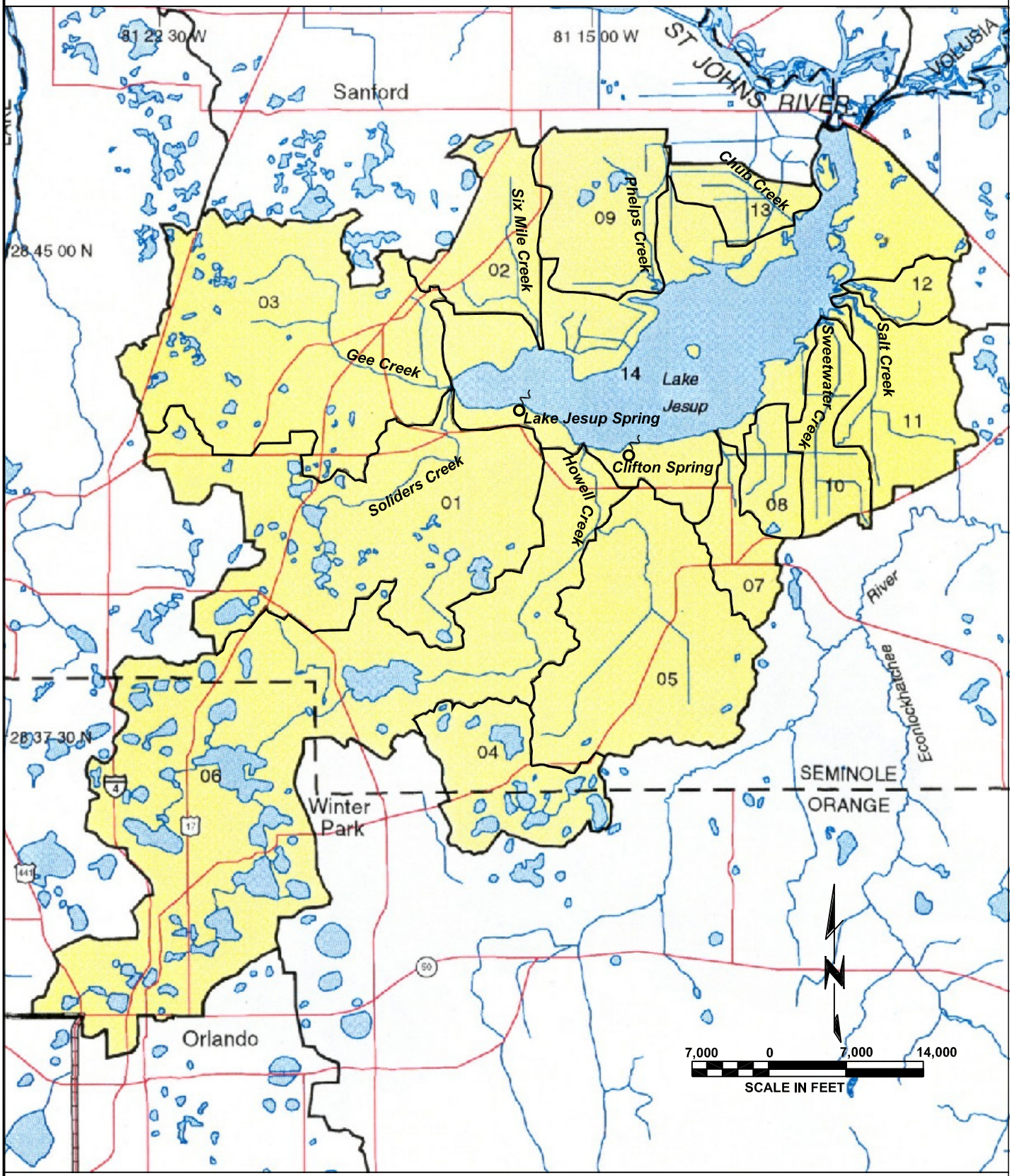

03 = Subbasin I.D.

= Spring

Background: SJRWMD Technical Publication SJ97-1 (Adamus et al., 1997)

Figure 1.3

Lake Jesup
Watershed and Subbasins

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Figure 1.4

Lake Jesup USGS Stage and Flow Gaging Stations

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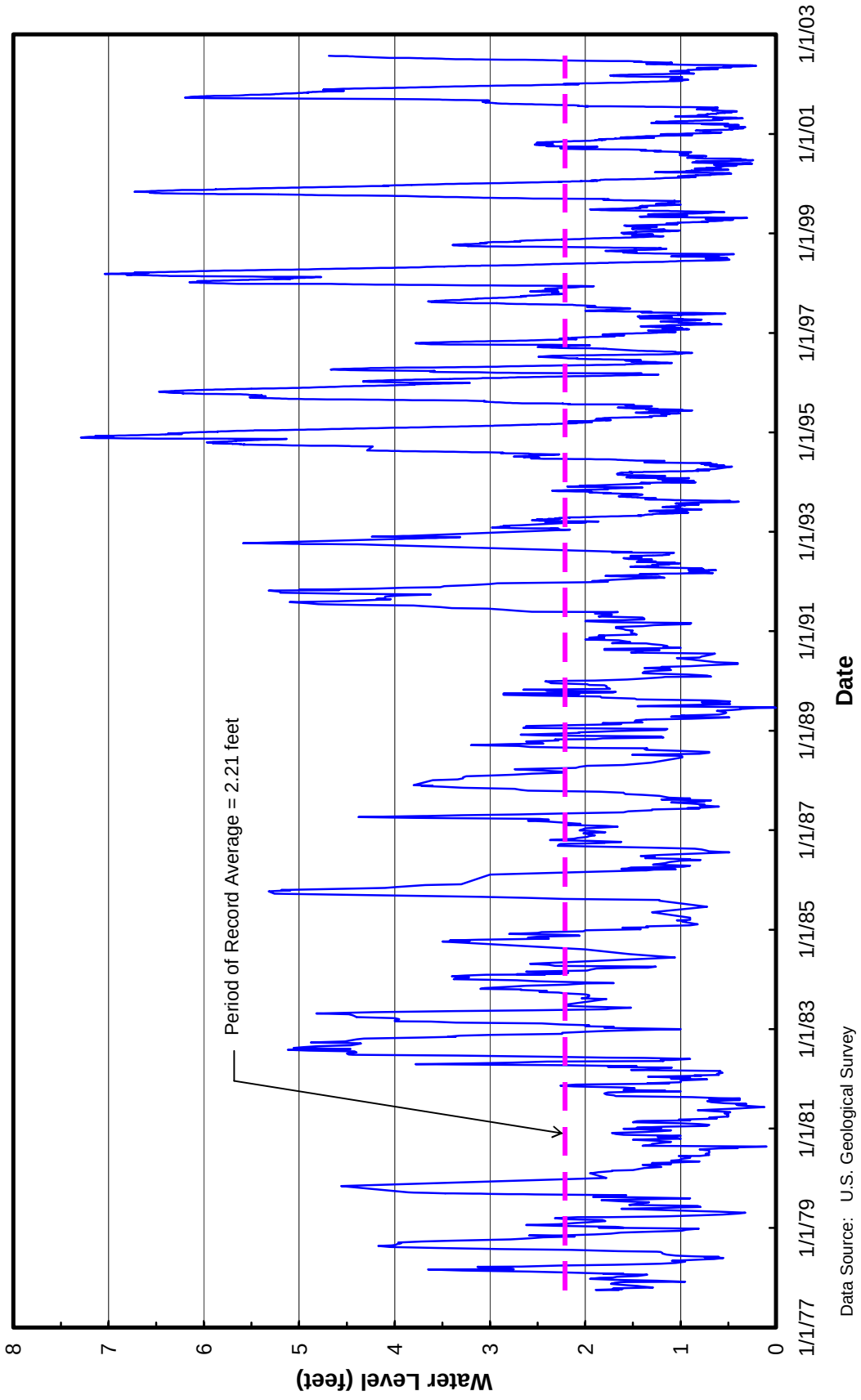

Figure 1.5 - Lake Jesup Average Daily Water Levels, 1977-2002

Lake Jesup's configuration, location, and narrow connection to the St Johns River, as well as other factors, have contributed to the lake's limited circulation and dilution patterns and the uneven distribution of sediment within the lake. The hydrologic residence time of Lake Jesup is estimated at 3 to 12 months, but the residence time within the western embayment of the lake may be much longer due to the poor circulation and mixing (Cable et al, 1997). Historic deposition of sediment throughout Lake Jesup has decreased the depth of this already shallow lake. Except for a small depressional area around Lake Jesup Spring, the top elevations of the lake-bottom sediment were measured in May 2002 at between +0.8 and -5.9 feet NGVD, with an average of approximately -2.4 feet NGVD.

Before the 1960s, Lake Jesup was a thriving water body, attracting thousands of recreational boaters and anglers each year. Over the years, bald eagles, manatees, ibises, wood storks, and sandhill cranes have made Lake Jesup their home. However, the water quality of the lake has deteriorated over the past half century, and Lake Jesup has become one of the most eutrophic bodies of water in Central Florida. This water quality decline is attributed to wastewater effluent discharges directly into the lake; untreated stormwater discharges from surrounding tributaries; unregulated agricultural runoff; construction of berms that separated the lake from parts of its flood plain limiting the lake's ability to cleanse itself; and construction of SR 46 bridge and causeway over the lake's confluence with the St. Johns River, which reduced its hydraulic connection with the river and its flushing time. All of these factors have taken a significant toll on the sensitive ecosystem and have caused a significant increase in nutrient loading to the lake. The increased nutrient loading has left a legacy of algae and nuisance vegetation growth that deprived the lake's aquatic habitats of oxygen, deteriorated its water quality, caused frequent fish kills and degradation of sportfish population, and created a nutrient-rich layer of unconsolidated sediment on the bottom of the lake that could be easily resuspended by wind activities.

Concerned with the health of Lake Jesup, the SJRWMD and the FDEP, together with several local governments, were able to end major direct effluent discharges into the lake by 1983, but the damage to the lake's health remained as a result of the other water-quality deteriorating factors. In 1994, the Florida Legislature passed the Lake Jesup Act, which created the Friends of Lake Jesup, a group of state agencies, environmental groups, and homeowners organizations charged with developing a sound restoration and management plan for the lake. The Act also provided funding for the collection of data, initiation of diagnostic studies, and conductance of demonstration projects. By law, this Act ended in 1998, but residents and representatives from state, regional, county and city governments, environmental advocacy groups and homeowner associations still actively work toward the lake's restoration.

Several restoration alternatives have been identified for the lake, including replacement of the existing SR 46 bridge and/or causeway to increase the lake's hydraulic connection with the St. Johns River. Increased riverine flows in Lake Jesup could potentially increase sediment resuspension and export to the river. The northern third of the lake is the area most likely to contribute the sediment discharges to the river. To reduce downstream impacts from sediment export and to reduce internal nutrient loading from lake-bottom sediment, hydraulic dredging of the lake appears to be one of the most promising restoration alternatives. The SJRWMD previously contracted Dames & Moore (2001) to perform a lake drawdown and hydraulic dredging feasibility study (see Section 1.3.1 of this report).

In conjunction with the alternatives for restoration of the lake itself, the SJRWMD and Seminole County are in the process of studying and recommending water quality

improvement projects for the contributing surface water subbasins surrounding Lake Jesup. Recent basin engineering and drainage inventory studies have been performed for the Lake Jesup Basin (CDM, 2001), Gee Creek Basin (Singhofen, 1996a), Soldiers Creek Basin (Singhofen, 1996b), Howell Creek Basin (DRMP, 1994), and Little Lake Howell Basin (Gee & Jenson, 1997). Implementation of water quality improvement projects for the Lake Jesup watershed will be critical to reduce post-dredging nutrient and sediment loading to the lake.

1.2 Objective and Scope

In 2001, the FWC received State funding for the Lake Jesup Aquatic Enhancement Project (the Project). The main objective of the Project is to dredge the lake-bottom nutrient-rich unconsolidated sediment layer and to enhance the aquatic vegetation around the lake's shoreline in an effort to reduce the lake's internal nutrient loading and sediment resuspension and subsequently improves the water quality and the aquatic habitats of the lake. The FWC and SJRWMD have worked cooperatively to identify land parcels for sediment deposal in the vicinity of Lake Jesup. As a result, an intergovernmental agreement between FWC and SJRWMD was reached to use the Cameron/Little Ranch property (Figure 1.2) located on the northern side of the lake for sediment disposal. The Project includes the following three phases:

- Preliminary Design (Phase I)
- Final Design and Permitting (Phase II)
- Construction Phase - General Administration of Construction Contracts (Phase III)

PB Water, a division of Parsons Brinckerhoff Quade & Douglas, Inc. was retained by the FWC to provide professional engineering services for the three phases of the Project. The PB Water scope of services for this phase (Preliminary Design) of the Project includes:

- Data review and collection, including sediment sampling, testing and analysis
- Estimation of sediment types, characteristics, and spatial distribution
- Conducting hydrographic survey and shoreline delineation
- Determination of dredging limits and corresponding total dredging volume
- Identification and prioritization of dredging areas within the lake
- Assessment and preliminary design of the Cameron/Little Ranch disposal site
- Preliminary environmental permitting assistance to the FWC

1.3 Relevant Previous Studies

1.3.1 Lake Jesup Drawdown/Dredging Feasibility Study

Under contract to the SJRWMD, Dames & Moore prepared a feasibility study of Lake Jesup to evaluate hydraulic dredging and lake drawdown alternatives for reducing sediment export to the St. Johns River (URS/Dames & Moore, 2001). Published in May, 2001, the study included the following detailed evaluations:

1. Pumped drawdown to -3.0 feet NGVD in order to expose, consolidate, and oxidize 50 to 55 percent of the lake-bottom sediment for a minimum period of 90 days, leaving a firm crust that is expected to remain indefinitely after lake refill. Lake Jesup

sediments contain approximately 82,800 tons of nitrogen (N) and 2,680 tons of phosphorus (P) (Keesecker, 1992). The drawdown would only expose 50 percent of the lake bottom and subsequently 50 percent of the nutrients (i.e., 41,400 tons N and 1,340 tons P). Assuming that 10 percent will remain bound in the sediment, then the drawdown could account for 4,100 tons of N and 134 tons of P removal. The cost of the drawdown option was estimated at between $25 million and $78 million.

2. Whole lake hydraulic dredging of the soft sediment would result in the removal of the total 82,800 tons of N and 2,680 tons of P. The cost of dredging and disposal of the 102 million cubic yards of sediment was estimated at $353 million.

A comparison of the anticipated short and long-term benefits was performed for the following four alternatives:

- No Action Alternative
- Drawdown Alternative
- Selective Hydraulic Dredging Alternative
- Whole Lake Hydraulic Dredging Alternative

Viewed from a cumulative impacts perspective, the analysis suggested that the whole lake dredging alternative would create the most significant positive long-term impact, with the lake drawdown alternative being the next most beneficial option.

1.3.2 Lake Jesup Hydrodynamic Model

The Florida Department of Transportation (FDOT) has determined that the existing SR 46 bridge over the confluence between Lake Jesup and the St. Johns River is in need of replacement. Upon a request from FDOT, the SJRWMD hired Scientific Environmental Applications, Inc., to prepare a three-dimensional hydrodynamic model of Lake Jesup. The modeling effort was conducted in two phases, with Phase II results being published in December, 2000 (Zarillo, 2000). The model was used to simulate and predict lake circulation and flushing patterns that would result from replacing the existing SR 46 bridge and/or causeway over the confluence between Lake Jesup and the St. Johns River with one of the replacement alternatives listed in Table 1.1. Figure 1.6 depicts the locations of Channel A, Channel B, Channel C, and the Government Cut.

Table 1.1 – State Route 46 Bridge and Causeway Replacement Alternatives (Zarillo, 2000)

Alternative	Channel A	Channel B	Channel C	Government Cut
Existing Condition	Open	Closed	Closed	Open
Case 1	Open	Open	Open	Closed
Case 2	Open	Open	Closed	Closed
Case 3	Open	Open	Open	Open
Case 4	Open	Open	Closed	Open
Case 5	Open	Closed	Open	Closed
Case 6 (1)	Open	Shallow	Shallow	Open

(1) Case 6 replaces the entire SR 46 causeway with shallow sheet flow through constructed marshland (except for Channel A , which remains as is).

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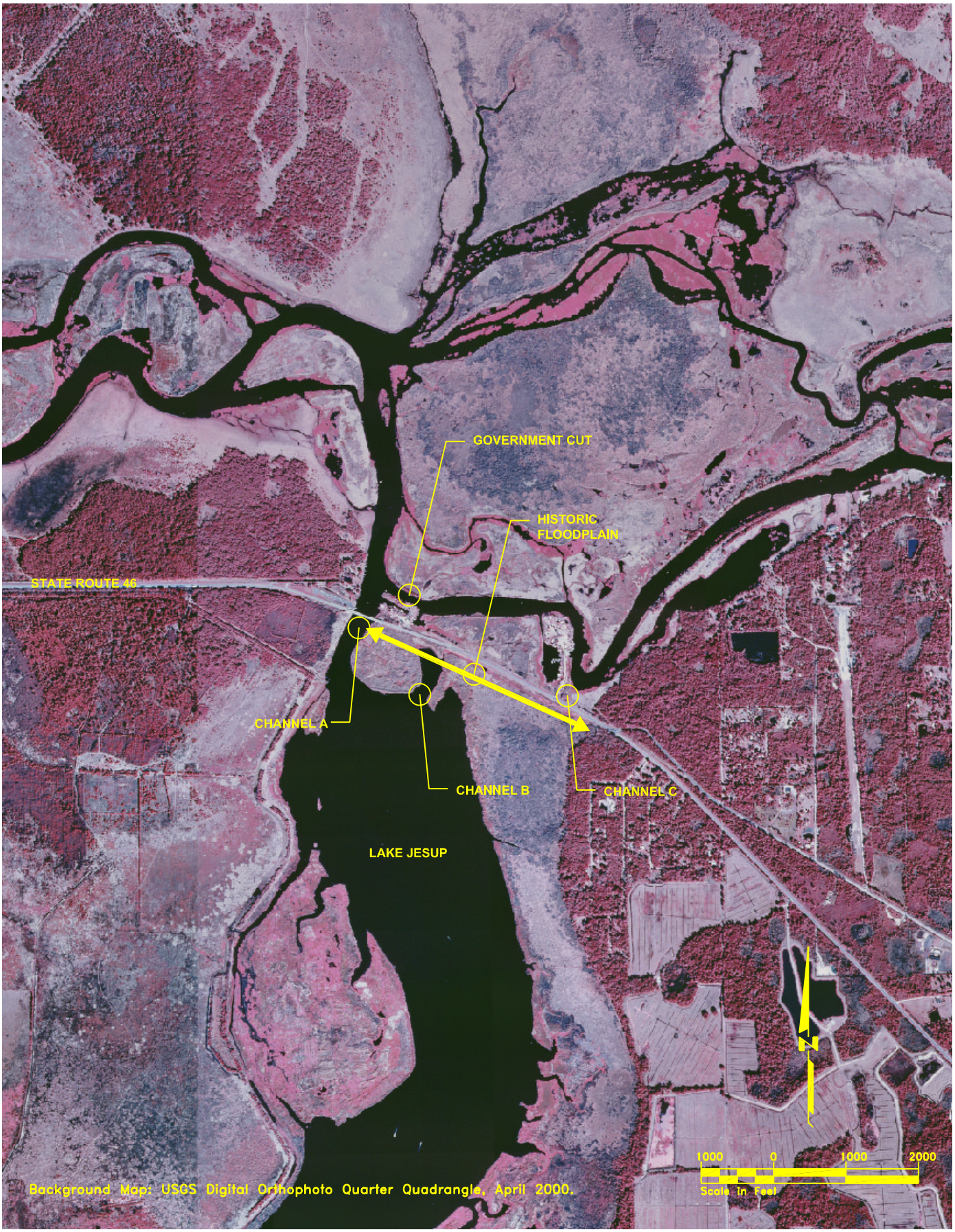

Figure 1.6

Lake Jesup
Outlet Channel Alternatives
at State Route 46

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Results of the model simulation indicated that Cases 1, 2 and 6 are the best alternatives with equal rank. Any of the three cases would provide good flushing of the upper lake area and moderate to good flushing of the central lake area. However, it is likely that the river water intruding into Lake Jesup would form a front that limits net flow in the lower lake and reduces flushing of the western compartments.

1.3.3 Lake Jesup Water Budget and Nutrient Budget

The water and nutrient budgets of Lake Jesup were investigated by Water and Air Research, Inc. (WAR), under contact to the SJRWMD. The results of the study were published as SJRWMD Special Publication SJ92-SP16 (Keesecker, 1992). The purpose of the study was to prepare comprehensive water and nutrient budgets for Lake Jesup based on available existing information from January 1980 to December 1990.

The final breakdowns of water budget and nutrient budget components for the lake were summarized as schematic diagrams in the report (attached herein as Appendix A for reference). The schematic diagrams include the estimated average annual values of the different components of Lake Jesup water and nutrient budgets for the period from January 1980 to December 1990. As shown in Appendix A (fig. 4.2.1, from Keesecker, 1992), the nitrogen and phosphorus pools (tons N, P) contained in the Lake Jesup sediment are much larger than those of the lake's water. However, the estimated annual nutrient fluxes (tons N, P per year) from the lake-bottom sediment into the water column are comparable to the other nutrient-contributing sources.

It should be emphasized that sediment dredging will significantly reduce one of the major nutrient sources within the lake, which is anticipated to improve the water quality of the lake. However, the watershed nutrient sources (i.e., surface runoff, bank seepage, and effluent discharges from existing wastewater treatment plants and on-site sewage disposal systems) also must be treated in order to maintain long-term water quality improvement.

1.3.4 Sediment and Nutrient Deposition in Lake Jesup

The sediment and nutrient deposition in Lake Jesup was investigated by a team of scientists from the University of Florida (UF), under a contract with the SJRWMD. The study was published as SJRWMD Special Publication SJ98-SP18 in December, 1997 (Cable et al., 1997). A brief summary of the study is provided below.

1.3.4.1 Sediment Sampling and Testing Programs

Sediment cores were obtained in March 1996 from 49 sampling locations that were established in an approximately equal grid within the open water area of the lake. The UF sampling locations are shown in Figure 1.7. As shown in the figure, the core samples were arranged in seven groups (Groups 21, B, 4, 40, 37, 43, and 45), representing various portions of the lake. These groups were based on the lake hydrology, geomorphology, and circulation patterns. Table 1.2 summarizes the average sediment thickness and water depth observed for each group.

The total depth of core samples collected at a given location ranged from 10 centimeters (cm) to 160 cm (approximately 0.33 to 5.25 feet) in depth. Sediment samples were collected from each core at 5-cm section intervals, resulting in a total of 786 sediment samples. The following laboratory tests were conducted on the samples:

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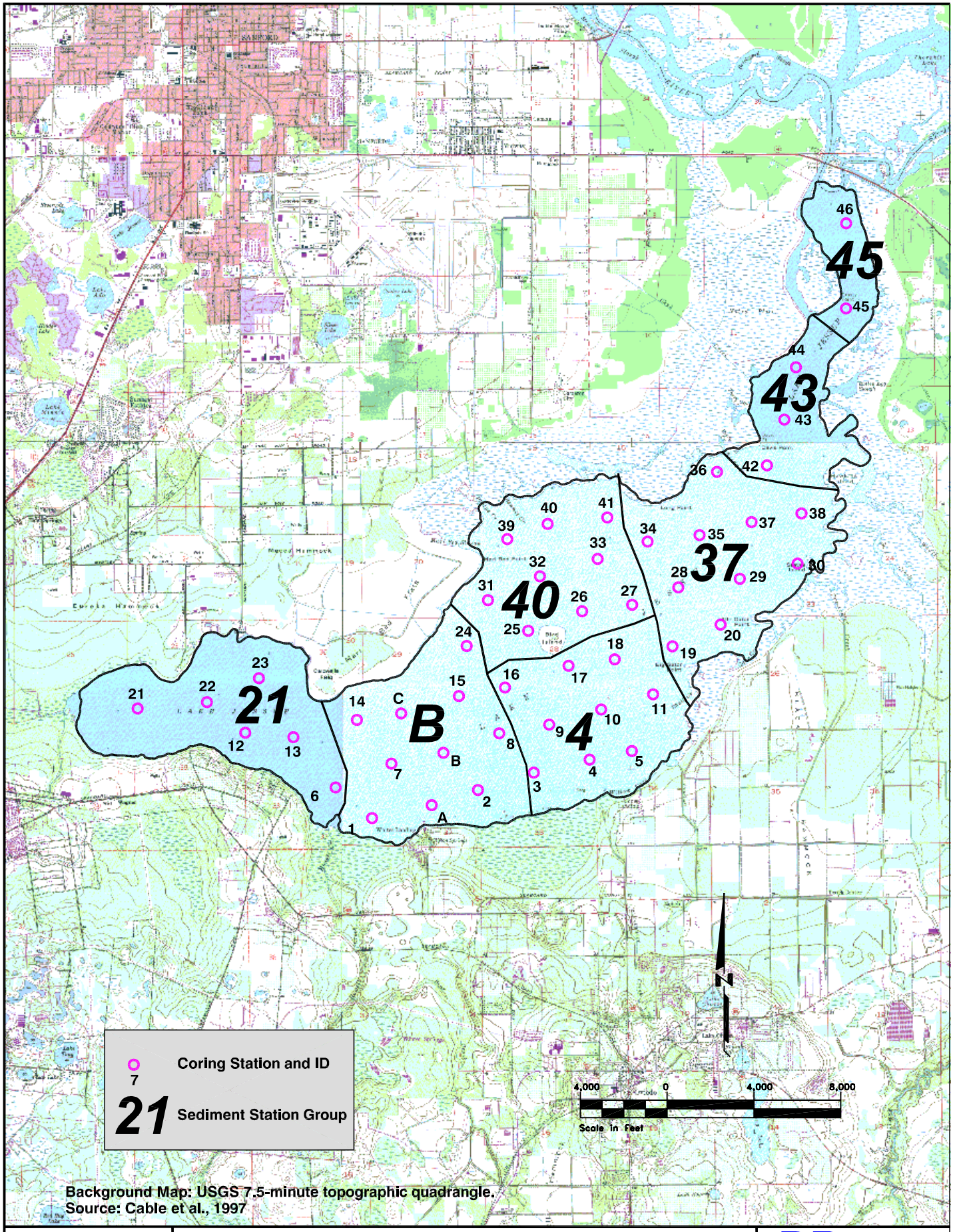

Background Map: USGS 7.5-minute topographic quadrangle.
Source: Cable et al., 1997

Figure 1.7

Lake Jesup
Sediment Coring Locations -
University of Florida Study, 1997

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- Nutrient tests (N, P, and organic content) on all core samples
- Lead-210 (^{210}Pb) dating and bulk sediment accumulation on eight core samples
- Silica measurements on six core samples

Table 1.2 – Lake Jesup Water Depth and Sediment Thickness (Cable et al., 1997)

Station Group (1)	Group Coverage		Mean Sediment Thickness (2) (feet)	Mean Water Depth (feet)
	Area (acres)	Percentage (%)		
21	1,868	17.5	7.5	6.0
B	1,697	15.9	9.2	6.2
4	1,697	15.9	4.9	6.3
40	1,954	18.3	3.0	6.3
37	1,772	16.6	5.9	5.9
43	952	8.9	5.6	5.7
45	760	7.1	5.6	6.7
Summary	**10,700**(3)	**100.0**	**5.9**	**6.2**

(1) Refer to Figure 1.7 for group areas.
(2) Includes all unconsolidated and a portion of the consolidated sediment
(3) Lake area from hydrographic survey (Arc Surveying & Mapping, Inc., 1996)

1.3.4.2 Sediment Types and Nutrient Characteristics

The UF study evaluated the vertical distribution and characteristics of sediments in Lake Jesup and identified the following two distinct sediment types:

- Upper sediments, which typically consist of loose organic material with some shell fragments and plant fibers present in places. The organic material content in the upper sediments is generally about 25 to 45 percent, with isolated samples of greater than 50 percent organic content.
- Deeper sediments, which generally contain some consolidated organic material but primarily consist of peat, sand, carbonate and gray/brown clays.

Nutrient analyses for all sediment samples included total phosphorus (TP), non-appetite inorganic phosphorus (NAIP), total organic carbon (TOC), and total nitrogen (TN). NAIP represents the fraction of TP that is biologically available. Nitrogen, carbon and phosphorus concentrations generally decrease with depth in the sediment profile. A horizon appears in TP concentrations at about 25 to 45 cm in most cores where the concentration decreases markedly from the surface to depth.

Sediments within the central and northern portions of the lake have consistently shown an increasing trend in organic matter content, TP, NAIP, and TN accumulation since the early 1900s. The western end of the lake (Group 21) has consistently reflected the highest accumulation of organic matter content and nutrients, particularly TN, during the 1950 to 1985 time interval, mainly due to wastewater effluent discharge into the lake.

The dry bulk density of the sediment samples ranged from near zero to about 1.5 grams per cubic centimeter (g/cm^3). As reported by Cable et al. (1997), most of the samples had dry bulk density values in the range of 0 to 0.25 g/cm^3.

1.3.4.3 Estimated Sediment Volume

Using the 1996 bathymetric survey (Arc, 1996) performed for the SJRWMD and the results of UF sediment sampling program, the report estimated that Lake Jesup contains about 102 million cubic yards (MCY) of soft sediments (Cable et al., 1997).

1.3.4.4 Sediment Depositional, Scour, and Transitional Zones

The UF study identified the following depositional, scour, and transitional zones within Lake Jesup. The depositional zones have the greatest accumulation of sediment with the longest historic record, while the transitional zones contain sediment that is typically subject to erosion, resuspension, and transport by physical processes to other locations.

- The western embayment is a depositional zone due to poor mixing with the rest of the lake, and possibly due to discharge from several historic wastewater effluent discharges.
- The southern perimeter of the lake within Groups 4 and 37 (Stations 4, 5, 11, 19, 20, 29, 30, and 38) is a depositional zone, where slowing currents deposit sediment.
- The central region of the lake (non-perimeter stations in Groups 4, 40 and 37) is a scour zone in which very little sediment is deposited.
- Transitional sites were identified along the north central edge of the lake (Stations 39, 40, 33, 35, 36, and 37) and within the narrow northern channel (Stations 42, 43, and 44).
- The greatest mass deposition occurred within Group 45 in the northern end of the lake due to river exchange. However, 81 percent of the sediment in this area was estimated to be inorganic.

2 PRE-DREDGING HYDROGRAPHIC SURVEY

2.1 Previous Hydrographic Survey of Lake Jesup

The SJRWMD hired Arc Surveying & Mapping, Inc. to conduct a hydrographic survey of Lake Jesup (Arc, 1996). The survey was completed in 1996 and included measurements of the top elevations of Lake Jesup sediment. A copy of the 1996 hydrographic survey report for the lake is provided as Appendix B. As documented in the report, a fathometer with a 200 megahertz transducer was used to determine the lake bottom elevation. Such an instrument would generally identify the top of unconsolidated sediment. The survey did not include information on sediment layering or hard bottom elevation. As a result, the 1996 survey was only used as a tool in planning the 2002 hydrographic survey of Lake Jesup that was conducted for this study, as described in the following section.

2.2 Updated Hydrographic Survey of Lake Jesup

For this Project, Foresight Surveyors, Inc. (FSI) was retained by PB Water to conduct a detailed hydrographic survey of Lake Jesup (FSI, 2002). The survey covered the entire open water area of the lake and extended to the edge of the shoreline vegetation around the lake. The survey included measurement of the top elevations of the upper-most unconsolidated sediment layer, the underlying consolidated sediment layer, and the lake's hard bottom. As directed by the FWC, the May 2002 shoreline vegetation delineation survey (Figure 1.2) defined the lateral extents within which dredging may be performed. In addition to the lateral dredging limits defined by the FWC, the results of the hydrographic survey were used to select the vertical dredging limits. The thickness and volume of the uppermost unconsolidated sediment layer, and the thickness of the underlying consolidated layer, were computed from the results of the hydrographic survey.

2.2.1 Fieldwork

The fieldwork for the hydrographic survey was started in April 2002 and completed in May 2002. The survey results were delivered to PB Water in June 2002. All depth measurements were referenced to the 1929 National Geodetic Vertical Datum (NGVD) in feet. Over the duration of the fieldwork in April and May 2002, the mean daily lake water elevation was recorded by FSI so that the actual elevations of sediment layers could be computed from the surveyed depths. During this time, the lake water elevation was in the lower portion of its normal range, ranging from 0.61 feet NGVD to 0.83 feet NGVD, with a mean value of approximately +0.7 feet NGVD. Horizontal control was referenced to North American Datum (NAD) 1983 state plane coordinates, Florida East zone, in feet. The survey work was performed by experienced hydrographic surveyors under the direct supervision of a Florida Registered Surveyor and Mapper.

The fieldwork included collecting measurements of the top elevations of the following surfaces:

1. *Surface #1* – The top surface of the upper-most unconsolidated (floc) sediment layer, which is planned to be dredged under this Project. The unconsolidated sediment layer consists mainly of black and very loose organic matter (muck) that contains, in some places, small quantities of shell fragments and plant fibers.
2. *Surface #2* – The top surface of the underlying consolidated layer, which mainly consists of plastic clay that generally contains small quantities of black decomposed organic matter, except for small areas within the lake where sand, thin layers of tan carbonate (marl), and/or soft brown/black fibrous organic deposits exist.
3. *Surface #3* – The top surface of the lake's hard bottom, limited to a minimum elevation of -11.3 feet NGVD, which corresponds to the full extent of the 12-foot survey rod (given the +0.7 feet NGVD mean lake water surface elevation during the survey period).

Figure 2.1 shows the locations of the hydrographic survey measurement points. A survey baseline, consisting of four segments, was selected along the approximate longitudinal centerline of the lake. Subsequently, survey points at approximate 500 to 1,000-foot spacing were selected parallel and perpendicular to the baseline. The survey baseline was not monumented in the field; however, the Florida state plane coordinates (NAD83 in feet) of the baseline were determined from the FSI survey maps. Trimble (4700 RTK Model) Global Positioning System (GPS) receivers were used for horizontal location of the survey points within the lake, utilizing the Cape Canaveral Coast Guard beacon (Site ID No. 809) for control. The actual state plane coordinates of the survey points were digitally recorded and stored using a Trimble Survey Controller (TSC1) installed on the survey boat.

The sediment/water interface, or the top surface of the unconsolidated sediment layer (Surface #1), was accurately detected and the corresponding depth was measured at each survey location using the photoelectric device (PED) shown in Figure 2.2. The depth measurements were made by slowly lowering the PED sensor into the water. When the sensor reaches the sediment/water interface, the light beam within the sensor becomes blocked, and the device activates an audible alarm signal. The PED was raised and lowered several times at each location to ensure accurate depth measurements. The top elevations of the upper-most unconsolidated sediment layer (Surface #1) were then calculated using the water level records of the two USGS water level gages located on the perimeter of the lake, as shown in Figure 1.4.

The top surface of the underlying consolidated layer (Surface #2) was detected and its corresponding depth was measured at each survey location using a graduated survey rod with an 8-inch diameter aluminum plate attached at its tip. The rod was manually forced into the sediment until it came to a full stop. The top elevations of the consolidated layer (Surface #2) were calculated using the daily USGS water level records.

The top surface of the lake's hard bottom (Surface #3) was detected and the corresponding depth was measured at each survey location using a 12-foot long graduated steel rod. The probe was forced into the sediment to a point of refusal. In areas of soft and deep clay deposits, the rod was pushed to its full extent, or to a low elevation of about -11.3 feet NGVD. Thus, the measured depths do not coincide with the actual hard bottom of the lake at deeper sediment depths.

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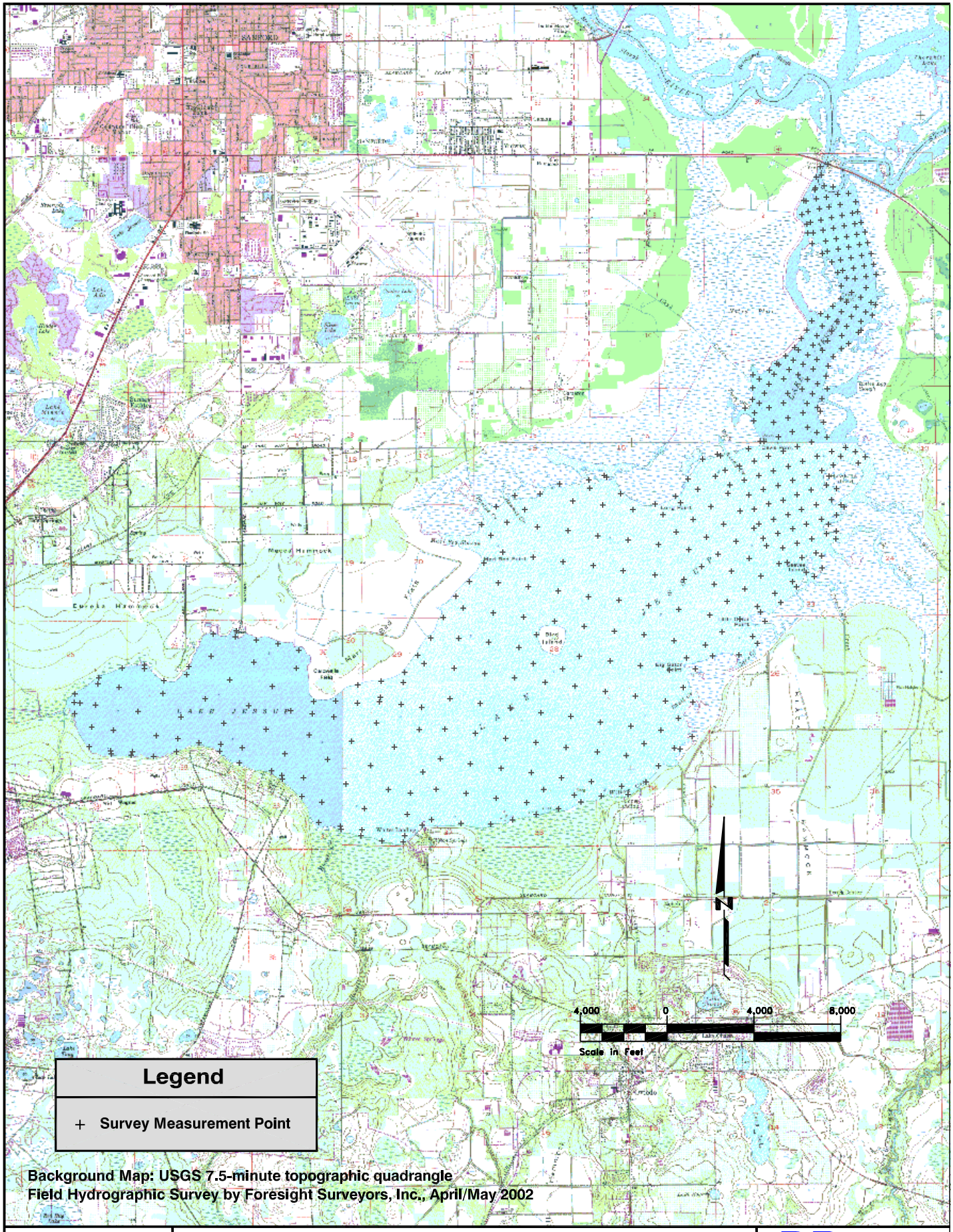

Figure 2.1

Lake Jesup
Hydrographic Survey Measurement Points

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Model 10 Sludge Gun, Manufactured by Markland Specialty Engineering, Inc.

Figure 2.2 - Photoelectric Device

2.2.2 Spatial and Vertical Distribution of Sediment

The spatial and vertical distribution of the different types of sediment existing within the open water area of Lake Jesup, as determined by the FSI survey, is presented in Figures 2.3 through 2.7. The survey data and field observations were recorded by FSI and the resulting digital files containing the state plane coordinates and elevations of the surveyed points were used to create color-shaded contour plots. The figures were prepared using linear/planar interpolation of the survey data to create Triangular Irregular Networks (TINs) for each of the three surfaces. These TINs were also used to estimate the unconsolidated sediment volumes for this Project, as detailed in Section 4 of this report.

The top surface of the upper-most unconsolidated sediment layer (Surface #1) is shown in Figure 2.3 with a 1-foot contour interval. As shown, the elevations vary between +0.8 feet NGVD along the shoreline of the lake to -8.8 feet NGVD in the vicinity of Lake Jesup spring near the southwest shoreline of the lake. The average elevation of Surface #1 is estimated at -2.5 feet NGVD. Also as shown, the majority of Surface #1 is above elevation -3 feet NGVD, except for several small and isolated depressional areas and a deep scour channel located along the southern central portion of the lake.

Figure 2.4 depicts the 1-foot elevation contours of the top surface of the underlying consolidated sediment layer (Surface #2). As shown, the elevations vary between +0.8 feet NGVD along the shoreline of the lake to -8.9 feet NGVD near Jesup Spring and the SR 417 bridge. The average elevation of Surface #2 is estimated at -4.1 feet NGVD. As seen in the figure, the majority of Surface #2 is above elevation -5 feet NGVD. Elevation contours of the top surface of the lake's hard bottom (Surface #3) are provided in Figure 2.5, down to a minimum elevation of -11.3 feet NGVD, which corresponds to the full extent of the survey rod as mentioned previously. The hard bottom elevations vary between -0.2 feet NGVD along the shoreline of the lake to -11.3 feet NGVD in the west central portion of the lake near the SR 417 bridge. The average elevation of Surface #3 is estimated at -8.0 feet NGVD.

The thickness of the unconsolidated sediment layer, which represents the difference in elevation between Surface #1 and Surface #2, was computed from the interpolated surface data (Figure 2.6). As seen in the figure, the thickness of the unconsolidated sediment layer varies between 0.0 feet and 6.1 feet. Except for an area of thick sediment deposits near the SR 417 bridge, the thickness of the unconsolidated sediment layer within the lake is generally less than 3 feet. Based on the FSI survey results, the average unconsolidated sediment thickness was computed at 1.62 feet, which is significantly less than the 5.9 feet of sediment thickness estimated by the 1997 UF study (Cable, et al., 1997). This is because the UF study included both unconsolidated and consolidated sediments in its estimate.

Figure 2.7 shows the thickness of the consolidated sediment layer within the open water area of the lake, which represents the difference in elevation between Surface #2 and Surface #3. The thickness of this underlying consolidated layer varies from 0.0 to 11.7 feet, with an average thickness of about 4.0 feet. It could be assumed that the lake's bottom sandy deposits may exist in the areas where the thickness of the consolidated layer is less than 1 foot. As shown, these areas are mainly located along most of the lake's northern shoreline, around Bird Island, and within the eastern outflow channel.

The average total (unconsolidated plus consolidated) sediment thickness measured in Lake Jesup was 5.62 feet, which is similar to the 5.9 feet estimated in the previous study by UF (Cable et al., 1997).

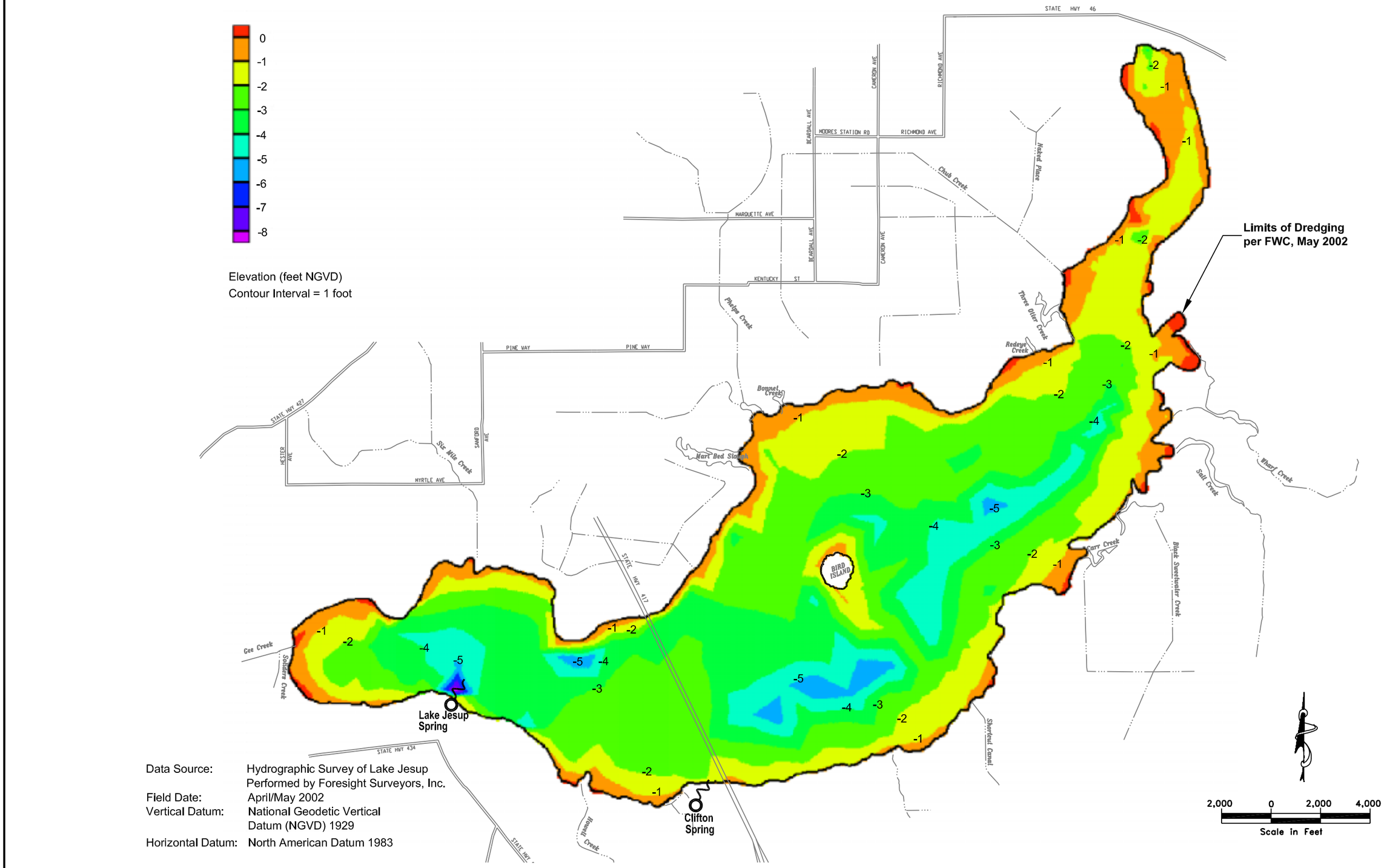

Figure 2.3

Lake Jesup
Top Elevation of Unconsolidated Sediment (Surface #1)

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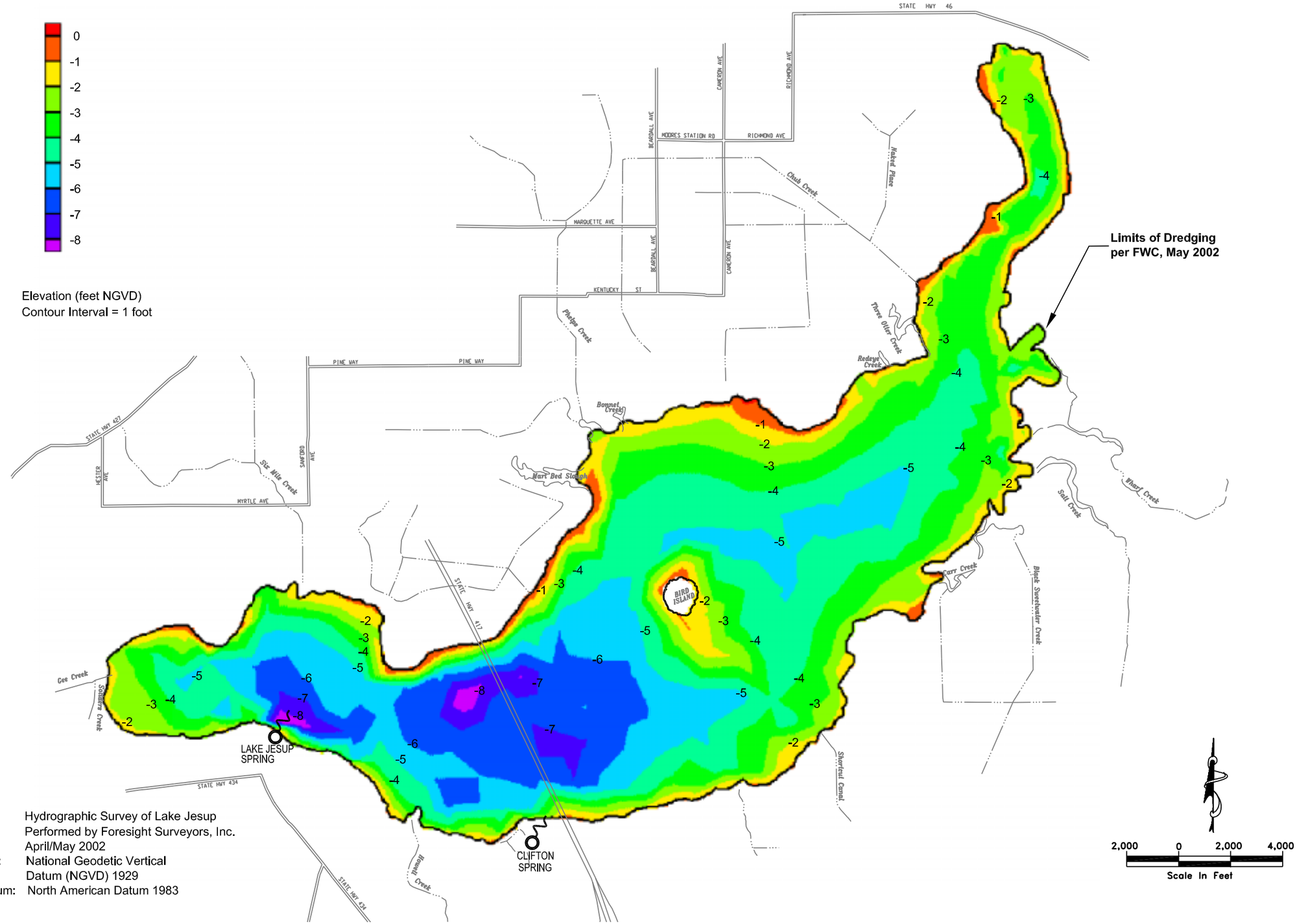

Data Source: Hydrographic Survey of Lake Jesup
Performed by Foresight Surveyors, Inc.
Field Date: April/May 2002
Vertical Datum: National Geodetic Vertical Datum (NGVD) 1929
Horizontal Datum: North American Datum 1983

Figure 2.4

Lake Jesup
Top of Consolidated Sediment (Surface #2)

PB Water
A Division of Parsons Brinckerhoff Quade & Douglas, Inc.
100 East Pine Street, Suite 500
Orlando, FL 32801 407-587-7600
Certificate of Authorization Number: 00001462

PLOTTED: August 13, 2002
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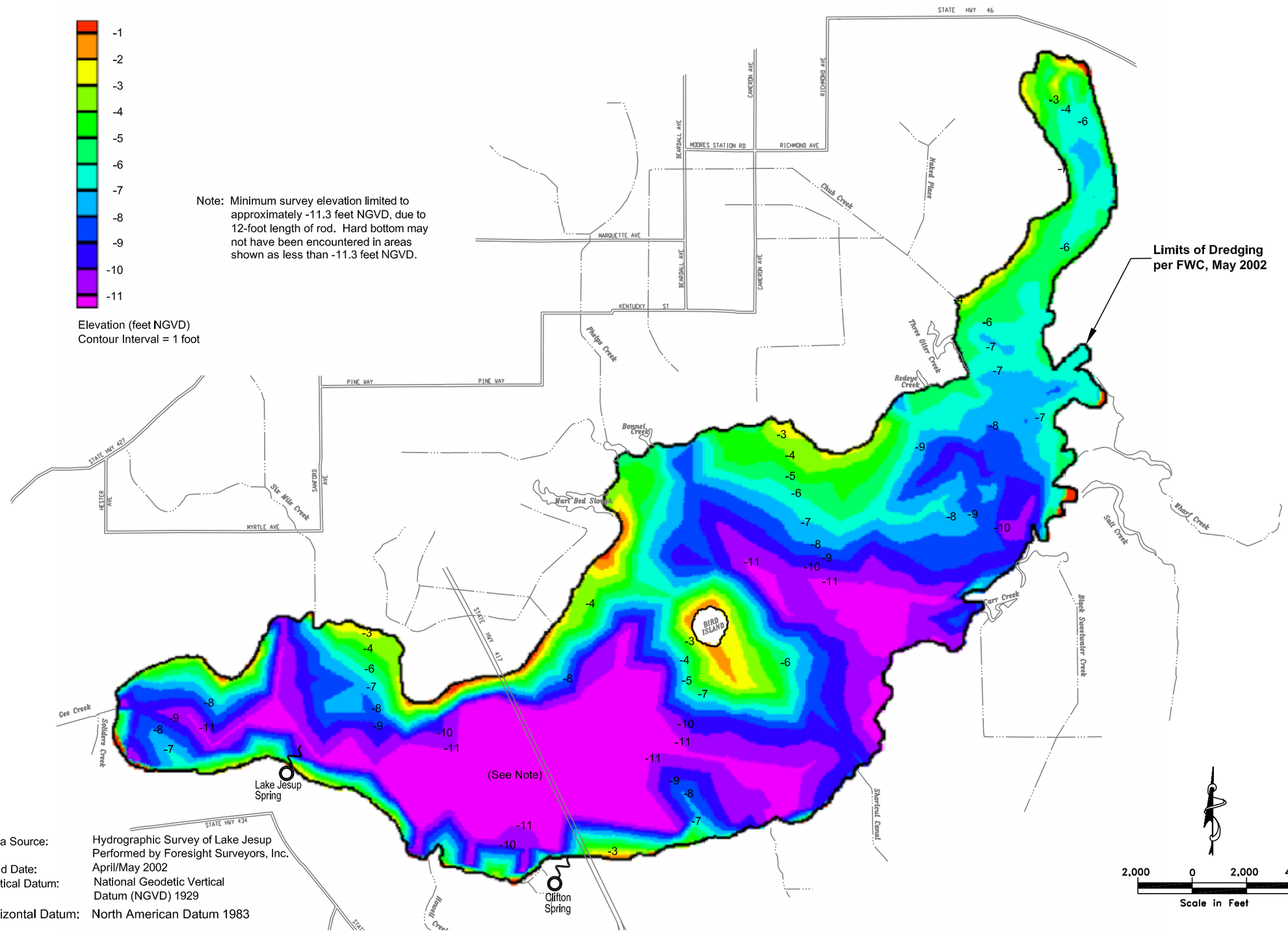

Figure 2.5

Lake Jesup
Top Elevation of Sediment Hard Bottom (Surface#3)

PB Water
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100 East Pine Street, Suite 500
Orlando, FL 32801 407-567-7900
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PLOTTED: August 13, 2002
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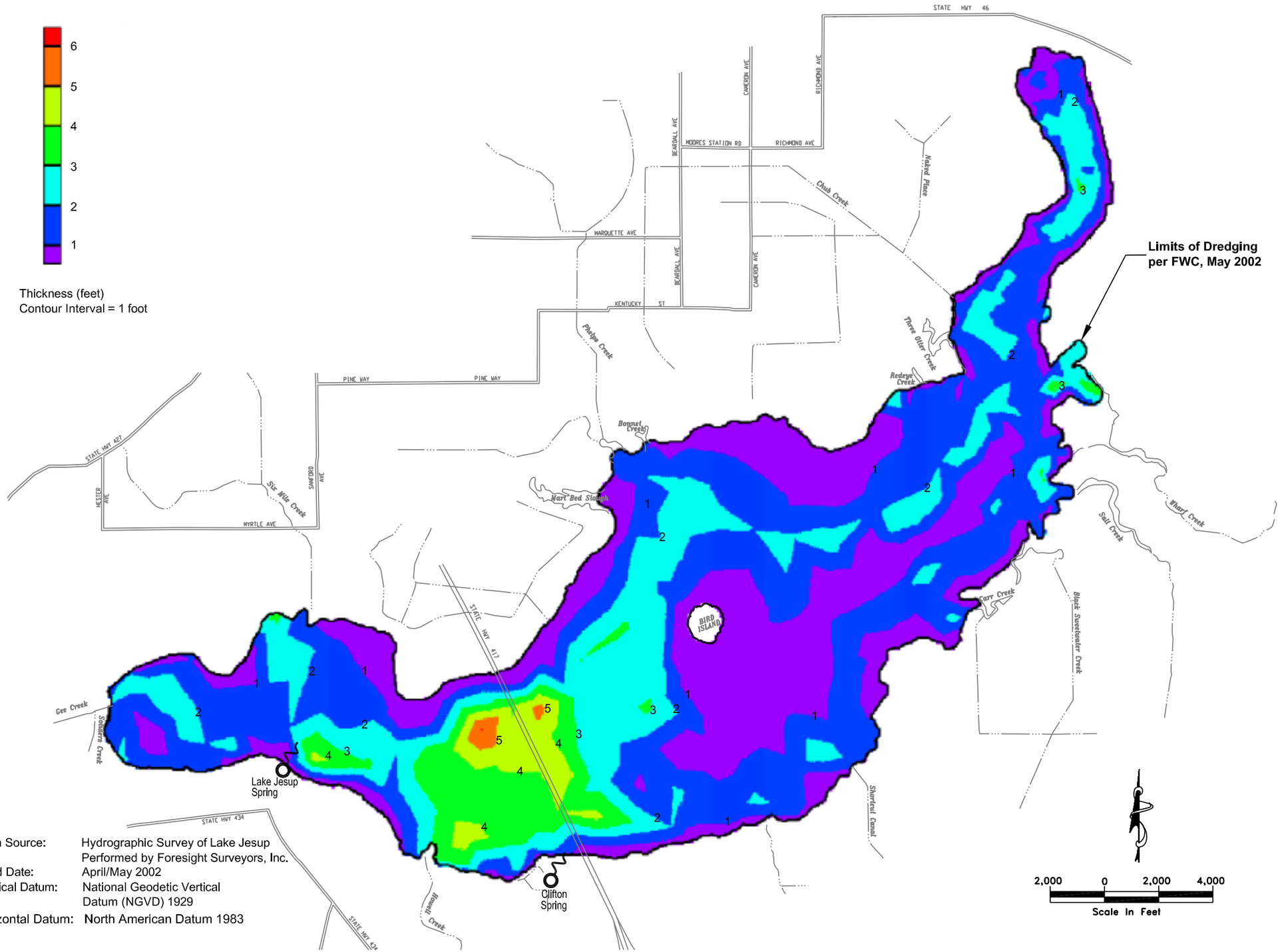

Figure 2.6

Lake Jesup
Thickness of Unconsolidated Sediment (Surface #1 Minus Surface #2)

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PLOTTED: August 13, 2002
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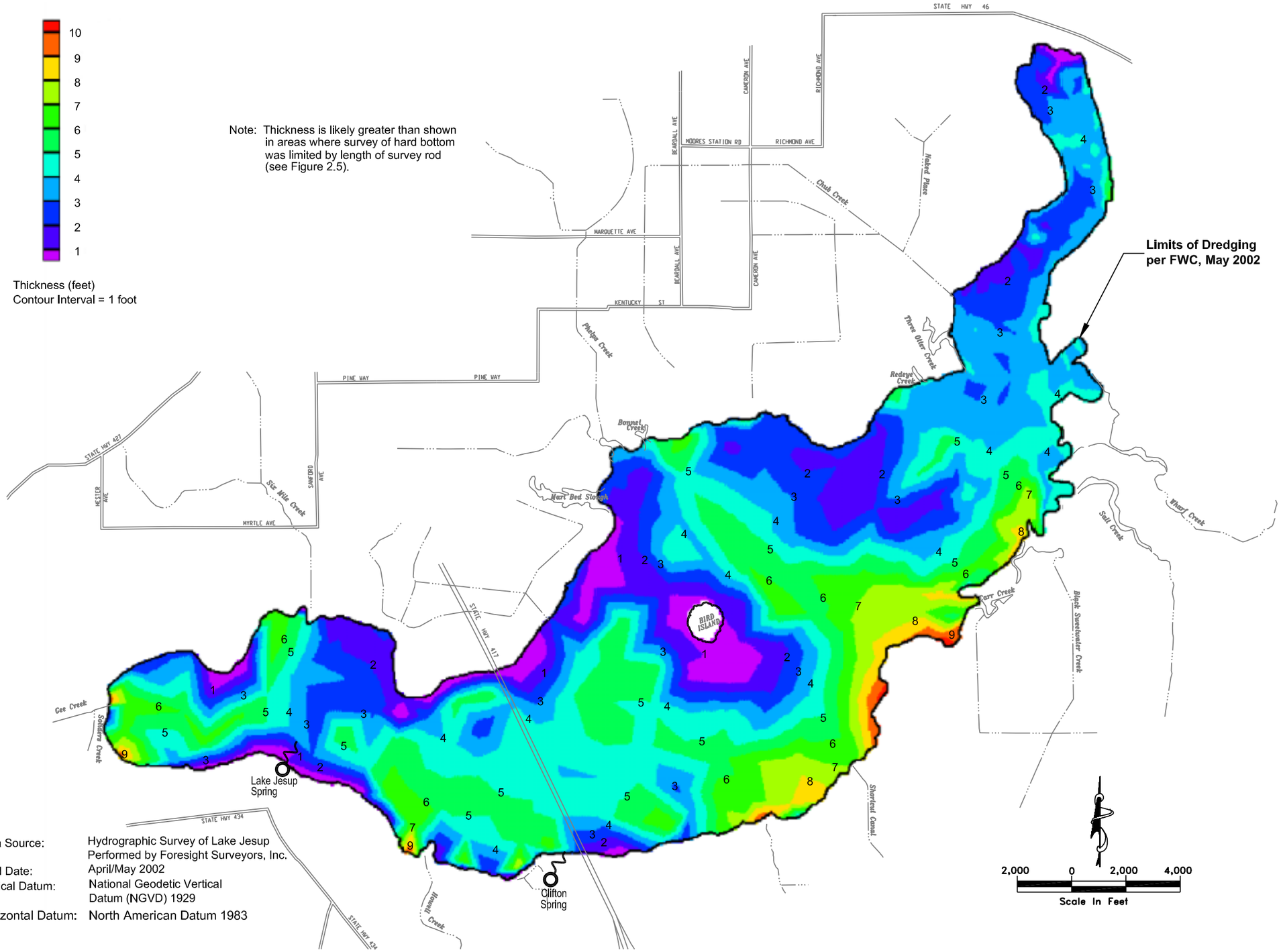

Figure 2.7

Lake Jesup
Thickness of Consolidated Sediment (Surface #2 Minus Surface #3)

PB Water
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100 East Pine Street, Suite 500
Orlando, FL 32801 407-587-7600
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PLOTTED: August 13, 2002
FILE NAME: Lake Jesup\PDR figures\Fig2_7new.dwg

3 SEDIMENT CHARACTERISTICS

3.1 Sediment Sampling Program

Madrid Engineering Group, Inc. (MEG) was retained by PB Water to conduct sediment sampling and physical testing and for this phase of the Project (Phase I - Preliminary Design). A copy of the MEG report is provided as Appendix C. Prior to the fieldwork, PB Water used the results of the previously referenced hydrographic survey of Lake Jesup (Arc, 1996) and the sediment and nutrient deposition in Lake Jesup (Cable et al., 1997) to identify 30 sediment coring locations within the open water area of Lake Jesup, including several locations near the discharge points of some of the lake's major tributaries (Figure 3.1). The sediment coring locations were selected so that the entire range of sediment types, thicknesses, and water depths could be assessed. The coring locations were located in the lake by the FWC using a GPS unit and were staked using clearly marked PVC pipes prior to the fieldwork.

The final locations of the sediment core samples, along with the corresponding numbers and types of samples collected by MEG in April 2002 at each location, are summarized in Table 3.1. As shown in the table, the sediment sampling program included the following:

- The water depth (to top of unconsolidated material) was measured at each coring location.
- Several 1-pint jar samples were collected from incremental sediment depths at each of the 30 coring locations shown in Figure 3.1. These sediment samples were collected using a hand-held piston sampler similar to that shown in Figure 3.2. The sediment samples were collected at 0.5-foot intervals in the upper 1 foot of unconsolidated sediment and at 1-foot intervals thereafter, until the top surface of the underlying consolidated layer (Surface #2) was reached, or to a maximum unconsolidated sediment thickness of 4 feet, whichever was shallower. As shown in Appendix C, the jar samples ranged from 4 inches to 4 feet in sediment depth. As shown in Table 3.1, a total of 102 jar sediment samples were collected from the 30 coring locations.
- Each sediment sample was carefully extruded from the piston sampler, visually classified in the field by a qualified engineering technician, immediately placed in a 1-pint plastic jar, and sent to the MEG laboratory by the end of each working day. As shown in Appendix C, the jar samples were numbered according to their locations (Figure 3.1) and depths (referenced to top of unconsolidated sediment—Surface #1). The size of each sediment sample was large enough to perform the physical characterization tests described in Section 3.2.
- Using the piston sampler, a 5-gallon bucket sediment sample was collected from the total unconsolidated sediment thickness at 27 of the coring locations shown in Figure 3.1 and Table 3.1. No bucket samples were collected from Locations 10, 18, and 20 due to a lack of sufficient unconsolidated sediment at these locations. As shown in Appendix C, the bucket samples ranged from approximately 6 inches to 4 feet of collected sediment thickness. Approximately 1 gallon of lake water was added to

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FILE NAME: Lake Jesup\PDR figures\Fig3_1.dwg

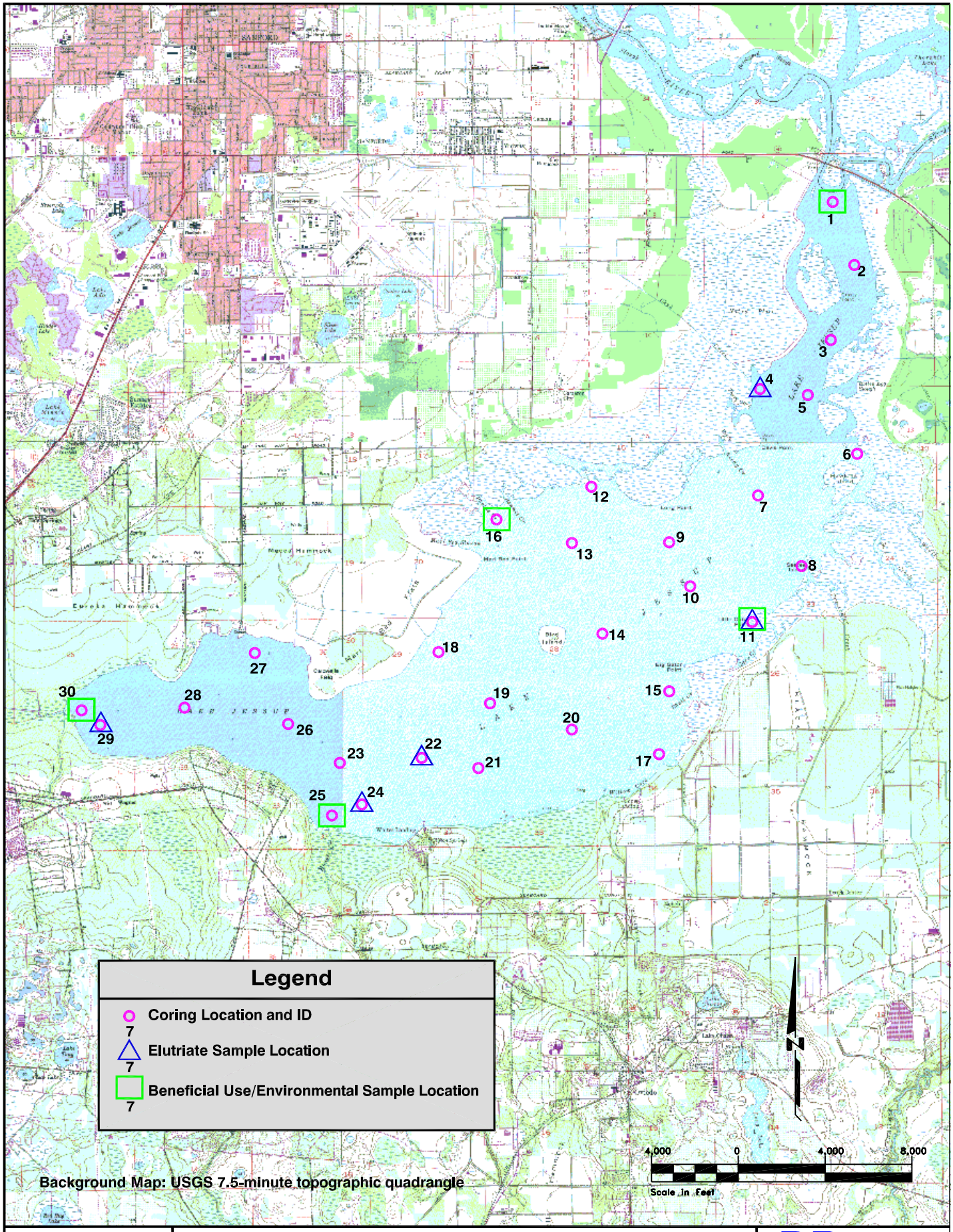

Figure 3.1

Lake Jesup

Sediment Coring Locations, April 2002

PB Water
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Quade & Douglas, Inc.
100 East Pine Street, Suite 500
Orlando, FL 32801 407-587-7800
Certificate of Authorization Number: 00001462

Table 3.1 – Lake Jesup Sediment Coring Locations and Samples Collected, April 2002

Coring Location/ Sample ID [1]	State Plane Coordinates (NAD83)		Number of Sediment and Water Samples Collected				
	Northing (feet)	Easting (feet)	5-Gallon Sediment Buckets for Physical Testing [2]	1-Pint Jar Sediment Samples for Physical Testing [3]	5-Gallon Sediment Buckets for Elutriate Testing [4]	5-Gallon Water Buckets for Elutriate Testing [4]	Sediment Jars for Beneficial Use Analysis Testing [5]
1	1,616,618	598,772	1	1			2
2	1,613,704	599,773	1	6			
3	1,610,228	598,683	1	4			
4	1,607,957	595,405	1	4	1	1	
5	1,607,684	597,620	1	4			
6	1,604,964	599,904	1	5			
7	1,603,034	595,316	1	4			
8	1,599,765	597,328	1	4			
9	1,600,865	591,200	1	3			
10	1,598,830	592,175		3			
11	1,597,176	595,044	1	2	1	1	2
12	1,603,438	587,600	1	2			
13	1,600,832	586,698	1	2			
14	1,596,634	588,112	1	2			
15	1,593,969	591,207	1	3			
16	1,601,921	583,209	1	5			2
17	1,591,058	590,734	1	3			
18	1,595,784	580,524		1			
19	1,593,415	582,910	1	4			
20	1,592,197	586,694		2			
21	1,590,415	582,369	1	2			
22	1,590,884	579,743	1	5	1	1	
23	1,590,654	575,952	1	4			
24	1,588,731	576,973	1	5	1	1	
25	1,588,219	575,588	1	2			2
26	1,592,456	573,563	1	3			
27	1,595,741	572,017	1	4			
28	1,593,211	568,765	1	3			
29	1,592,410	564,866	1	5	1	1	
30	1,593,086	564,000	1	5			2
TOTALS			27	102	5	5	10

(1) Refer to Figure 3.1.
(2) Physical testing performed by MEG on 18 buckets and by University of Florida on 9 buckets.
(3) Physical testing performed by MEG on all 102 jar sub-samples.
(4) Elutriate testing on sediment and water samples performed by Environmental Research & Design, Inc.
(5) Beneficial use analysis chemical testing performed by PC&B Environmental Laboratories, Inc.

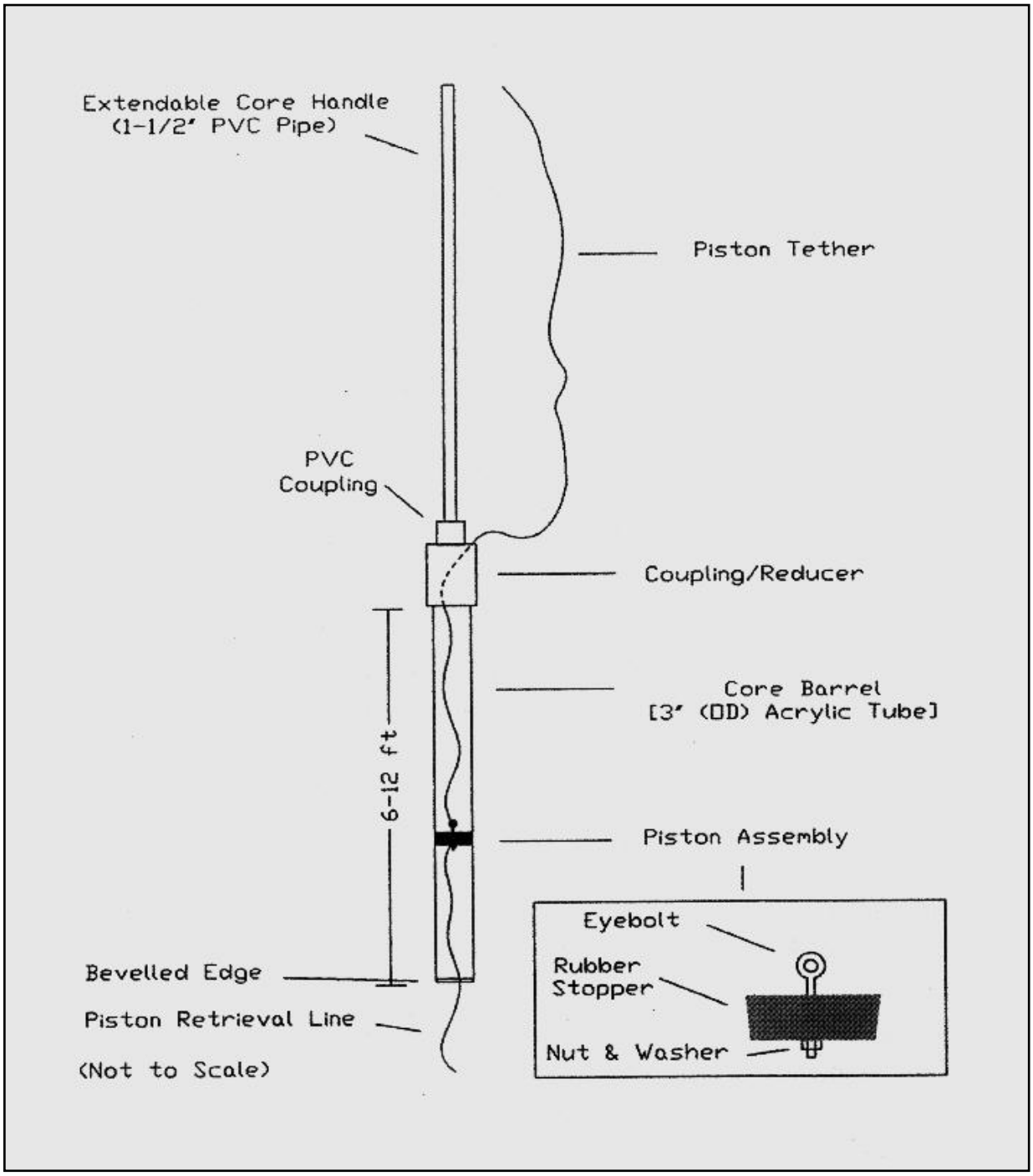


Figure 3.2 - Hand-Held Piston Sampler

each of the bucket samples. The buckets were tightly sealed immediately following collection, and subsequently were sent to the MEG laboratory for physical testing as described in Section 3.2 below.

- MEG shipped 9 of the 27 bucket samples (Buckets 3, 4, 5, 14, 15, 16, 27, 28, and 29) to the University of Florida laboratory for column settling and flocculation testing (see Sections 3.2.7 and 3.3.1).
- In addition to the first 27 bucket samples, MEG collected two more 5-gallon bucket samples from 5 of the 30 coring locations shown in Figure 3.1 and Table 3.1 (Locations 4, 11, 22, 24, and 29). Of these two 5-gallon bucket samples, the first bucket consisted of sediment and water, and the second bucket consisted of only lake water. These ten buckets were delivered to the laboratory of Environmental Research & Design, Inc. (ERD) for elutriate and flocculation testing, as described below in Sections 3.3.1 and 3.3.2.
- Finally, two environmental jar samples were collected from the upper 4 to 12 inches of unconsolidated sediment at five selected coring locations (Locations 1, 11, 16, 25, and 30). As seen in Figure 3.1, these five sampling locations were selected near the discharge locations of some of the lake's major tributaries, where past wastewater and industrial discharges were reported. The jar samples were immediately sealed, stored in an ice cooler, and sent to the PC&B Environmental laboratory on the same day they were collected for chemical testing and beneficial use analysis (see Section 3.3.3). The jar samples were collected, handled, transported, and delivered in accordance with PC&B's state-approved Quality Assurance Project Plan (QAPP).

3.2 Laboratory Testing Program – Physical Characteristics

3.2.1 Sample Preparation

As mentioned above, the jar and bucket sediment samples, which were collected during the sampling program, were sent to different laboratories for physical, chemical, and beneficial use testing. All laboratory tests were performed in general accordance with applicable standards. Some of the bucket samples were mixed and thoroughly homogenized into composite sediment samples. The jar, bucket and composite samples were subjected to the laboratory tests detailed in Appendices C through F and summarized in the following sections.

3.2.2 Visual Classification

All jar sediment samples were visually inspected and classified in the field by MEG using the procedures outlined by the Unified Soil Classification System (ASTM D-2487). The results of the visual classification are included in the laboratory report (Appendix C). The visual classification results, together with the results of the following laboratory tests, were used to identify the different sediment types and corresponding characteristics.

Similar to the UF study (Cable et al., 1997), the visual classification of sediment samples that were collected for this study indicates that Lake Jesup sediment mainly consists of an upper layer of unconsolidated (floc) sediment underlain by a consolidated sediment layer. The unconsolidated sediment layer mainly consists of black and very loose organic matter (muck) that contains, in some places, small quantities of shell fragments and plant fibers.

The consolidated sediment layer consists mainly of plastic clay that generally contains small quantities of black decomposed organic matter, except for small areas within the lake where sand, thin layers of tan carbonate (marl), and/or soft brown/black fibrous organic deposits exist.

3.2.3 Moisture and Solids Content Testing

Natural moisture and solids content testing was performed on each of the 102 jar sediment samples that were collected by MEG for this study. The tests were performed in accordance with the procedures outlined in ASTM D-2216. Also, moisture and solids content tests were conducted on the fine fraction (portion passing through a U.S. No. 40 sieve size) of 14 selected jar samples to determine the actual behavior of the fine fraction of unconsolidated sediment after gravity settling and segregation from the coarser fraction and shells in the disposal area.

Additional moisture and solids content testing was conducted on jar, bucket, and composite samples in conjunction with the other laboratory tests described below. It should be emphasized that the measured solids or moisture contents may vary slightly from the actual in-situ values due to inappropriate sampling or potential loss of moisture prior to laboratory testing.

The moisture and solids content are two different ways of presenting the moisture condition of sediment, computed as follows:

$$w_c = (w_w / w_s) \times 100\% \quad \text{..... [3-1]}$$

$$s = (w_s / w_t) \times 100\% \quad \text{..... [3-2]}$$

where
- w_c = moisture content, expressed as a percentage by weight;
- s = solids content, expressed as a percentage by weight;
- w_w = weight of water;
- w_s = dry weight of solids; and
- w_t = $w_w + w_s$ = total weight of sample.

The results of the solids and natural moisture content tests are detailed in Appendix C and summarized in Table 3.2 for the 102 jar sediment samples collected by MEG. Figure 3.3 shows the variation of the solids content of all 102 sediment samples versus depth, while Figure 3.4 shows the variation of the solids content versus depth for only unconsolidated jar sediment samples. The graph depicted in Figure 3.4 excludes unconsolidated sediment samples that contained shells or mineral deposits due to anticipated segregation of the coarser fractions of sediment in the disposal area. The plot also excludes the uppermost unconsolidated sediment samples (0 to 6 inches) due to inaccuracy as a result of possible dilution with water during sampling. As shown in the figure, the solids content of sediment generally increases with depth, presumably due to self-weight consolidation and a decrease in organic content with depth.

Assuming an average dredging depth of about 1.5 feet, an average solids content of 14.2 percent (by weight) was estimated for this portion of unconsolidated lake sediment and was used in the preliminary sizing analysis of the disposal area (see Table 3.2).

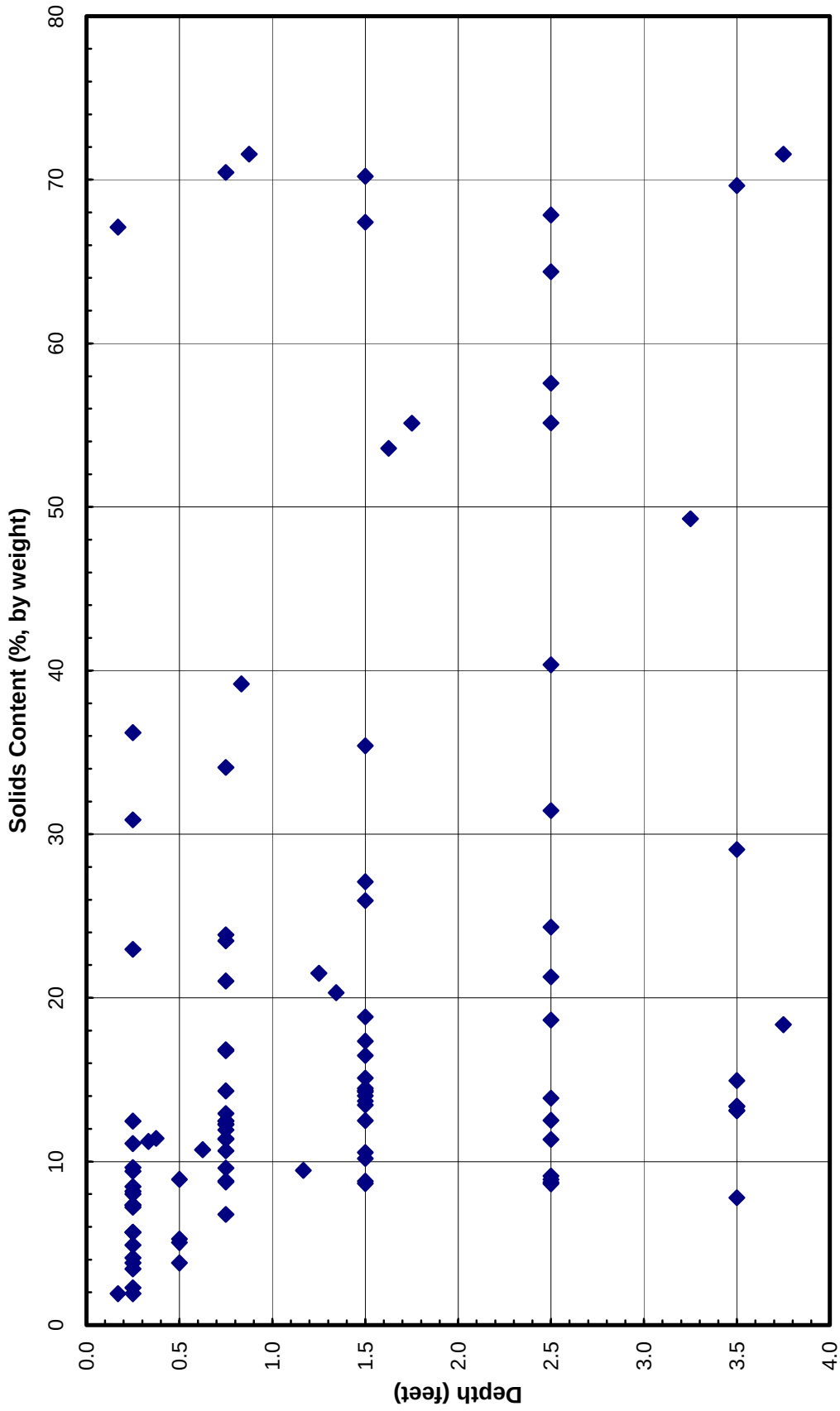


Figure 3.3 - Lake Jesup Sediment Solids Content vs. Depth

Data Source: Laboratory Analysis of Discrete Sediment Samples, Madrid Engineering Group 2002

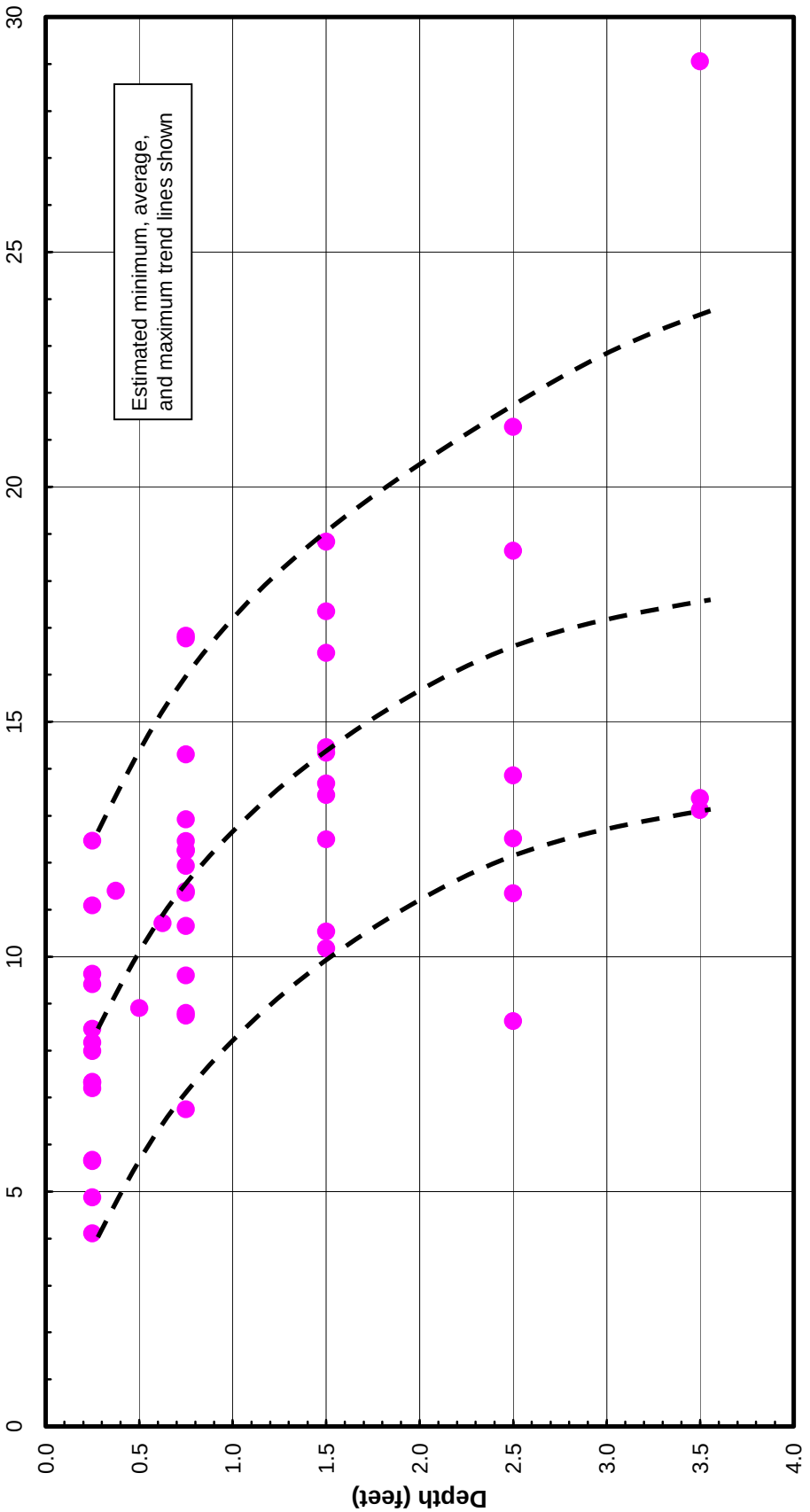


Figure 3.4 - Lake Jesup Sediment Solids Content vs. Depth (Unconsolidated Samples Only, Excluding Uppermost Samples and Samples Containing Shells/Mineral Deposits)

Data Source: Laboratory Analysis of Discrete Sediment Samples, Madrid Engineering Group 2002

Table 3.2 – Lake Jesup Sediment Solids Content vs. Depth for Jar Samples

Sediment Depth (1) (feet)	All Jar Samples (Unconsolidated and Consolidated Sediment Samples)			Only Unconsolidated Sediment Samples (Excluding Uppermost Samples and Samples Containing Shells/ Mineral Deposits)		
	Solids Content (%, by weight)			Solids Content (%, by weight)		
	Minimum	Maximum	Average	Minimum (2)	Maximum (2)	Average (2)
0.0 – 0.5	1.9	67.1	12.5	4.0	12.5	8.3
0.5 – 1.0	3.8	71.6	18.1	7.0	16.0	11.5
1.0 – 2.0	8.7	70.2	23.7	10.0	18.8	14.2
2.0 – 3.0	8.6	67.9	28.4	12.0	21.5	16.5
3.0 – 4.0	7.8	69.6	24.2	13.0	23.5	17.5

(1) Depth into sediment, referenced to elevation of top of unconsolidated material (Surface #1).
(2) Trend line value (Figure 3.4).

3.2.4 Organic Content Testing

Organic content tests were conducted on a selection of 14 jar sediment samples and 5 bucket samples, as shown in Tables 3.3 and 3.4, respectively. The tests were conducted on the fine fractions of the sediment samples after removing large shells and coarse particles. The jar and bucket samples were chosen to be representative of the entire range of unconsolidated sediment depths and moisture contents across the open water area of the lake.

The organic content is defined as the ratio of organic weight to the total dry weight of a sample, expressed as a percentage. The organic content test is conducted by weighing the sample after drying it in a 100^{o}C oven for 24 hours, then weighing it again after heating it in a 300^{o}C furnace for 8 hours to burn off the organic contents, leaving behind inorganic sediment. The organic content represents the percentage of weight loss.

As shown in Table 3.3, the organic content of the fine fractions of the 14 jar sediment samples varied between 16.1 and 42.2 percent. As shown in Table 3.4, the organic content of the 5 bucket samples varied between 18.5 and 34.0 percent.

The variation of the organic content versus solids content for the 14 jar sediment samples is presented as Figure 3.5. As shown in the figure, a power formula correlation was developed between solids and organic content. Using this correlation and assuming an average solids content of 14.2 percent for the upper 1.5 feet of unconsolidated sediment, an average organic content of 26.0 percent was estimated for this same sediment thickness.

3.2.5 Carbon Content, Atterberg Limits, and Specific Gravity Testing

MEG also conducted carbon content, Atterberg limits, and specific gravity tests on five bucket samples of unconsolidated sediment after removing large shells and coarse particles. The results are included in Table 3.4.

Table 3.3 – Lake Jesup Sediment Organic Content Results for 14 Jar Samples (Sediment Passing No. 40 U.S. Sieve)

Sample Number [1]	Sediment Depth [2] (feet)	Solids Content (%, by weight)	Organic Content [3] (%)
2	2.0 – 3.0	17.8	23.3
5	0.5 – 1.0	16.3	26.0
6	1.0 – 2.0	16.2	22.5
7	1.0 – 2.0	23.7	17.9
10	0.5 – 1.0	23.0	22.1
13	0.0 – 1.5	11.9	26.4
16	0.5 – 1.0	20.4	20.7
17	0.0 – 0.5	8.0	32.3
20	0.5 – 1.0	28.7	16.1
22	0.5 – 1.0	6.7	42.2
23	2.0 – 3.0	23.9	20.1
25	0.0 – 0.5	36.1	16.9
27	1.0 – 2.0	15.0	26.5
29	0.5 – 1.0	13.0	32.4

(1) Refer to Figure 3.1 for sample locations.
(2) Referenced to elevation of Surface #1.
(3) Does not include shells that were removed on No. 40 Sieve.

Table 3.4 – Lake Jesup Unconsolidated Sediment Test Results for Five Bucket Samples (Excluding Large Shells and Coarse Particles)

Bucket Sample Number [1]	Sediment Depth [2] (feet)	Solids Content (%, by weight)	Fines Content (Percent Passing No. 200 Sieve) (%)	Organic Content (%)	Carbon Content [3] (mg/L)	Specific Gravity of Solids (G_s)
2	0.0 – 3.0	8.3	92.6	29.3	< 0.1	1.58
13	0.0 – 2.0	8.6	84.6	26.5	0.6	1.70
22	0.0 – 4.0	6.9	87.6	34.0	1.4	1.63
23	0.0 – 3.0	7.0	87.3	32.9	0.4	1.61
25 [4]	0.0 – 1.0	20.4	21.0	18.5	0.3	1.14 [5]

(1) Refer to Figure 3.1 for bucket sample locations.
(2) Depth into sediment, referenced to elevation of top of unconsolidated material (Surface #1).
(3) Does not include shells that were removed during sample preparation.
(4) Contained shell fragments and sand.
(5) Questionable value.

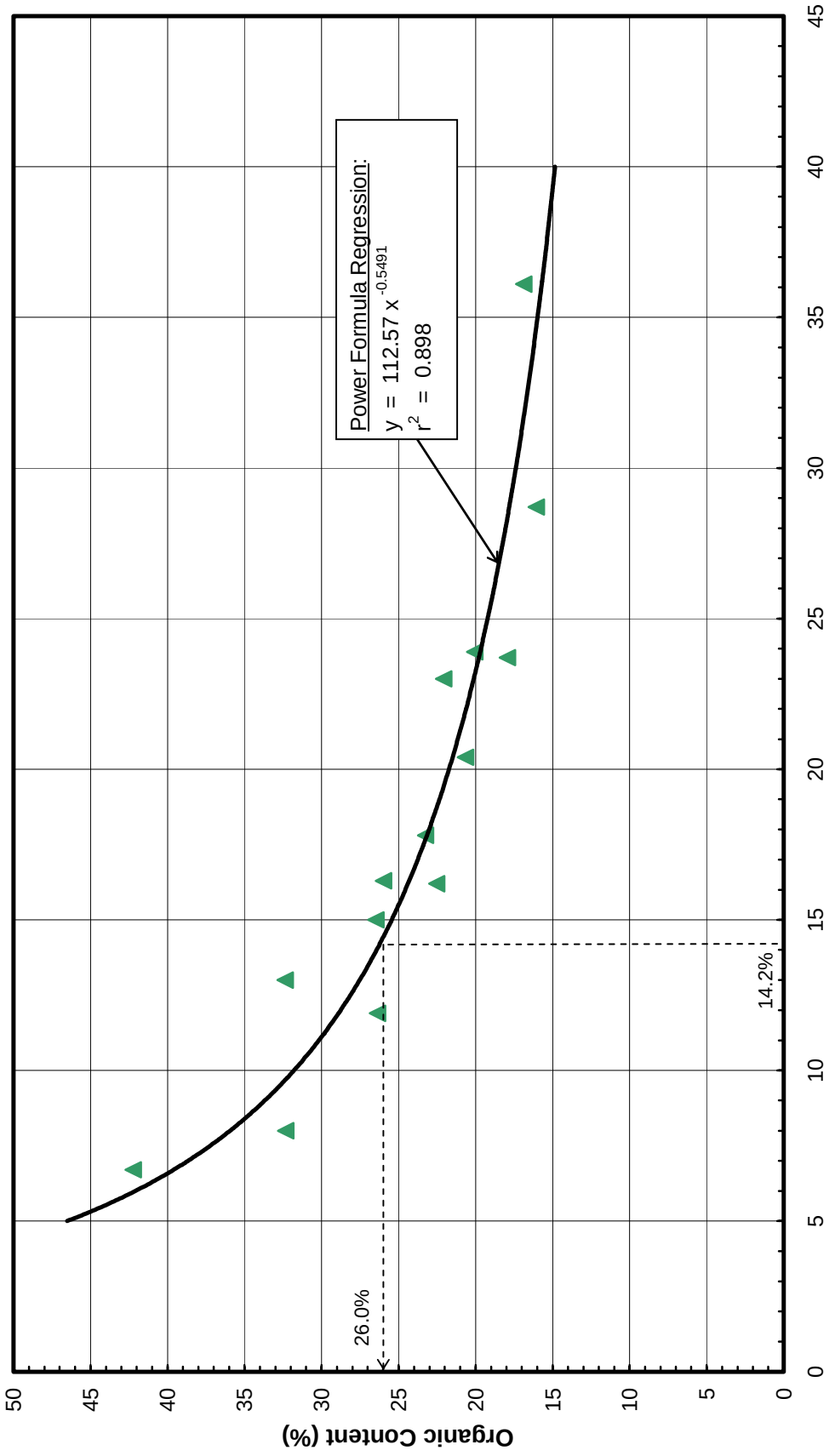


Figure 3.5 - Lake Jesup Sediment Organic Content vs. Solids Content

Data Source: Laboratory Analysis of Discrete Sediment Samples, Madrid Engineering Group 2002

Similar to an organic content test, the carbon content test is conducted by weighing the sample after drying it in a 100°C oven for 24 hours, then weighing it again after heating it in a 950°C furnace for 8 hours to burn off the organic and carbonate contents. The carbon content is then calculated from the Loss on Ignition (LOI) using the molecular weight and atomic weight ratio of carbon dioxide and carbon. The carbon content of the unconsolidated sediment, after removing all shells and coarse particles, varied from less than 0.1 milligrams per liter (mg/L) to 0.4 mg/L.

The Atterberg limits test results indicated that all unconsolidated sediment samples are non-plastic, which is consistent with highly organic (muck) sediment.

The specific gravity (G) for any substance is the ratio of its weight to the weight of an equal volume of water. From the bucket sediment samples, MEG computed the specific gravity of the solids (G_s), which is the specific gravity of only the solid portion of the sediment. The tests were conducted in accordance with ASTM D-854. With the exception of the G_s value for Bucket 25 that was questionably measured at 1.14, the G_s values for the unconsolidated sediment ranged between 1.58 and 1.70 with an average of 1.63. The G_s results are consistent with those found in the literature for organic sediment in Florida lakes.

3.2.6 Grain Size Distribution Testing

3.2.6.1 Full Sieve Analysis

MEG conducted full grain size distribution tests on five bucket samples of unconsolidated sediment after removing large shells and coarse particles. The tests were conducted in accordance with ASTM D-422-63, *Particle Size Analysis of Soils*, for the soil fraction greater than 0.074 mm (No. 200 U.S. Sieve) using the wet sieve procedure. The grain size distribution curves for the individual samples are included in the MEG laboratory report (Appendix C).

The grain size distribution curves for all five bucket samples of unconsolidated sediment (with large shell fragments and coarse particles removed) are plotted together in Figure 3.6. The darker vertical lines on Figure 3.6 show the grain sizes at which the sediment samples could be fractioned into gravel, coarse sand, fine sand, silt, and clay size particles. As shown, sediment particles greater than 0.3 mm, which covers the grain size range of gravel and coarse sand, could be assumed to represent the shell fraction of sediment. With the exception of Bucket 25, which may contain a higher percentage of shell fragments, Figure 3.6 shows that the unconsolidated sediment samples contain less than 5 percent shell fragments, 6.1 to 12.6 percent of fine sand size particles, and more than 85 percent (by dry weight) of slit and clay size particles.

3.2.6.2 Fines Content

The fines content represents the percent by dry weight of sediment fractions passing through the No. 200 U.S. Sieve (finer than 0.074 mm). With the exception of Bucket 25 that contains a higher percentage of shell fragments, Table 3.4 illustrates that the fines content of the unconsolidated sediment samples ranged from 84.6 to 92.6 percent. In addition, MEG conducted fines content testing on 13 more bucket samples and the results are presented in Appendix C. The fines content of these samples varied from 25.4 to 91.0 percent, which is consistent with the other test results.

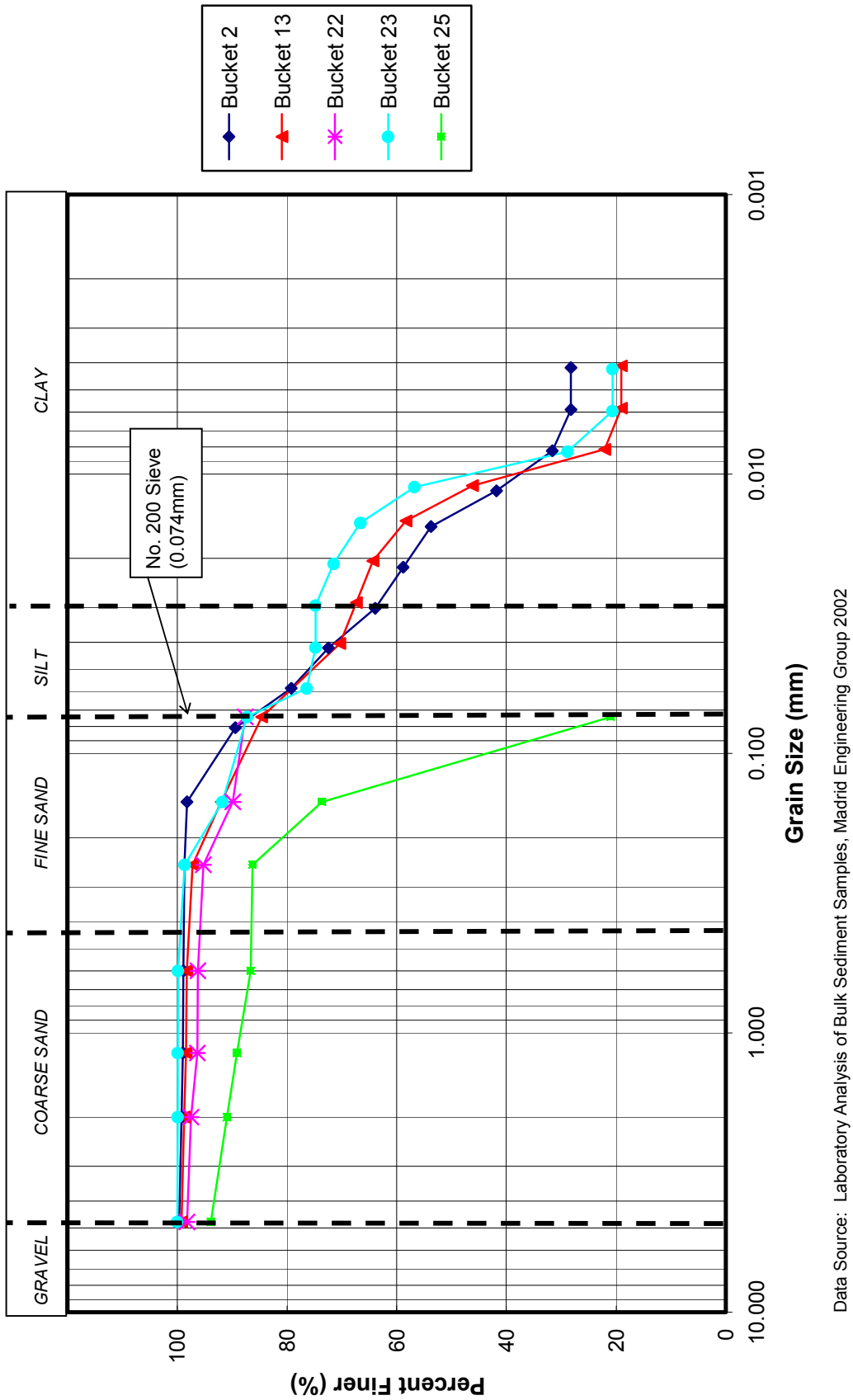


Figure 3.6 - Lake Jesup Sediment Grain Size Distribution Results

Data Source: Laboratory Analysis of Bulk Sediment Samples, Madrid Engineering Group 2002

3.2.6.3 Hydrometer Tests

Hydrometer tests were performed by MEG on three of the above five bucket samples (Bucket Samples 2, 13, and 23) to determine the percentages of the silt and clay fractions of unconsolidated sediment. As shown in Figure 3.6, the results were plotted on the corresponding grain size distribution curves. The fines fraction of unconsolidated sediment consisted approximately of 63 to 75 percent clay and 25 to 37 percent silt.

3.2.6.4 Column Settling Tests

Column settling tests are required to determine the sedimentation or settling and clarification behaviors of sediment in the disposal area. The results are required to estimate the retention time and area/volume requirements for clarification of the return water from the disposal area, in order to meet applicable State water quality standards prior to discharge back into the lake or other receiving water bodies. The settling process of a slurry with a very low solids content commonly behaves as "flocculent settling." Flocculent settling also describes the behavior of residual suspended solids in the clarified supernatant water above the water/sediment interface for slurries exhibiting an interface. At higher solids concentrations, the settling process behaves as "zone settling", in which a clearly defined interface is formed between the supernatant water and the settling materials.

The nine 5-gallon bucket samples that were sent to the University of Florida laboratory were reduced to three 15-gallon composite samples by combining and thoroughly mixing Buckets 3, 4, and 5 into Composite Sample A; Buckets 14, 15, and 16 into Composite Sample B; and Buckets 27, 28, and 29 into Composite Sample C. As seen by the relative locations of these nine samples in Figure 3.1, the three Composite Samples A, B, and C are representative of the eastern, central, and western portions of the lake, respectively. The three composite samples were then subjected to the following column settling and flocculation tests. The test procedures and results are detailed in the UF final report, included herein as Appendix D.

For column settling, each composite sample was:

- Sieved using a No. 10 U.S. Sieve to remove shells and coarse particles;
- Diluted to an initial solids content of about 5 percent to resemble the lower limit of solids content anticipated during dredging;
- Thoroughly homogenized using a mixer; and
- Immediately poured into a clear plastic column (5.7-inch inside diameter) for testing.

Similar to that described in the U.S. Army Corps of Engineers Manual EM 1110-2-5027 (ACOE, 1987a), each column was equipped with side probes, spaced at 1-foot intervals, to extract small sub-samples for solids content testing during the settling test. The initial heights of the samples were selected at 6, 5, and 4 feet for Samples A, B, and C, respectively. The height of the water/sediment interface was recorded for each test at increasing time intervals for a total period of 3 weeks. Also, small sediment sub-samples were extracted from each side probe after 1, 5, and 15 days of settling. At the end of each settling test, all supernatant water together with the upper 1 inch of settled sediment was removed and the remaining sediment was homogenized and tested for fine, solids, organic, and total carbon contents.

The results of the three settling tests are shown in Figure 3.7 (normalized values) and summarized in Table 3.5. The results indicated that zone process is prevalent, with shell fragments and coarse particles dropping immediately out of suspension, followed by a turbid water/sediment interface. A clear/ turbid water interface started to develop at the top of the

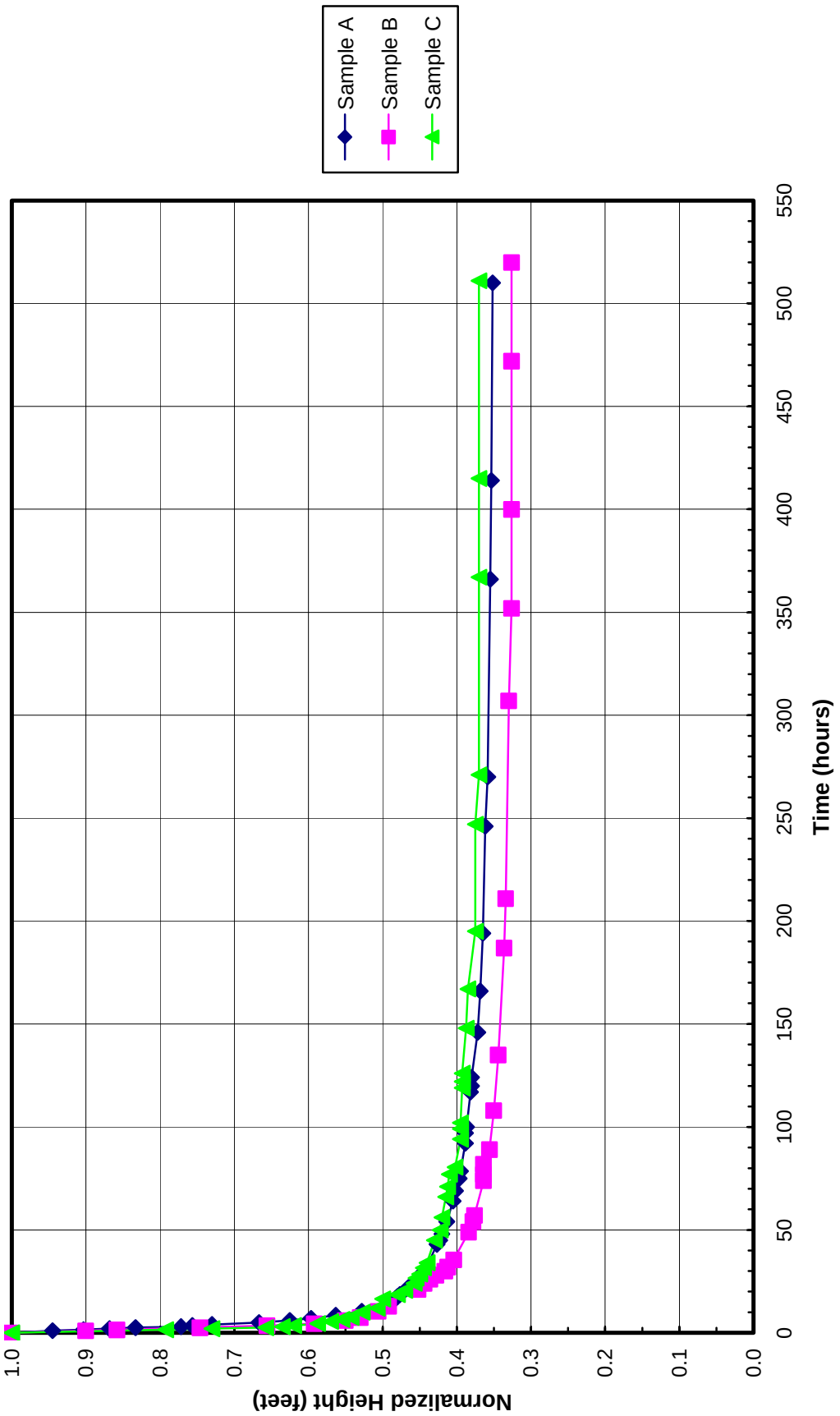


Figure 3.7 - Lake Jesup Sediment Column Settling Test Results

Data Source: Laboratory Analysis of Composite Bulk Sediment Samples, University of Florida 2002

Table 3.5 – Lake Jesup Sediment Column Settling Test Results

Composite Sample ID (1)	Height of Side Probe (feet)	Solids Content (%, by weight) after			Average Solids Content of Settled Sediment (%, by weight)	Percent Passing No. 200 Seive (%)	Organic Content (%)	Total Carbon Content (2) (%)
		1 day	5 days	15 days				
A	5.5	0.2	0.2	0.2	10.8	61.4	20.0	8.5
	4.5	1.2	0.3	0.3				
	3.5	1.2	0.8	0.3				
	2.5	5.9	2.8	0.4				
	1.5	7.6	9.2	9.4				
	0	8.1	12.0	16.9				
B	4.5	0.1	< 0.1	< 0.1	8.7	66.3	25.1	9.7
	3.5	0.1	0.1	0.1				
	2.5	0.2	0.1	0.1				
	1.5	6.1	6.0	0.8				
	0	14.2	11.4	16.6				
C	3.5	0.3	0.2	0.2	8.1	42.4	24.8	10.2
	2.5	0.3	0.2	0.2				
	1.5	4.0	8.6	2.1				
	0.5	4.0	9.4	14.1				

(1) Composite Sample A is a combination of bucket samples 3, 4, and 5.
Composite Sample B is a combination of bucket samples 14, 15, and 16.
Composite Sample C is a combination of bucket samples 27, 28, and 29.
Refer to Figure 3.1 for locations of original bucket samples.
(2) Does not include shells that were removed on No. 10 U.S. Sieve during sample preparation.

water column after a few days. As shown in Figure 3.7, the initial height of the turbid water/ sediment interface reached an average value of about 45 percent after 1 day of settling and an asymptotic value of about 33 percent after 15 days of settling. The settling rates of the three samples are similar and relatively rapid, but the turbidity of the supernatant water remained high.

Table 3.5 shows that the solids content (by weight) of settled sediments at the bottom of the three columns, which mainly contain coarser particles, ranged from 14.1 to 16.9 percent after 15 days of settling. The average solids content for the settled sediments, after removing all supernatant water together with the upper 1 inch of settled sediment, ranged from 8.1 to 10.8 percent by weight after 15 days of settling. As a result, an average solids content range of 15 to 20 percent (by weight) at the end of dredging/sediment disposal was selected for use in the sizing analysis the disposal area.

3.2.7 Weight-Volume Relationship

The physical characteristics described above were based on sediment component weights, since standard laboratory testing procedures for these sediment properties incorporate weight measurements. As an alternative, it is sometimes useful to consider these characteristics based on volume. The measured specific gravity of the solids (G_s) for an unconsolidated sediment sample would allow a conversion between weight and volume. However, the G_s

values measured for Lake Jesup unconsolidated sediment are variable, which makes conversion to volume-based characteristics dependent on the individual sample. Nonetheless, the average measured G_s value of 1.63 can be used to obtain approximate volume-based physical characteristics.

Lake-bottom sediment consists of two main components: soil (solids) and water. The soil component can be subdivided further into organic and inorganic material. For a given sample, each sediment component has an associated weight and volume. The components, weights and volumes for a sediment sample are sometimes presented as a phase diagram. Figure 3.8 presents such a phase diagram for a "typical" 1-cubic-foot (ft^3) sample, representative of the measured average in-situ condition at a depth of 1.5 feet.

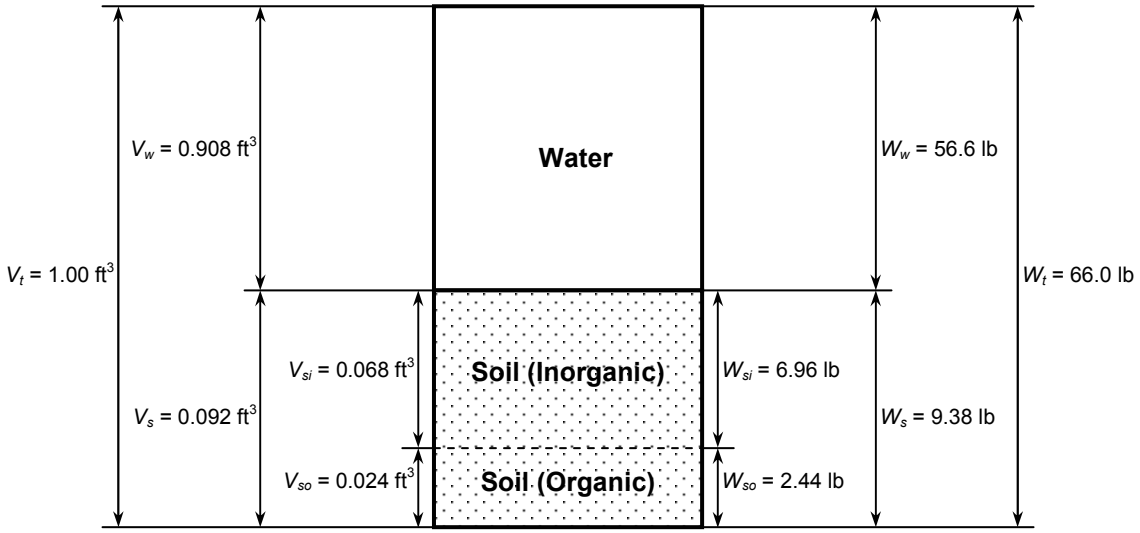
As shown in Figure 3.8, the solids content by volume (s_v) can be computed from the measured solids content by weight (s) and the measured G_s value. An average s value of 14.2 percent by weight corresponds to a value of 9.2 percent by volume. Using an assumed value of 1.63 for G_s, a summary of approximate solids content values, based on volume, are presented in Table 3.6 for the Lake Jesup sediment jar samples.

Because organic content, carbon content, and fines content are all defined as a percentage of the total soil (solid) component of sediment only (water is removed before measuring these parameters), the values of these physical characteristics are the same on a by-weight or by-volume basis. The percentage values shown in the subsections above for these parameters can be interpreted as percent by weight or by volume.

Table 3.6 – Lake Jesup Sediment Solids Content (Volumetric Basis) vs. Depth

Sediment Depth (1) (feet)	All Jar Samples (Unconsolidated and Consolidated Sediment Samples)			Only Unconsolidated Sediment Samples (Excluding Uppermost Samples and Samples Containing Shells/ Mineral Deposits)		
	Solids Content (%, by volume) (2)			Solids Content (%, by volume) (2)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
0.0 – 0.5	1.2	55.6	8.1	2.5	8.1	5.3
0.5 – 1.0	2.4	60.7	11.9	4.4	10.5	7.4
1.0 – 2.0	5.5	59.1	16.0	6.4	12.4	9.2
2.0 – 3.0	5.5	56.5	19.6	7.7	14.4	10.8
3.0 – 4.0	4.9	58.4	16.4	8.4	15.9	11.5

(1) Depth into sediment, referenced to elevation of top of unconsolidated material (Surface #1).
(2) Computed from Table 3.2 as $s / (s + 1.63 (1 – s))$.



"TYPICAL" 1-CUBIC-FOOT UNCONSOLIDATED SEDIMENT SAMPLE (REPRESENTATIVE OF AVERAGE IN-SITU CONDITION)

Volume Components

V_{so} = volume of organic solids
V_{si} = volume of inorganic solids
V_s = volume of solids (V_{so} + V_{si})
V_w = volume of water
V_t = total volume of sediment (V_s + V_w)

Weight Components

W_{so} = weight of organic solids
W_{si} = weight of inorganic solids
W_s = weight of solids (W_{so} + W_{si})
W_w = weight of water
W_t = total weight of sediment (W_s + W_w)

Properties

$$G_s = \text{specific gravity of solids} = \frac{W_s}{V_s \times (62.4\ \text{lb/ft}^3)} = \frac{9.38\ \text{lb}}{(0.092\ \text{ft}^3)(62.4\ \text{lb/ft}^3)} = 1.63$$

$$s = \text{solids content (by weight)} = \frac{W_s}{W_t} = \frac{9.38\ \text{lb}}{66.0\ \text{lb}} = 0.142 \quad (14.2\%)$$

$$s_v = \text{solids content (by volume)} = \frac{V_s}{V_t} = \frac{s}{s + G_s(1-s)} = \frac{0.092\ \text{ft}^3}{1.00\ \text{ft}^3} = 0.092 \quad (9.2\%)$$

$$\text{organic content (by weight or volume)} = \frac{W_{so}}{W_s} = \frac{2.44\ \text{lb}}{9.38\ \text{lb}} = 0.260 \quad (26.0\%) = \frac{V_{so}}{V_s}$$

Figure 3.8 - Lake Jesup Unconsolidated Sediment Phase Diagram and Weight-Volume Relationship

3.3 Laboratory Testing Program – Chemical Characteristics

3.3.1 Elutriate Testing

As mentioned in Section 3.1, the 5-gallon buckets of sediment and water samples that were collected from coring Locations 4, 11, 22, 24, and 29 were sent to ERD for elutriate and flocculation testing. The elutriate tests was conducted on filtered sediment and water samples from each of the five locations. The samples were prepared and tested in accordance with FDEP's *Deepwater Ports Maintenance, Dredging, and Disposal Manual* (December 1984). The elutriate test results are presented in Table 3.7 and detailed in Appendix E.

As shown in Table 3.7, the turbidity, biochemical oxygen demand (BOD), nitrogen (NH_3, NO_3, and Total N), and phosphorus (Ortho-P and Total P) levels of the filtered sediment samples range from 2 to >10 times those of the corresponding filtered water samples. The differences are expected to significantly decrease with elapsed time. Thus, the disposal area shall have adequate retention time for the supernatants to meet the turbidity and water quality requirements of the Project prior to discharge back into the lake.

In addition to the parameters shown in Table 3.7, ERD also performed elutriate testing for organochlorine pesticides (Method 8081) and organophosphorus pesticides (Method 8141) on all filtered water and sediment samples. All results were found to be below detectable limits for these pesticides (see Appendix E).

3.3.2 Flocculation Testing of Supernatants

In the event that the turbidity and water quality requirements are not met by retention, flocculation and/or wetland filtration of return water would be required. Due to the relatively high turbidity levels of the supernatants observed in the three settling column tests, flocculation tests were conducted on supernatants after 3 and 7 days of gravity settling using alum and polymers to evaluate accelerated clarification/treatment characteristics of the supernatants.

3.3.2.1 Three-Day Flocculation Testing

For flocculation testing, the slurry that was left over after filling each of the three settling columns (Composite Samples A, B, and C) was placed in a 5-gallon bucket and allowed to settle for 72 hours in the UF laboratory. Subsequently, the supernatant water accumulated within each bucket was carefully extracted without causing disturbance to settled sediment, thoroughly homogenized, and divided into five sub-samples. To these sub-samples, predetermined doses of alum (aluminum sulfate, $Al_2(SO_4)_3$) and two types of commercially available polymers (Magnafloc-455 from CIBA and DF409 from Ashland Chemicals) were immediately added to the sub-samples while stirring. The sub-samples were then allowed to settle for 24 hours before measuring supernatant turbidity. Table 3.8 summarizes the results of the 3-day flocculation tests performed by UF.

As shown in Table 3.8, the turbidity levels of the supernatants ranged from 122 to 214 NTU after 3 days of gravity settling without flocculation. Also, the turbidity levels dropped to less than 10 NTU with the application of approximately 10 parts per million (ppm) of polymer or 150 ppm of alum as $Al_2(SO_4)_3$ (or 9.5 ppm as Al). Assuming that the unit price of polymer is 2 to 3 times that of alum, the polymer would be 5 to 7.5 times less expensive than alum. However, the application of alum would reduce the concentrations of phosphorus and other nutrients.

Table 3.7 – Lake Jesup Water and Sediment Elutriate Test Results for Bucket Samples

Water Quality Parameter	Units	Filtered Water Samples					Filtered Sediment Samples				
		4	11	22	24	29	4	11	22	24	29
pH (24 hrs)	s.u.	7.72	8.04	8.05	8.07	7.99	7.41	7.42	7.01	7.81	7.78
Turbidity	NTU	0.7	0.5	1	0.5	0.4	3.7	9.9	14.0	2.6	6.7
TDS	mg/L	0.69	0.74	0.68	0.66	0.66	0.84	0.81	0.89	0.66	0.61
VDS	mg/L	0.13	0.15	0.11	0.09	0.15	0.17	0.15	0.15	0.11	0.12
Ammonia (NH_3)	µg/L	25	54	54	54	54	352	336	369	431	563
Nitrate (NO_3)	µg/L	671	747	717	911	853	5168	5333	11050	3390	2321
Total N	µg/L	1573	1653	1745	1809	1792	5875	6118	13186	4239	3452
Ortho-P	µg/L	14	14	14	14	14	202	350	1024	90	57
Total P	µg/L	24	27	26	21	25	273	392	1524	129	80
BOD	mg/L	8.3	7.7	8.3	7.4	7.9	12.4	12.3	12.5	11.5	24.0
COD	mg/L	12	12	14	12	15	20	20	25	17	13
TOC	mg/L	17.2	17.2	17.0	17.0	17.1	21.2	20.2	19.4	18.4	15.6
Monomeric Al	µg/L	36	36	36	22	133	112	278	293	51	97
Copper (Cu)	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	4	< 2	2	< 2
Cadmium (Cd)	µg/L	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Mercury (Hg)	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lead (Pb)	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Zinc (Zn)	µg/L	4	2	4	< 2	7	12	4	10	< 2	7

TDS = Total Dissolved Solids
VDS = Volatile Dissolved Solids
N = Nitrogen
P = Phosphorus
BOD = Biochemical Oxygen Demand
COD = Chemical Oxygen Demand
TOC = Total Organic Carbon
Al = Aluminum
s.u. = Standard Units
NTU = Nephelometric Turbidity Units
mg/L = milligrams per liter
µg/L = micrograms per liter

Values with "<" indicate detection limit per FDEP-approved QAPP.

3.3.2.2 Seven-Day Flocculation Testing

Representative portions of the 5-gallon buckets of sediment and water samples that were collected from each of the coring Locations 4, 11, 22, 24, and 29 were combined and thoroughly homogenized at the ERD laboratory into a composite sample, representing Lake Jesup sediment and water. The composite sample was allowed to settle for 7 days, after which the supernatant was carefully extracted, thoroughly homogenized, and divided into five sub-samples. Predetermined doses of alum were immediately added to the sub-samples while stirring. The sub-samples were allowed to settle for 24 hours before measuring the water quality parameters shown in Table 3.9.

A comparison of Tables 3.8 and 3.9 shows that the turbidity levels of the supernatants decreased from a range of 122 to 214 NTU after 3 days of gravity settling without flocculation to about 47 NTU after 7 days. Similar to the UF results, the turbidity levels dropped to less than 10 NTU with the application of approximately 10 mg/L of alum as Al. Also, the phosphorus and BOD levels dropped below those measured for lake water with the addition of 10 mg/L of alum as Al.

Table 3.8 – Lake Jesup Alum and Polymer Flocculation Test Results: Supernatant Turbidity (1) (NTU) after 3 Days of Settling

Supernatant Sample	Alum Dosage (ppm or mg/L)				
	0 (Initial)	20 as Alum (1.27 as Al)	50 as Alum (3.16 as Al)	100 as Alum (6.33 as Al)	150 as Alum (9.50 as Al)
A	122	110	47	10	5
B	172	144	61	19	10
C	214	176	49	6	2
	Magnafloc-455 Dosage (ppm or mg/L)				
	0 (Initial)	1	3	5	10
A	122	110	49	23	13
B	172	133	97	46	27
C	214	170	104	49	44
	DF409 Dosage (ppm or mg/L)				
	0 (Initial)	1	3	5	10
A	122	107	81	18	2
B	172	172	132	51	14
C	214	212	119	42	5

(1) Measurement recorded after 24 hours from flocculation.

$Al_2(SO_4)_3 \rightarrow 2\ Al + 3\ S + 12\ O$ (Molecular weight of Aluminum = 27.0, Sulfur = 32.1, Oxygen = 16.0)
To convert from ppm as $Al_2(SO_4)_3$ to mg/L as Al, a molar ratio of 15.8 can be used, since
$[2\ Al / Al_2(SO_4)_3] * 100\ ppm = [2*(27.0) / 342.1]*100\ ppm = 15.8$

3.3.3 Beneficial Use Testing

As mentioned in Section 3.1, the two environmental jar samples that were collected from the upper 4 to 12 inches of unconsolidated sediment at each of the locations shown in Figure 3.1 (Locations 1, 11, 16, 25, and 30) were sent to the PC&B analytical laboratory for beneficial use testing. The jar samples were collected, handled, and tested in accordance with the PC&B's state-approved QAPP for the analyses listed in Table 3.10. The beneficial use test results are detailed in Appendix F.

As shown in Table 3.10, the jar sediment samples were tested for metals and heavy metals, nutrients, pesticides, hydrocarbons, oil and grease, and other chemical tests. The results of the beneficial use testing (Appendix F) indicated that the sediment samples are not contaminated and should be suitable for Class III landfill disposal.

Table 3.9 – Lake Jesup Alum Flocculation Test Results: Water Quality Parameters (1) after 7 Days of Settling

Water Quality Parameters	Units	Alum Dose (as Al)				
		Raw	2.5 mg/L	5.0 mg/L	10 mg/L	15 mg/L
pH (initial)	s.u.	6.91	6.73	6.61	6.38	6.13
pH (24 hours)	s.u.	6.88	7.16	7.03	6.77	6.65
Turbidity	NTU	47.0	31.0	16.4	5.1	1.1
TSS	mg/L	69.0	61.5	23.8	8.4	1.2
TDS	mg/L	0.87	0.87	0.81	0.77	0.78
NH_3	µg/L	1218	58	54	54	54
NO_3	µg/L	6232	6065	6202	2247	681
Total N	µg/L	8462	8236	7756	7398	7192
Ortho-P	µg/L	440	55	10	14	14
Total P	µg/L	592	354	140	60	25
BOD	mg/L	46	34	14	< 2	< 2
COD	mg/L	48.3	50.2	21.9	4.8	< 3
Total Al	µg/L	1076	1566	536	429	127
Cu	µg/L	3	3	3	< 2	< 2
Cd	µg/L	< 1	< 1	< 1	< 1	< 1
Pb	µg/L	< 2	< 2	< 2	< 2	< 2
Zn	µg/L	4	4	< 2	2	21

(1) Measured values after 24 hours from alum addition.

TSS = Total Suspended Solids

Table 3.10 – Lake Jesup Unconsolidated Sediment Beneficial Use Testing

Beneficial Use Test	No. of Tests
EPA 160.3 – Percent Solids	5
EPA 160.4 – Organic Content	5
EPA 9045 – Soil pH	5
SM 2340B – Total Hardness as CaCO3 (CCE)	5
Metals and Heavy Metals	
EPA 6010 – Calcium	5
EPA 6010 – Copper	5
EPA 6010 – Iron	5
EPA 6010 – Magnesium	5
EPA 6010 – Potassium	5
EPA 6010 – Zinc	5
EPA 6010 – Arsenic	5
EPA 6010 – Barium	5
EPA 6010 – Cadmium	5
EPA 6010 – Chromium	5
EPA 6010 – Lead	5
EPA 6010 – Selenium	5
EPA 6010 – Silver	5
EPA 7471 – Mercury (Total)	5
Nutrients	
EPA 6010 – Total Phosphorus	5
EPA 9200/351.2 – Total Nitrogen	5
EPA 9060 – Total Organic Carbon	5
Pesticides	
EPA 8141 – Organophosphorus Pesticides	5
EPA 8081A – Chlorinated Pesticides	5
Petroleum Hydrocarbons	
EPA 8082 – PCB in Soil	5
EPA 8310 – PAH's	5
EPA 8270 – Semivolatile Organics	5
EPA 8021 – Aromatic Volatile Organics	5
Oil and Grease	
EPA 1664 – Oil and Grease	5

4 DREDGING FEASIBILIITY AND PRIORITIZATION

4.1 Characterization of Dredged Materials

4.1.1 Sediment Types

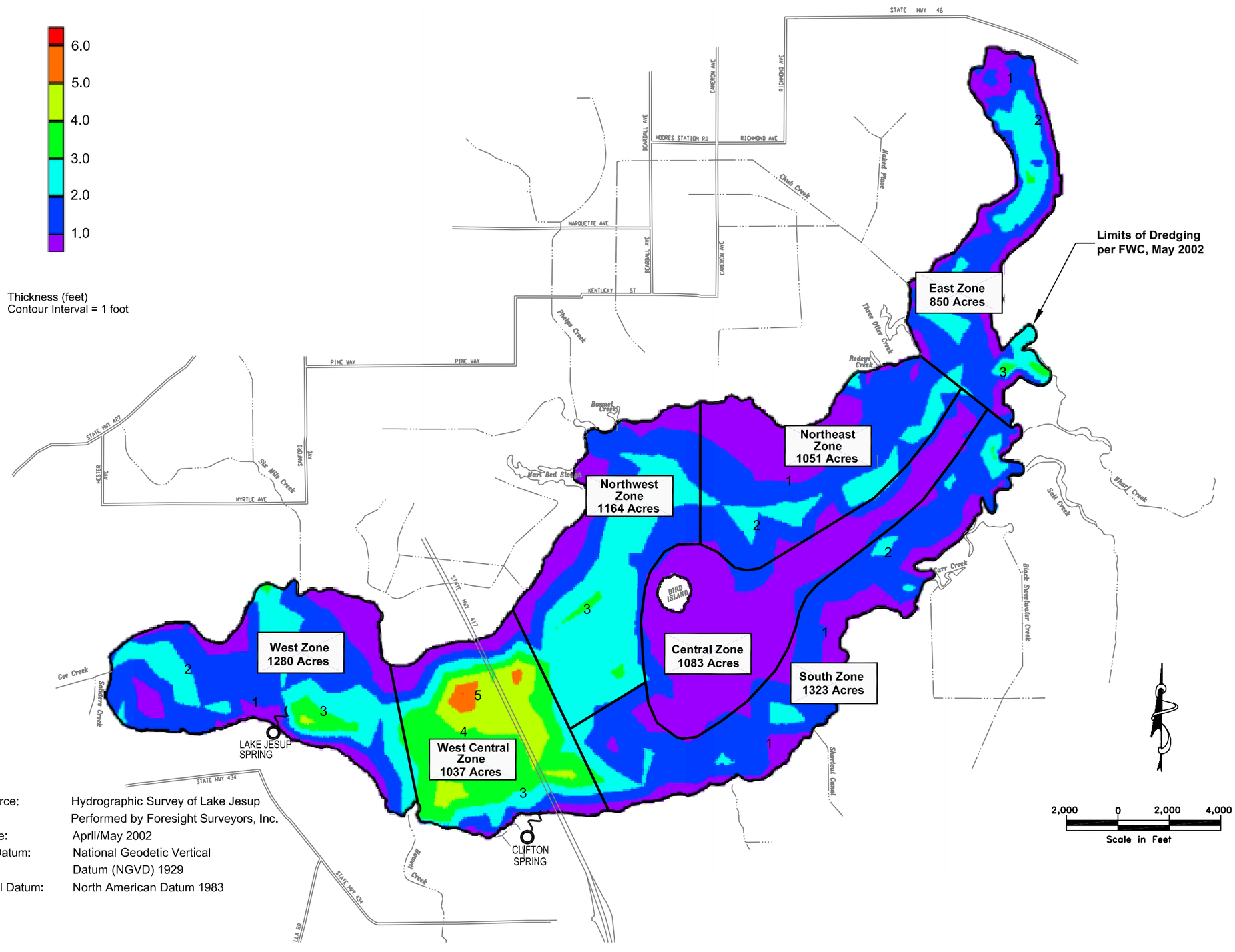
The results of the sediment sampling and testing programs that were conducted for this study and described in Section 3 indicated that Lake Jesup sediment consists mainly of an upper layer of unconsolidated material underlain by a consolidated layer. The unconsolidated sediment layer mainly consists of black to brown, very loose, organic matter (muck), which contains small quantities of shell fragments, sand, and plant fiber in some places. The unconsolidated sediment is highly prone to erosion and resuspension, with subsequent movement, deposition, and export. In contrast, the consolidated sediment layer consists mainly of highly plastic clay that generally contains smaller quantities of black decomposed organic matter, except for small areas within the lake where sand, thin layers of pink/tan carbonate (marl), and/or soft brown/black fibrous organic deposits exist.

4.1.2 Spatial Distribution of Unconsolidated Sediment

The spatial distributions of the different types of sediment that exist within the open water area of Lake Jesup, as identified by the 2002 hydrographic survey (FSI, 2002), were discussed in Section 2.2.2. At this time, only the unconsolidated sediment layer is targeted for dredging. To break down the total volume of unconsolidated sediment into manageable portions, the open water area of the lake was subdivided into zones. Future dredging within these zones can be prioritized based upon Project goals, funds, and schedule, as well as available areas for sediment disposal.

Based on the measured distribution of unconsolidated sediment (Figures 2.3 and 2.6), and considering lake hydrology, geomorphology, prevailing wind direction, and circulation patterns, the Lake Jesup unconsolidated sediment layer was divided into seven zones, similar to those identified in the UF study (Cable et al., 1997). Figure 4.1 shows the approximate limits and corresponding surface area of each zone, together with the surveyed unconsolidated sediment thickness (from Figure 2.6). Depending on the depositional patterns of unconsolidated sediment within the lake, these zones could be characterized as depositional, transitional, or scour as follows:

- The East Zone (corresponding approximately to UF study Groups 43 and 45—see Figure 1.7), which is the narrow portion leading to the outlet at SR 46, is assumed to have the greatest mass deposition of mostly inorganic sediment due to river exchange.
- The West Zone (corresponding approximately to UF Group 21) is a depositional zone due to poor mixing with the rest of the lake and possibly due to several historic wastewater and industrial effluent discharges. Depositional zones generally have the greatest accumulation of sediment with the longest historic records.
- The West Central Zone near SR 417 (corresponding approximately to Group B in the UF study) is also a depositional zone that has the deepest unconsolidated sediment deposits within the lake and appears to correspond with a deep sinkhole feature.



Data Source: Hydrographic Survey of Lake Jesup
Performed by Foresight Surveyors, Inc.
Field Date: April/May 2002
Vertical Datum: National Geodetic Vertical Datum (NGVD) 1929
Horizontal Datum: North American Datum 1983

Figure 4.1

Lake Jesup
Unconsolidated Sediment Dredging Zones

PB Water
A Division of Parsons Brinckerhoff Quade & Douglas, Inc.
100 East Pine Street, Suite 500
Orlando, FL 32801 407-587-7600
Certificate of Authorization Number: 00001462

PLOTTED: August 13, 2002
FILE NAME: Lake Jesup\PDR figures\Fig4_1new.dwg

- The South Zone (corresponding approximately to the southern perimeter of the lake within UF Groups 4 and 37) is a depositional zone, where slowing currents appear to deposit unconsolidated sediment.
- The Central Zone (which corresponds approximately to the non-perimeter stations within UF Groups 4, 37, and 40) is a scour zone with very little sediment deposition.
- The Northeast and Northwest Zones (corresponding approximately to the north shoreline of the lake within UF Groups 4, 37, and 40—see Figure 1.7) are transitional. The transitional zones contain sediment that is typically subject to erosion, resuspension, and transport by physical processes to other locations.

Derived from the results of the UF sediment study (Cable et al., 1997), Table 4.1 summarizes the estimated unconsolidated sediment average thickness distribution within the lake, as well as that portion of the sediment thickness deposited only since 1900. The unconsolidated sediment thickness was estimated as that portion of the total sediment thickness above a very discrete change in dry bulk density with depth. From Figure 4.2, a maximum dry bulk density value of approximately 0.19 g/cm^3 was estimated at the bottom of the unconsolidated sediment layer. The average total thickness of Lake Jesup unconsolidated sediment was estimated at 2.1 feet (comparable to the average of 1.62 feet measured for this Project), while the average thickness deposited since 1900 was estimated at 1.1 feet.

Also, from a comparison of the UF sediment coring locations in relation to the seven zones selected for this study (Figure 4.1), estimates based on the UF data are presented in Table 4.1 for the average unconsolidated sediment thickness within each zone. Average thicknesses of unconsolidated sediment accumulated since 1900 were estimated to range from 1.5 feet in the East Zone to 0.8 feet in the Central Zone.

4.1.3 In-Situ Sediment Characteristics

4.1.3.1 Sediment Characteristics Based on 1997 UF Study

The UF study (Cable et al., 1997) concluded that the mass concentrations (in milligrams of nutrient per gram of sediment—mg/g) of organic matter content (OC), total phosphorus (TP), non-apatite inorganic phosphorus (NAIP), total nitrogen (TN), and total carbon (TC) generally decrease with depth in the upper unconsolidated sediment layer. However, the areal storage (in grams or milligrams of nutrient per square centimeters of sediment area) of each of these constituents generally increases with depth as a result of increased dry density of sediment with depth. The UF study indicated the appearance of a horizon at about 1 to 1.5 feet from the sediment surface where the TP mass concentration decreases markedly with depth. This horizon generally corresponds with the bottom surface of the unconsolidated sediment layer in most areas of the lake. The study also indicated that sediment within the central and northern portions of the lake has consistently shown an increasing trend in OC, TP, and TN accumulation since the early 1900s. The western end of the lake has consistently reflected the highest accumulation of organic matter content and nutrient (particularly TN) content during the 1950 to 1985 time interval, mainly due to wastewater effluent discharge into the lake.

Using the results of the UF study (Cable et al., 1997), the vertical distributions of sediment density and cumulative nutrient areal storage were averaged for the seven zones selected for this study (Figure 4.1). This information is summarized in Table 4.2, and plotted in the subsequent figures (Figures 4.2 through 4.7).

Table 4.1 – Lake Jesup Unconsolidated Sediment Estimated Average Thickness, Based on the 1997 UF Study

UF Coring Location ID (1)	Average Thickness (feet)		UF Coring Location ID (1)	Average Thickness (feet)		Zone (2)	Average Thickness (feet)	
	Total	Since 1900		Total	Since 1900		Total	Since 1900
1	3.3	1.3	26	0.7	0.5	East	1.8	1.5
2	3.0	1.8	27	1.0	0.3			
3	2.1	0.8	28	0.7	0.3	South	2.4	1.2
4	2.6	1.5	29	2.3	2.0			
5	3.9	0.1	30	1.6	1.3	Northeast	1.2	0.9
6	3.6	1.2	31	2.0	1.0			
7	4.3	1.5	32	2.1	1.2	Northwest	2.4	0.8
8	2.6	0.8	33	2.0	1.5			
9	0.5	0.5	34	0.2	0.2	W. Central	3.4	1.4
10	0.5	0.2	35	1.8	1.3			
11	1.8	1.6	36	1.5	1.0	West	2.8	1.3
12	3.9	1.0	37	1.8	1.8			
13	2.3	1.3	38	1.6	1.3	Central	1.0	0.8
14	3.6	1.2	39	2.3	0.7			
15	3.0	0.8	40	2.0	1.0			
16	3.6	0.8	41	0.2	0.2	**Total**	**2.1**	**1.1**
17	0.2	0.2	42	2.1	1.5			
18	0.3	0.2	43	2.3	1.8			
19	2.1	1.5	44	1.6	1.5			
20	3.0	1.0	45	1.6	1.3			
21	2.6	2.1	46	1.5	1.3			
22	2.1	1.2	A	3.9	1.8			
23	2.3	1.0	B	4.3	1.6			
24	2.1	0.5	C	1.6	0.7			
25	1.5	0.7						

(1) Refer to Figure 1.7.
(2) Refer to Figure 4.1.

The dry bulk density of sediment (Figure 4.2) increased from an average of about 0.04 g/cm^3 (2.5 pounds per cubic foot (lb/ft^3)) at the top (i.e., first 2 inches) of the unconsolidated sediment to less than 0.19 g/cm^3 (11.9 lb/ft^3) at the top of the underlying consolidated sediment layer. Dry bulk density is defined as the mass (or weight) of solids divided by the total volume (solids plus water) of a sediment sample. The dry density values listed above appear small because the solids component is only a small portion of the total sediment volume. Using an average specific gravity of the solids of 1.63 for unconsolidated sediment, this range of dry density corresponds to a solids content (by weight) range of about 3.9 percent at the surface to 17.7 percent at the bottom, which is similar to the range of values measured in this study by MEG for unconsolidated sediment (refer to Table 3.2 and Appendix C).

Table 4.2 – Lake Jesup Sediment Density and Cumulative Nutrient Storage, Based on the 1997 UF Study

Zone [1]	UF Coring Locations [2] In Zone	Depth (feet)	Dry Bulk Density [3] (g/cm^3)	Cumulative OC (g/cm^2)	Cumulative TP (mg/cm^2)	Cumulative NAIP (mg/cm^2)	Cumulative TN (mg/cm^2)	Cumulative TC (g/cm^2)
East	43, 44, 45, 46	0.5	0.10	0.4	1.6	0.3	20	0.2
		1.0	0.16	1.1	3.3	0.9	46	0.5
		1.5	0.20	1.9	4.9	1.3	77	0.8
		2.0	0.24	2.9	8.8	2.3	114	1.3
		3.0	0.63	4.9	22.2	4.0	191	3.2
		4.0	0.52	7.0	--	4.8	262	5.3
South	2, 3, 4, 5, 8, 11, 19, 20, 29, 30, 38	0.5	0.08	0.3	1.2	0.3	16	0.2
		1.0	0.12	0.9	3.0	0.7	41	0.4
		1.5	0.15	1.7	5.3	1.2	70	0.8
		2.0	0.19	2.7	8.3	1.7	99	1.2
		3.0	0.23	4.7	12.0	2.3	159	2.5
		4.0	0.18	6.4	15.2	3.0	234	3.8
Northeast	27, 28, 33, 34, 35, 36, 37, 41, 42	0.5	0.08	0.4	1.7	0.4	18	0.1
		1.0	0.13	1.0	3.6	0.8	43	0.5
		1.5	0.18	1.7	5.0	1.3	70	0.7
		2.0	0.38	2.5	8.9	1.8	105	1.2
		3.0	0.48	5.0	15.0	3.1	190	3.3
		4.0	0.13	7.8	16.6	--	276	5.2
Northwest	8, 15, 16, 24, 25, 31, 32, 39, 40	0.5	0.09	0.3	1.1	0.3	16	0.2
		1.0	0.12	1.0	2.6	0.7	42	0.4
		1.5	0.19	1.6	3.8	0.9	68	0.8
		2.0	0.37	2.3	5.6	1.3	97	1.1
		3.0	0.52	4.2	11.4	2.7	167	2.3
		4.0	0.19	6.1	--	--	249	4.0
West Central	1, 2, 6, 7, 14, A, B, C	0.5	0.06	0.4	1.1	0.3	18	0.2
		1.0	0.10	0.9	2.5	0.6	41	0.4
		1.5	0.11	1.5	3.9	0.9	68	0.7
		2.0	0.12	2.2	5.2	1.3	96	1.0
		3.0	0.15	3.8	8.3	2.0	161	1.8
		4.0	0.27	5.4	15.6	3.0	217	2.6
West	6, 12, 13, 21, 22, 23	0.5	0.06	0.3	1.1	0.2	16	0.1
		1.0	0.11	0.8	2.7	0.7	40	0.4
		1.5	0.13	1.5	3.8	1.0	68	0.7
		2.0	0.20	2.1	5.0	1.2	93	1.0
		3.0	0.25	3.8	10.7	1.8	158	1.8
		4.0	0.38	4.7	--	2.3	211	2.6
Central	9, 10, 17, 18, 25, 26, 28, 29, 37, 38	0.5	0.08	0.4	1.8	0.5	28	0.3
		1.0	0.12	1.2	4.2	1.0	63	0.8
		1.5	0.23	2.3	5.7	1.5	100	1.2
		2.0	0.30	2.4	9.7	2.0	109	1.3
		3.0	0.25	4.7	12.8	2.6	172	3.0
		4.0	--	--	--	--	--	--
Entire Lake	All 49 Stations	0.5	0.08	0.4	1.4	0.3	19	0.2
		1.0	0.12	1.0	3.1	0.7	46	0.5
		1.5	0.17	1.7	4.6	1.1	74	0.8
		2.0	0.26	2.5	7.0	1.6	100	1.2
		3.0	0.36	4.4	12.2	2.4	167	2.4
		4.0	0.28	6.0	16.1	3.3	232	3.5

(1) Refer to Figure 4.1.
(2) Refer to Figure 1.7.
(3) Excludes coring stations with no unconsolidated sediment encountered.

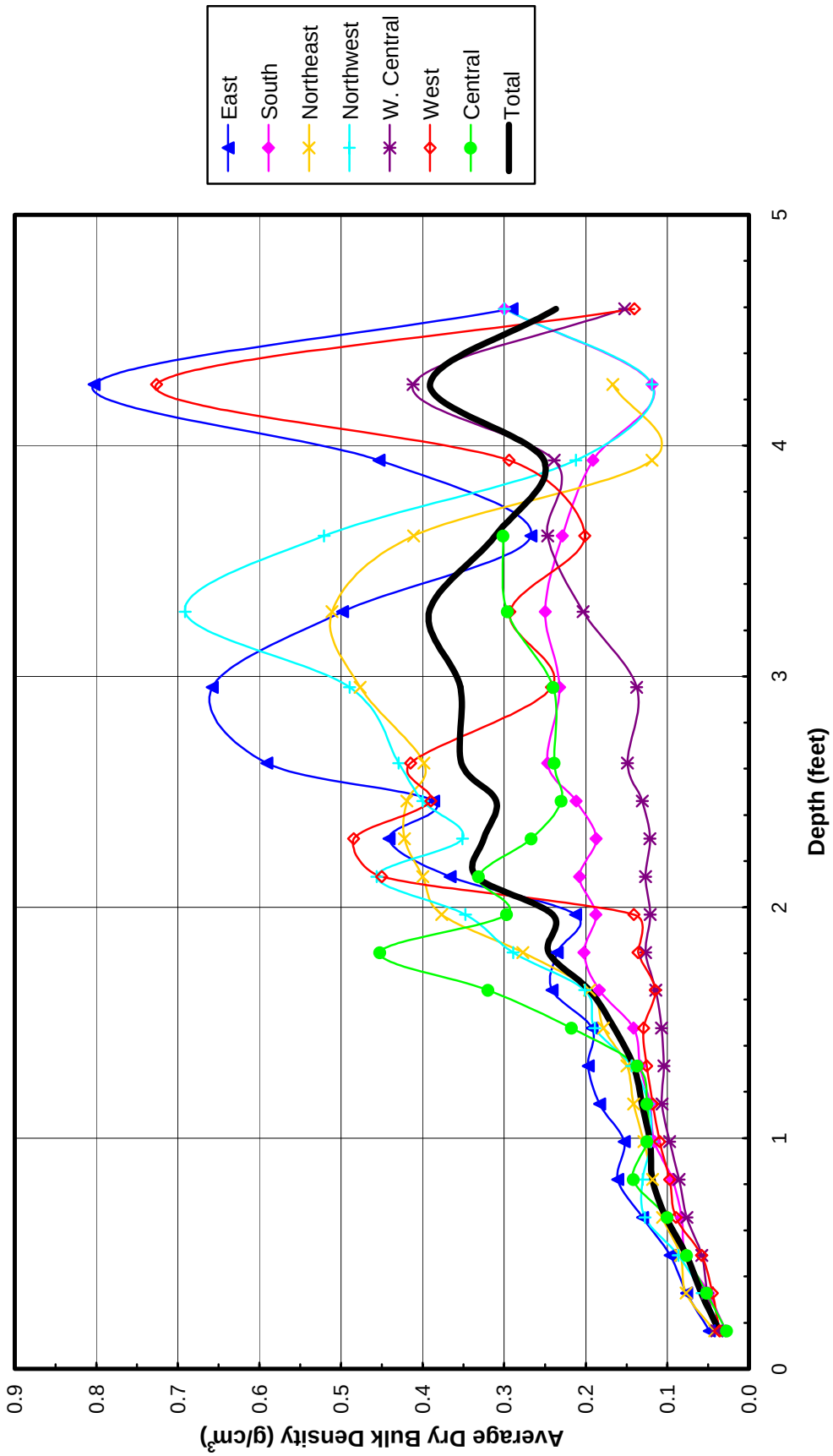


Figure 4.2 - Lake Jesup Sediment Dry Bulk Density vs. Depth (Excludes Coring Stations with no Unconsolidated Sediment Encountered)

Data Source: Derived from Results of UF Study, *Sediment and Nutrient Deposition in Lake Jesup* (Cable et al., 1997)

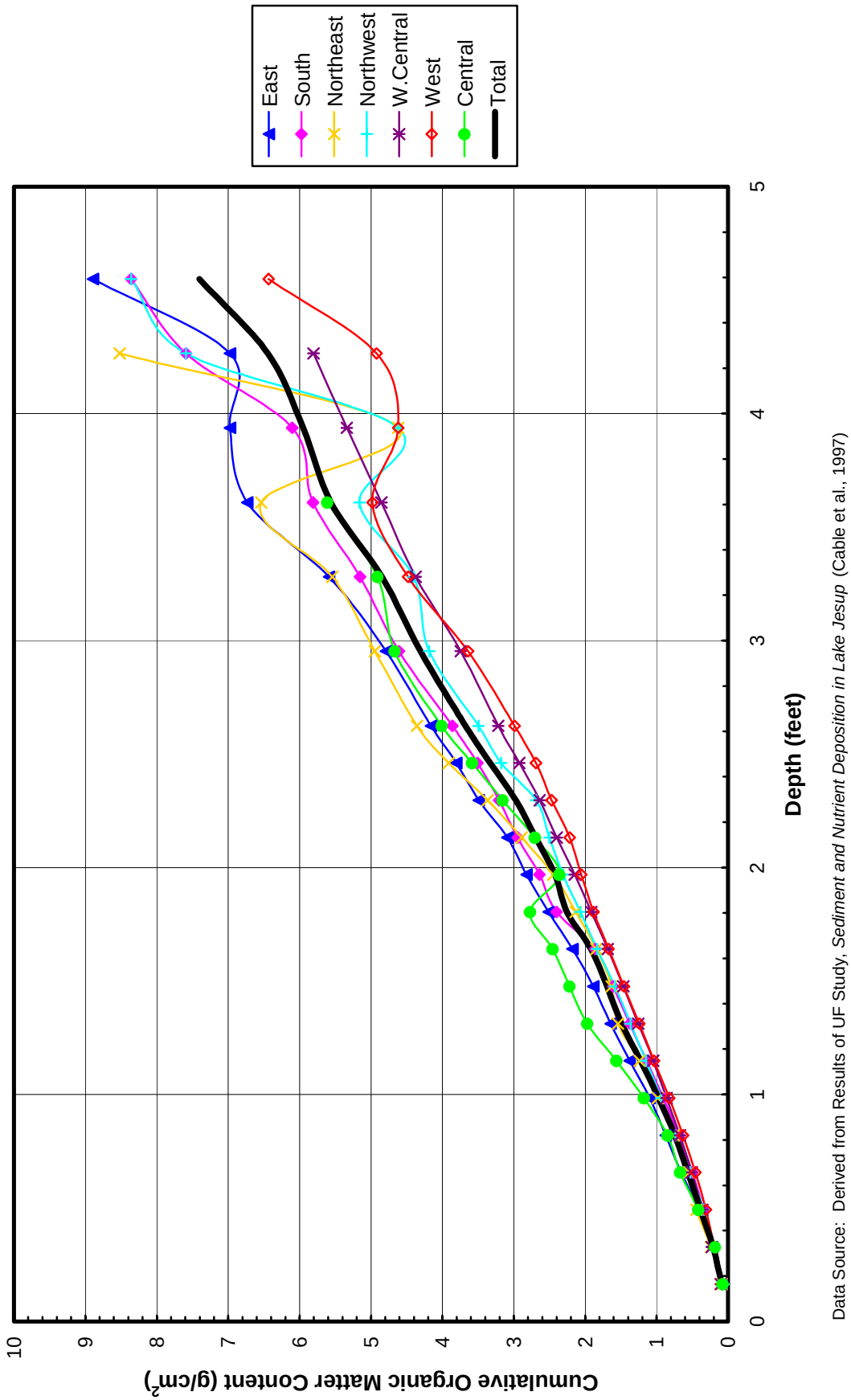


Figure 4.3 - Lake Jesup Sediment Cumulative Organic Matter Content vs. Depth

Data Source: Derived from Results of UF Study, *Sediment and Nutrient Deposition in Lake Jesup* (Cable et al., 1997)

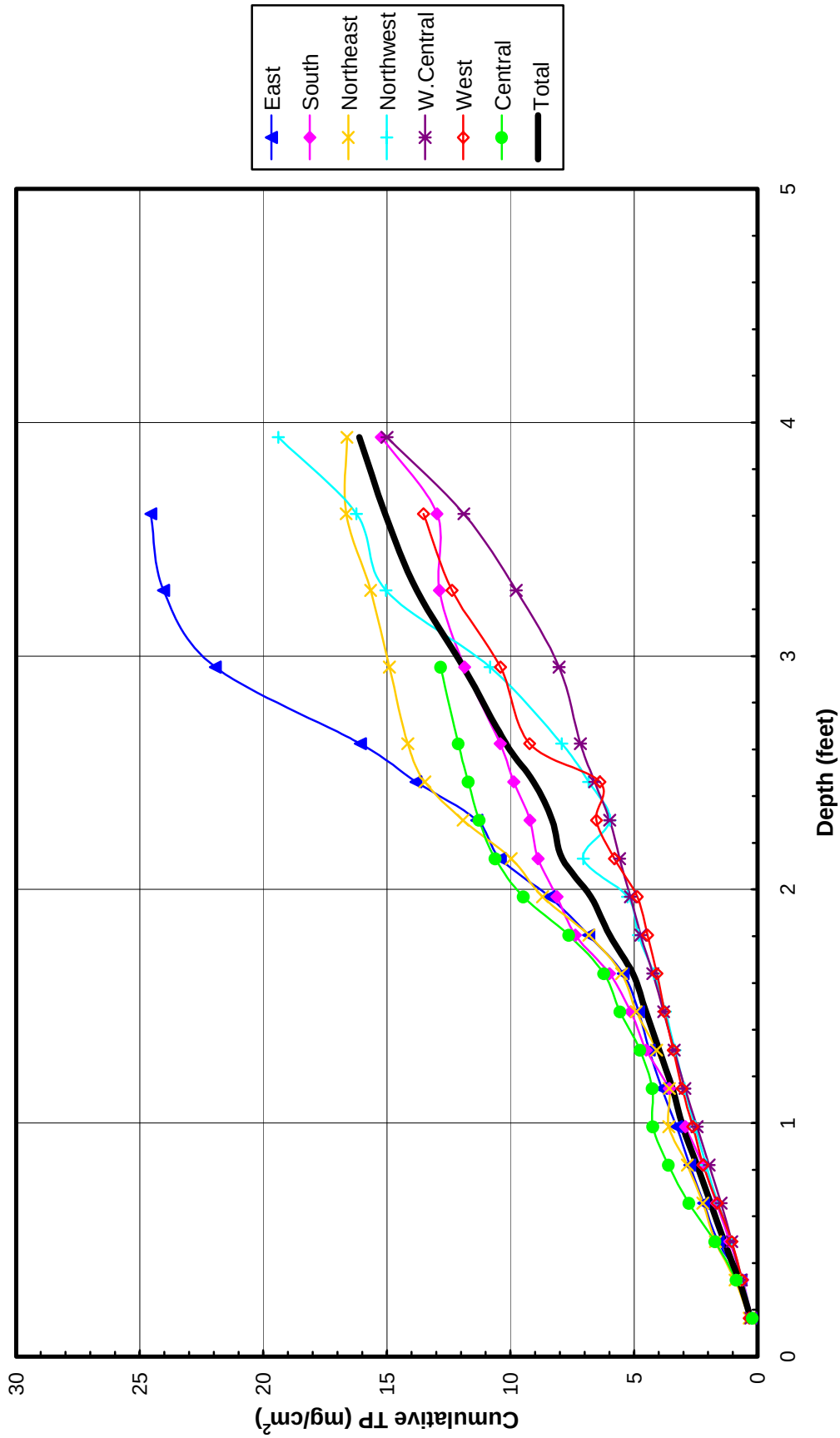


Figure 4.4 - Lake Jesup Sediment Cumulative Total Phosphorus vs. Depth

Data Source: Derived from Results of UF Study, *Sediment and Nutrient Deposition in Lake Jesup* (Cable et al., 1997)

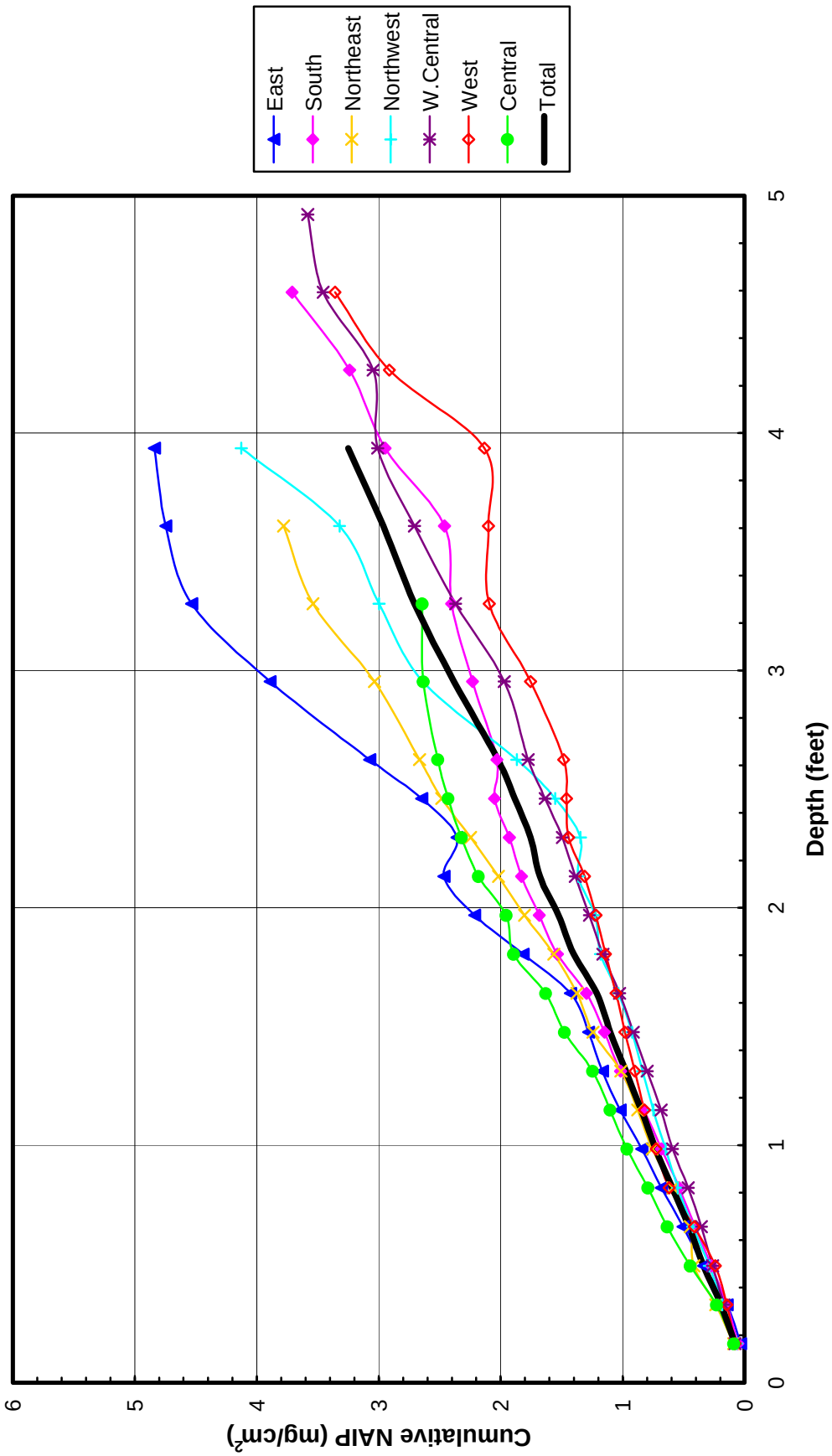


Figure 4.5 - Lake Jesup Sediment Cumulative Non-Apatite Inorganic Phosphorus vs. Depth

Data Source: Derived from Results of UF Study, *Sediment and Nutrient Deposition in Lake Jesup* (Cable et al., 1997)

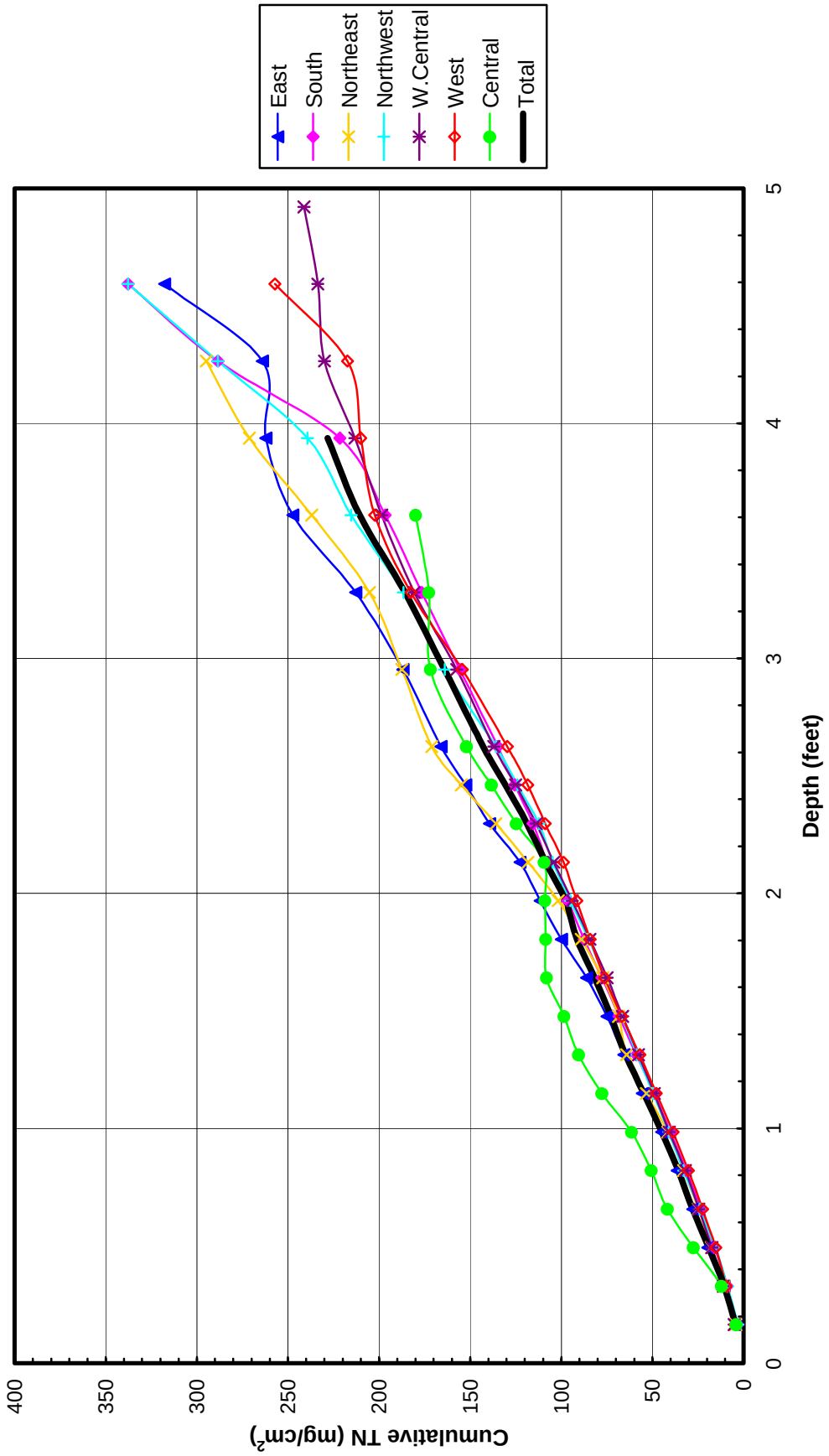


Figure 4.6 - Lake Jesup Sediment Cumulative Total Nitrogen vs. Depth

Data Source: Derived from Results of UF Study, *Sediment and Nutrient Deposition in Lake Jesup* (Cable et al., 1997)

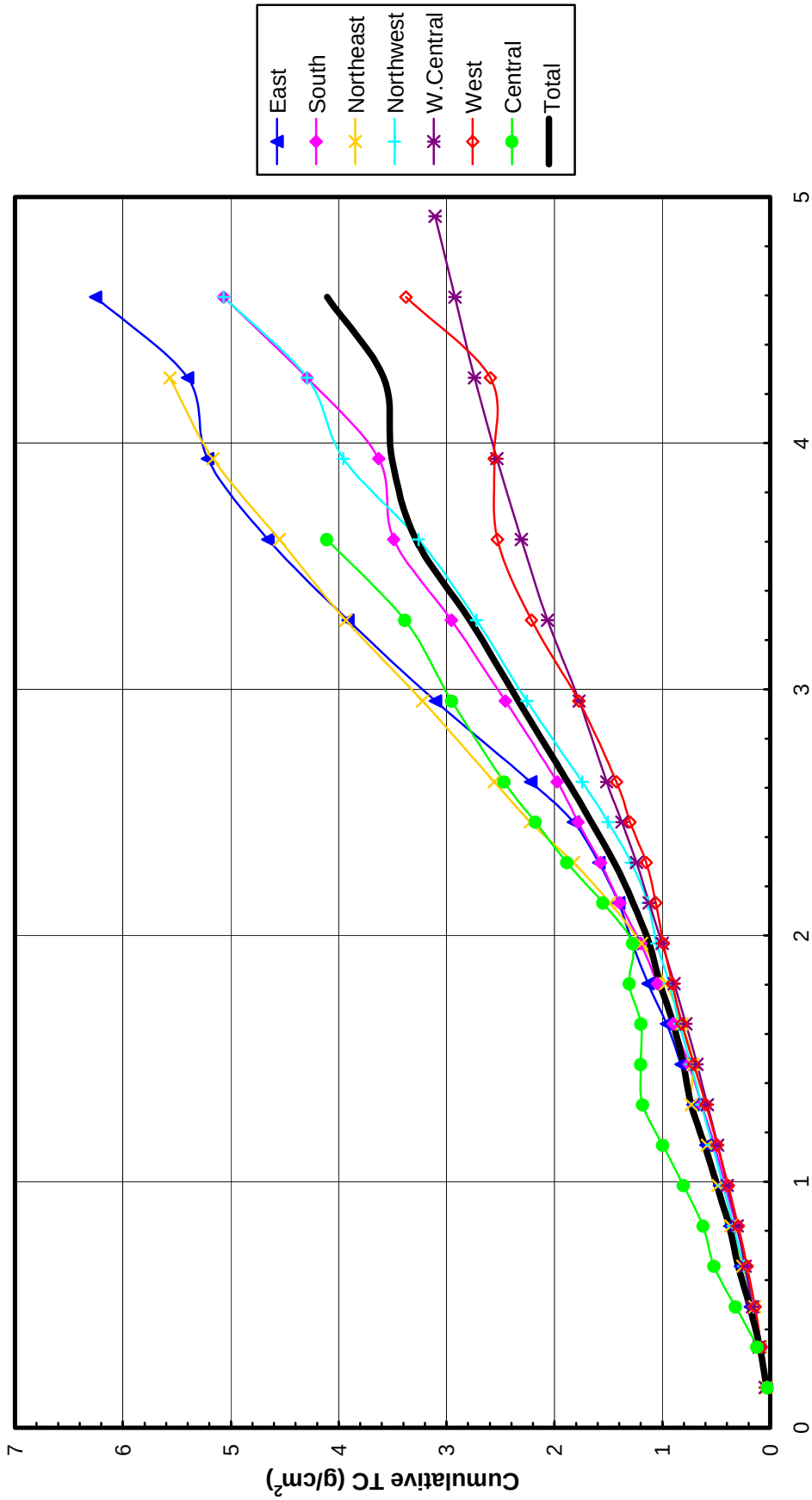


Figure 4.7 - Lake Jesup Sediment Cumulative Total Carbon vs. Depth

Data Source: Derived from Results of UF Study, *Sediment and Nutrient Deposition in Lake Jesup* (Cable et al., 1997)

Figures 4.3 through 4.7 show the average cumulative areal storage (in mg/cm^2) of OC (organic matter content), TP, NAIP, TN, and TC in Lake Jesup sediment with depth for each of the seven zones. Using the information from Table 4.2 along with an assumed total open water surface area of 7,800 acres, the top 4 feet of the unconsolidated and consolidated sediment in Lake Jesup was estimated to contain approximately 2.1 million tons of organic matter; 5,600 tons of TP; 1,100 tons of NAIP; 81,000 tons of TN; and 1.2 million tons of TC. However, the unconsolidated sediment layer alone contains about 0.71 million tons of organic matter; 2,000 tons of TP; 430 tons of NAIP; 29,000 tons of TN; and 0.36 million tons of TC. Although, these values represent only 30 to 39 percent of the total nutrient storage in lake sediment, their contributions to the degradation of the water quality of the lake are nonetheless relatively much higher due to the mobility and resuspension potential of the unconsolidated sediment.

4.1.3.2 Unconsolidated Sediment Characteristics Based on Current Study

The results of the sediment sampling and testing programs that were conducted for this study and described in Section 3 indicate that the unconsolidated sediment layer found within the open water area of Lake Jesup consists mainly of very loose organic matter (muck). The results also indicate that the unconsolidated sediment generally contains 5 to 15 percent by dry weight of coarse material/fraction and 85 to 95 percent of fine material/ fraction. The coarse fraction of unconsolidated sediment consists mainly of shell fragments, sand, and/or plant fiber, while the fine fraction consists of clay, silt, and/or decomposed organic matter. The coarse fraction varies in gradation from whole shells with a nominal diameter of about 10 millimeters (mm) to small shell fragments and fine sand particles less than 0.1 mm in diameter. The fine fraction of unconsolidated sediment consists approximately of 63 to 75 percent by dry weight of clay size particles and 25 to 37 percent of silt size particles.

The variation of solids content versus depth for the unconsolidated sediment layer within Lake Jesup was presented previously (Table 3.2, Table 3.6, and Figure 3.4) and showed that the average in-situ solids content (by weight) of unconsolidated sediment increased with depth from 8.3 percent at 0.25 feet to 17.5 percent at 3.5 feet. The increase in solids content with depth is presumably attributed to self-weight consolidation and a decrease in organic content with depth. As mentioned previously in Section 3.2, assuming an average dredging depth of 1.5 feet, an average in-situ solids content of 14.2 percent (by weight) and an average organic content of 26.0 percent were estimated for the unconsolidated sediment layer and used in disposal area preliminary design. With an average dredging depth assumed at 1.5 feet, an estimated total of 0.44 million tons of organic matter would be removed from the entire lake.

4.1.4 Estimated In-Situ Volume and Thickness of Unconsolidated Sediment

Based on the results of the 2002 FSI survey, in-situ volume and average thickness were estimated as a function of potential maximum dredging depth for the unconsolidated sediment layer within each of the seven zones from Figure 4.1 (see Table 4.3 and Figure 4.8). For computation of these volumes and thicknesses, it was assumed that dredging would be performed at a given location to the full thickness of the unconsolidated sediment layer or to the selected maximum dredging depth, whichever was less. That is, the estimated unconsolidated sediment volume for a selected maximum dredging depth excludes the volume of consolidated sediment that may exist above that depth.

As shown in Table 4.3 and Figure 4.8, the total in-situ volume of unconsolidated sediment within the entire lake was estimated at 10.6, 14.5, 17.1, and 20.3 million cubic yards (MCY)

Table 4.3 – Lake Jesup Unconsolidated Sediment Estimated Volume and Thickness vs. Maximum Dredging Depth

Zone [1]	Maximum Dredging Depth (feet)	Unconsol. Sediment Volume (MCY)	Average Thickness (feet)	Zone [1]	Maximum Dredging Depth (feet)	Unconsol. Sediment Volume (MCY)	Average Thickness (feet)
East	0.5	0.67	0.49	West Central	0.5	0.80	0.48
	1.0	1.26	0.92		1.0	1.57	0.94
	1.5	1.71	1.25		1.5	2.30	1.37
	2.0	2.00	1.47		2.0	2.99	1.79
	2.5	2.13	1.55		2.5	3.64	2.18
	3.0	2.15	1.57		3.0	4.24	2.54
	4.0	2.16	1.57		4.0	5.02	3.00
	5.0	2.16	1.57		5.0	5.18	3.10
	6.0	2.16	1.57		6.0	5.19	3.10
South	0.5	1.04	0.49	West	0.5	0.98	0.48
	1.0	1.97	0.92		1.0	1.87	0.91
	1.5	2.60	1.22		1.5	2.62	1.27
	2.0	2.84	1.33		2.0	3.11	1.51
	2.5	2.89	1.35		2.5	3.31	1.60
	3.0	2.90	1.36		3.0	3.38	1.64
	4.0	2.90	1.36		4.0	3.41	1.65
	5.0	2.90	1.36		5.0	3.41	1.65
	6.0	2.90	1.36		6.0	3.41	1.65
Northeast	0.5	0.75	0.44	Central	0.5	0.56	0.32
	1.0	1.39	0.82		1.0	0.81	0.46
	1.5	1.89	1.12		1.5	0.88	0.51
	2.0	2.15	1.27		2.0	0.90	0.51
	2.5	2.19	1.29		2.5	0.90	0.52
	3.0	2.20	1.30		3.0	0.90	0.52
	4.0	2.20	1.30		4.0	0.90	0.52
	5.0	2.20	1.30		5.0	0.90	0.52
	6.0	2.20	1.30		6.0	0.90	0.52
Northwest	0.5	0.91	0.48	**Entire Lake**	0.5	5.72	0.45
	1.0	1.75	0.93		1.0	10.62	0.85
	1.5	2.48	1.32		1.5	14.49	1.15
	2.0	3.07	1.63		2.0	17.07	1.36
	2.5	3.40	1.81		2.5	18.47	1.47
	3.0	3.54	1.88		3.0	19.31	1.54
	4.0	3.54	1.89		4.0	20.12	1.60
	5.0	3.54	1.89		5.0	20.28	1.61
	6.0	3.54	1.89		6.0	20.30	1.62

(1) Refer to Figure 4.1.

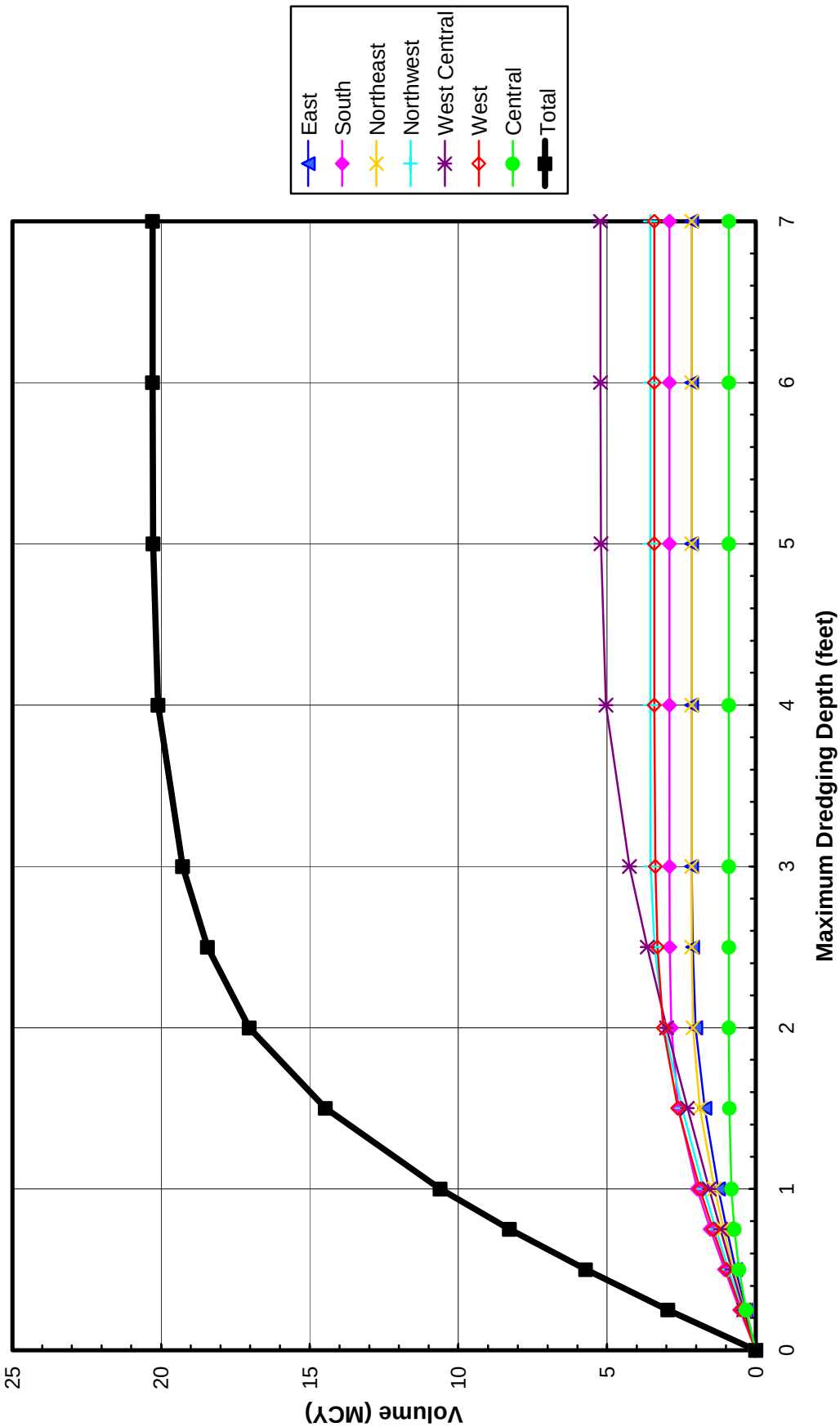


Figure 4.8 - Lake Jesup Unconsolidated Sediment Volume vs. Maximum Dredging Depth

Data Source: Lake Jesup Hydrographic Survey, Foresight Surveyors 2002

at maximum dredging depths of 1, 1.5, 2, and 6 feet respectively. The total in-situ volumes of unconsolidated sediment within the East, South, Northeast, Northwest, West Central, West, and Central Zones were estimated at 2.2, 2.9, 2.2, 3.5, 5.2, 3.4, and 0.9 MCY, respectively. These volumes correspond to average in-situ thicknesses of 1.6, 1.4, 1.3, 1.9, 3.1, 1.7, and 0.5 feet for the East, South, Northeast, Northwest, West Central, West and Central Zones, respectively.

4.1.5 Cumulative Nutrient Storage and Concentration in Unconsolidated Sediment

Developed from the volumetric nutrient storage and unconsolidated sediment volume information described above, Table 4.4 summarizes (by zone) the cumulative nutrient storage and concentration versus depth within the unconsolidated sediment only. This table may serve as a preliminary design tool for the prioritization of dredging areas and depths, given available Project goals, funds, and disposal site volume. The prioritization process is discussed in greater detail in Section 4.3 below.

The cumulative storage of organic matter in unconsolidated sediment within the entire area of Lake Jesup was estimated at 0.29, 0.44, 0.55, and 0.67 million tons at 1, 1.5, 2, and 3 feet, respectively, which corresponds to concentrations ranging from 22,000 to 35,000 tons of organic matter per million cubic yards of unconsolidated sediment (tons/MCY). The organic matter concentrations were fairly consistent throughout all zones of the lake.

The total cumulative storage of TP within the unconsolidated sediment of the entire lake area was estimated at 890, 1,220, 1,560, and 1,870 tons at 1, 1.5, 2, and 3 feet, respectively, which corresponds to TP concentrations of 84, 84, 91, and 97 tons/MCY, respectively, of unconsolidated sediment.

The cumulative storage of TN in Lake Jesup unconsolidated sediment was estimated at 13,000, 19,000, 23,000, and 27,000 tons at 1, 1.5, 2, and 3 feet, respectively, which corresponds to TN concentrations that range from 1,100 to 1,400 tons/MCY.

4.2 Dredging Methods, Rates, and Cost

4.2.1 Dredging Methods

Dredging is commonly accomplished by any of the following three mechanisms:

1. Suction dredging, in which soft/loose materials are dredged using dustpan, hopper, plain suction, or sidecaster dredges.
2. Mechanical dredging, in which soft/loose or consolidated/hard materials are dredged using clamshell, dipper, or ladder dredges.
3. A combination of suction and mechanical dredging, in which soft/loose or consolidated/ hard materials are dredged using cutter-head or auger-head hydraulic dredges.

The selection of any of these methods depends mainly on the following factors:

- *Sediment*—volume, type, depth, thickness, physical and chemical characteristics, quality, contamination, final use, etc.

Table 4.4 – Lake Jesup Unconsolidated Sediment Estimated Cumulative Nutrient Storage and Concentration vs. Depth

Zone (1)	Depth (feet)	Unconsol. Sediment Volume (MCY)	Estimated Cumulative Storage (tons)			Estimated Concentration (tons/MCY)		
			OC	TP	TN	OC	TP	TN
East	0.5	0.67	15,900	60	736	23,800	90	1,100
	1.0	1.26	38,600	116	1,590	30,600	92	1,260
	1.5	1.71	58,500	155	2,350	34,200	91	1,380
	2.0	2.01	74,200	220	2,960	36,900	109	1,480
	3.0	2.15	82,100	265	3,280	38,200	123	1,530
	4.0	2.16	82,700	265	3,300	38,300	123	1,530
South	0.5	1.04	19,600	66	934	18,900	64	898
	1.0	1.97	49,700	160	2,210	25,200	81	1,120
	1.5	2.60	74,800	240	3,210	28,800	92	1,230
	2.0	2.84	88,800	279	3,590	31,300	98	1,260
	3.0	2.90	91,900	285	3,690	31,700	98	1,270
	4.0	2.90	91,900	285	3,690	31,700	98	1,270
Northeast	0.5	0.75	18,500	71	745	24,700	95	994
	1.0	1.39	38,300	137	1,620	27,600	99	1,160
	1.5	1.89	56,400	176	2,370	29,900	93	1,250
	2.0	2.15	69,000	233	2,870	32,100	108	1,340
	3.0	2.20	72,800	244	3,010	33,100	111	1,370
	4.0	2.20	72,800	244	3,010	33,100	111	1,370
Northwest	0.5	0.91	17,300	55	800	19,000	60	879
	1.0	1.75	45,600	124	2,010	26,100	71	1,150
	1.5	2.48	72,500	173	3,060	29,200	70	1,230
	2.0	3.07	96,200	232	4,000	31,300	76	1,300
	3.0	3.54	120,200	293	4,860	34,000	83	1,370
	4.0	3.54	120,200	293	4,860	34,000	83	1,370
West Central	0.5	0.80	16,200	47	784	20,200	59	980
	1.0	1.57	38,000	108	1,790	24,200	69	1,140
	1.5	2.30	63,000	163	2,850	27,400	71	1,240
	2.0	2.99	89,600	215	3,930	30,000	72	1,310
	3.0	4.24	146,200	321	6,170	34,500	76	1,460
	4.0	5.02	180,600	479	7,370	36,000	96	1,470
West	0.5	0.98	17,200	58	845	17,600	59	862
	1.0	1.87	43,100	136	2,020	23,100	73	1,080
	1.5	2.62	69,800	184	3,210	26,700	70	1,220
	2.0	3.11	86,100	217	3,880	27,700	70	1,250
	3.0	3.38	97,400	254	4,340	28,800	75	1,280
	4.0	3.41	98,200	254	4,380	28,800	74	1,280
Central	0.5	0.56	13,300	55	873	23,800	98	1,560
	1.0	0.81	24,200	89	1,350	29,800	110	1,680
	1.5	0.88	28,200	95	1,500	32,000	107	1,720
	2.0	0.90	28,400	99	1,510	31,500	110	1,670
	3.0	0.90	28,400	99	1,510	31,500	110	1,670
	4.0	0.90	28,400	99	1,510	31,500	110	1,670
Entire Lake	0.5	5.72	124,100	437	6,140	21,700	76	1,070
	1.0	10.62	288,000	893	13,300	27,100	84	1,250
	1.5	14.49	443,800	1,220	19,300	30,600	84	1,330
	2.0	17.07	551,000	1,560	23,000	32,300	91	1,350
	3.0	19.31	668,600	1,870	27,200	34,600	97	1,410
	4.0	20.12	705,800	1,960	28,600	35,100	98	1,420

(1) Refer to Figure 4.1.

- *Dredging Area*—shape, size, water depth, access, physical and environmental constraints, aquatic vegetation, potential damage to adjacent structures, etc.
- *Disposal Area*—distance from dredging areas, size, shape, availability, ownership, access, subsurface conditions, land use of surrounding areas, adjacent utilities, physical and environmental constraints, final site use, disposal methods, etc.
- *Project and Regulatory Requirements*—project budget and schedule, local noise/odor/ fire ordinances, interference with ongoing operations, pumping rate, etc.

The cutter-head hydraulic dredges are commonly used in dredging thin to thick and shallow to deep deposits of soft to consolidated materials that exist in small or large areas. On the other hand, the auger-head hydraulic dredges are best suited for dredging thin and shallow deposits of unconsolidated sediment that exist in large areas similar to that of Lake Jesup.

Turbidity problems around the dredge could be significantly reduced by using a floating turbidity curtain, which typically consists of a continuous polyethylene sheet buoyed at the surface and weighted at the bottom. If auger-head is used, a mud shield can be used to further reduce turbidity or replace the floating turbidity curtain.

4.2.2 Production Rates and Pumping Distances

The production rates of the cutter-head dredges are typically much higher than those of the auger-head dredges. However, both dredges typically pump and discharge the dredged water/sediment slurry into the disposal areas at a relatively low solids content of 5 to 20 percent (by weight). Due to the relatively low in-situ solids content of Lake Jesup unconsolidated sediment, the solids content of the slurry is expected to vary approximately between 3 and 15 percent, with an average value of between 7 and 12 percent assumed for preliminary design. The production or dredging rates of the auger-head or cutter-head hydraulic dredge can be estimated using the following formula:

$$P = 0.297\, r\, s \qquad \text{..... [4-1]}$$

where P = Production rate of in-situ sediment [CY/hr];
r = Slurry rate [gallons per minute, gpm]; and
s = Ratio of dredged slurry solids content to in-situ sediment solids content.

Using Equation 4-1, assuming a standard 8 to 10-inch auger-head dredge (which typically has a slurry rate of approximately 2,000 gpm), and assuming a slurry solids content of 7 percent (by weight), an in-situ sediment production rate of 293 CY/hr per dredge is estimated. Assuming 75-percent efficiency, this production rate corresponds approximately to 3,510 CY of in-situ sediment volume for a 16-hour working day, and 5,270 CY for a 24-hour working day. Assuming a 16-hour to 24-hour working day for 7 days per week, a production rate of 1.28 to 1.92 MCY, respectively, of in-situ sediment volume per year is estimated for a single 8 to 10-inch auger-head dredge.

Depending on the type and horsepower of the dredge's pump and the type and diameter of the dredge pipeline, as well as the sediment types and characteristics, an auger-head dredge can pump the dredged slurry up to a maximum distance of about 10,000 feet. Booster pumps would be required for longer pumping distances. Depending on the physical

characteristics of sediment and the pressure rating of the discharge line, booster pumps would be required approximately every 1.5 to 2 miles after the first 1.5 to 2 miles.

Figure 4.9 shows the estimated mean pumping distances between the Cameron/Little Ranch disposal area and the approximate distance-center of each of the zones described previously. As shown, the mean pumping distance ranges approximately from 12,000 feet for the East Zone to 31,500 feet for the West Zone. Thus, one to two standard booster pumps would be required for dredging the lake.

4.2.3 Selection of Appropriate Dredge

Given the distribution, characteristics, and estimated volumes of unconsolidated sediment with Lake Jesup, we envision that at least two 10-inch auger-head dredges would be required, with a minimum combined production rate of 4,000 gpm. Alternatively, a large specialty auger-head dredge could be used. We also envision that the selected dredge(s) would be equipped with the following:

- A boom-mounted submersible pump to reduce turbidity and increase solids content of the sediment slurry.
- A highly accurate, real-time, navigational and dredging control system with vertical and horizontal accuracies of less than 2 inches and 10 feet, respectively.
- A noise control system to minimize disturbance to lake habitats and lakeside residents.
- A densiometer to continuously measure the solids content of dredged slurry in the discharge pipeline.

To maximize the solids content of the dredged slurry, the dredging head of the dredge needs to be buried into sediment most of the time during dredging. The cutter-head dredges, despite their high production rates, are not recommended for the following main reasons:

- The shallow water depth of the lake may cause the cutter head to be partially exposed above water, which may interrupt the dredging operation.
- The high potential for over-dredging and disturbance of the underlying consolidated sediment layer.

4.2.4 Engineer's Opinion of Probable Unit Costs for Dredging and Pumping

Based on the unconsolidated sediment volumes and characteristics of Lake Jesup, as well as our experience with similar projects, the probable unit costs for dredging and pumping shown in Table 4.5 below can be used for preliminary design purposes.

4.3 Priority Ranking of Dredging Areas

4.3.1 Ranking Criteria for Dredging Areas

As shown in Table 4.3, a total in-situ volume of about 20.3 MCY of unconsolidated sediment was estimated within the open water area of Lake Jesup. The dredging cost of this volume is expected to exceed the approximately $16 million that the FWC has allocated so far for the project. Until additional funds become available, the FWC has requested PB Water to

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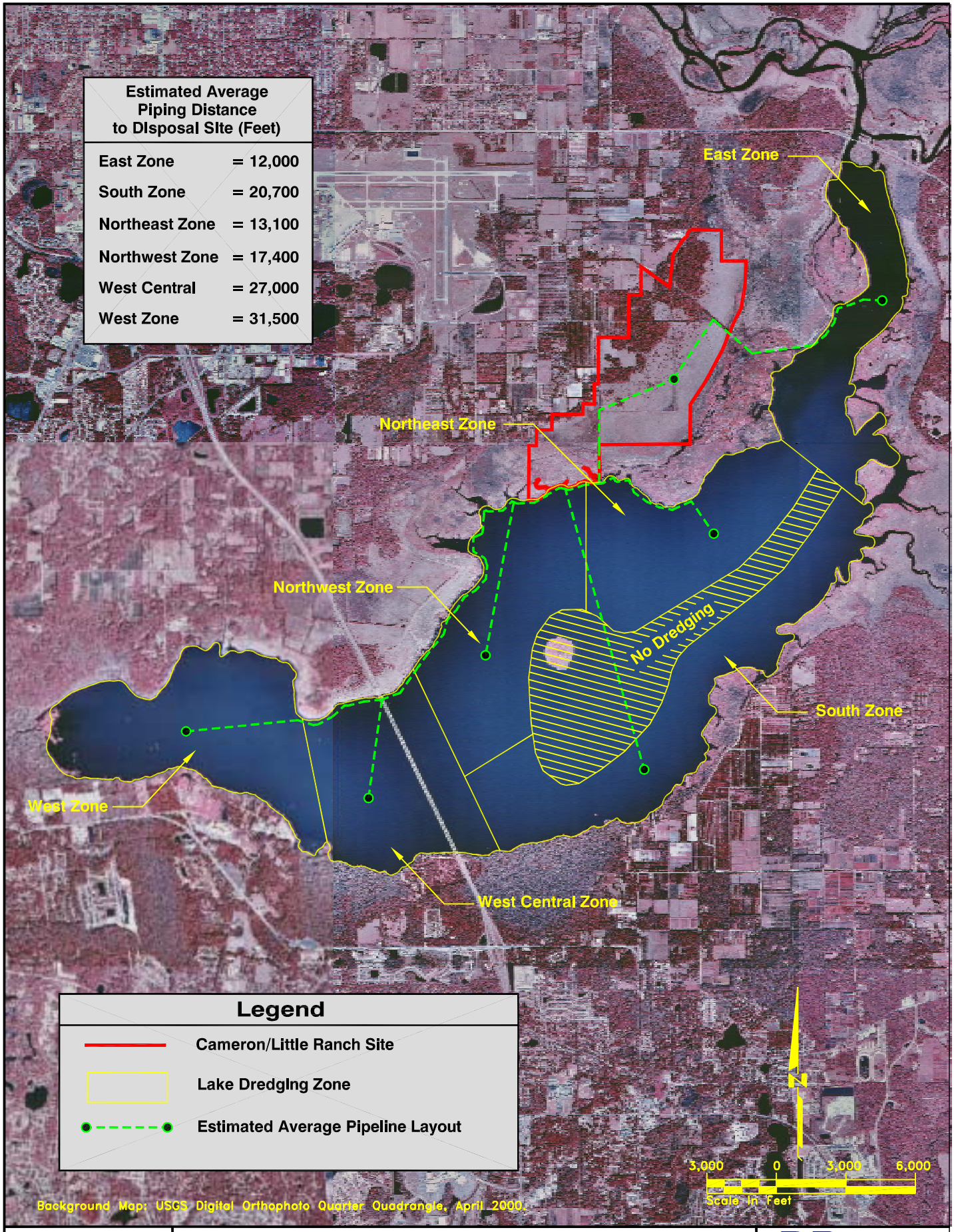

Figure 4.9

Estimated Average Pumping Distance Between Dredging Zones and Disposal Area

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Table 4.5 – Engineer's Opinion of Probable Dredging/Pumping Unit Costs for Lake Jesup Unconsolidated Sediment

Item	Pumping Distance (miles)	Units	Probable Unit Cost
Mobilization of Single 8 to 10-inch Auger-Head Dredge	N/A	Each	$250,000
Dredging/Pumping (combined)	0.0 – 2.0 2.0 – 4.0 4.0 – 6.0	CY	$1.25 $1.75 $2.25

Notes:
Costs shown are in Year 2002 dollars, subject to changes in fuel costs.
N/A = not applicable
CY = cubic yards

rank the seven zones shown in Figure 4.1 with respect to dredging priority. As a result, the following main prioritization criteria were developed and used to preliminarily rank these zones:

1. Depositional classification (i.e., depositional, transitional, or scour) and relative location (proximity to disposal site) of each zone.
2. Estimated unconsolidated sediment volume within each zone (and corresponding dredging and pumping cost).
3. Estimated TP storage for each zone.

It should be noted that other criteria might apply, thus the results of this ranking process should be judged as preliminary in nature. As shown, the first criterion is a qualitative but principal criterion that supercedes the other two quantitative criteria. The following subsections briefly describe the above criteria and associated parameters.

4.3.2 Prioritization Based on Criterion No. 1

As mentioned in Section 4.1.2, the UF study (Cable et al., 1997) concluded that the East Zone has the greatest mass deposition of mostly inorganic sediment due to river exchange. The study also concluded that the Central and Northeast/Northwest Zones are scour and transitional areas, respectively, while the South, West Central, and West Zones are depositional areas. Also as mentioned in Section 4.2, the replacement alternatives for the existing SR 46 bridge are expected to increase the hydraulic exchange with the St. Johns River and subsequently increase lake flushing, sediment resuspension, and export to the St. Johns River, mainly from the eastern end of the lake. Using Criterion No. 1 alone, the seven zones were ranked in prioritization order as follows:

1. East
2. South
3. West
4. West Central

5. Northeast
6. Northwest
7. Central

The Central Zone was excluded from further ranking due to its scour nature and very thin thickness of unconsolidated sediment. It is not recommended for dredging.

4.3.3 Prioritization Based on Criterion No. 2

The total in-situ volumes of unconsolidated sediment within the East, South, Northeast, Northwest, West Central, and West Zones were estimated at 2.2, 2.9, 2.2, 3.5, 5.2, and 3.4 MCY, respectively. Using Criterion No. 2, the six zones were ranked in ascending order based on increasing sediment volume. In this manner, the lake zones with the smallest volumes and least dredging cost (but still with significant benefit to the health of the lake) are prioritized:

1. East (tie)
1. Northeast (tie)
3. South
4. West
5. Northwest
6. West Central

4.3.4 Prioritization Based on Criterion No. 3

The TP storage amounts within the unconsolidated sediment for the East, South, Northeast, Northwest, West Central, and West Zones were estimated at 265, 285, 244, 293, 479, and 254 tons, respectively (Table 4.4). Using Criterion No. 3 alone, the six zones were ranked in prioritization order as follows:

1. West Central
2. Northwest
3. South
4. East
5. West
6. Northeast

4.3.5 Preliminary Priority Ranking Based on All Criteria

Table 4.6 summarizes the ranking of each zone based of the combined and individual applications of the above three criteria. As shown, the zones were ranked in descending order for Criteria Nos. 1 and 3 and in volume-ascending order for Criterion No. 2. Using the following formula, the final ranking of the six zones was derived.

$$R_F = 0.5\,R_1 + 0.4\,R_2 + 0.1\,R_3 \quad \text{..... [4-2]}$$

where R_F = Final rank based on Criteria Nos. 1, 2, and 3;
R_1 = Ranking based on Criterion No. 1;
R_2 = Ranking based on Criterion No. 2; and
R_3 = Ranking based on Criterion No. 3.

The above weighting factors were based on the relative importance of each criterion in determining the overall dredging priority for each zone. Table 4.6 shows the final rank of each zone, as well as the sediment volumes, estimated time to dredge, and corresponding opinion of probable dredging/ pumping cost. Based on these results and the currently available project budget, the FWC may elect to dredge the entire East and South Zones, as well as the upper 1 to 2 feet of highly nutrient-rich sediments that have accumulating since 1900 within the Northeast, West, West Central and Northwest Zones.

Table 4.6 – Lake Jesup Unconsolidated Sediment Dredging Priority, Based on Selected Ranking Criteria

Zone (1)	Probable Dredging/ Pumping Cost (2)	Estimated Time to Dredge (3) (days)	Final Rank	Criterion No. 1		Criterion No. 2		Criterion No. 3	
				Depositional Pattern	Rank	Sediment Volume (MCY)	Rank	TP (tons)	Rank
East	$3,900,000	209	1	Depositional	1	2.2	1	265	4
South	$5,100,000	276	2	Depositional	2	2.9	3	285	3
Northeast	$3,900,000	209	3	Transitional	5	2.2	1	244	6
West	$7,700,000	323	4	Depositional	3	3.4	4	254	5
West Central	$11,700,000	494	5	Depositional	4	5.2	6	479	1
Northwest	$6,100,000	333	6	Transitional	6	3.5	5	293	2

(1) Refer to Figure 4.1.
(2) Engineer's opinion, based on Year 2002 dollars, excluding mobilization costs, and subject to changes in fuel costs. Refer to Table 4.5 for unit costs.
(3) Assumes 4,000-gpm slurry production rate, 7-percent slurry solids content by weight, and continuous 24-hour/7-day operation at 75-percent efficiency.

4.4 Potential Dredging Impacts

Restoration of the Lake Jesup aquatic system via hydraulic dredging will provide a significant environmental benefit. Design, construction, and operation of dredging and disposal activities will be performed to avoid any anticipated negative impacts. However, if any unexpected impacts should occur during Lake Jesup dredging operations, immediate steps will be taken to correct such impacts through the use of proven techniques.

In general, hydraulic dredging of unconsolidated lake sediment has the potential to impact several items, including: lake water levels; regional groundwater flow and levels; in-lake turbidity and contaminant release during sediment dredging; pollutant discharge and odor from the disposal area; long-term chemical changes of sediment in the disposal area; aquatic wildlife; and wetland habitat. The applicability of each of these potential impacts is discussed below with regard to the proposed Lake Jesup aquatic enhancement project.

4.4.1 Water Level Fluctuation

The potential for lowering the water levels of the lake as a result of dredging and removing water/sediment slurry is expected to be negligible since the water levels of the lake are mainly influenced by the water level fluctuations of the St. Johns River. During sediment dredging/removal operation, the net lake outflow into the river would be reduced by a small amount (estimated at less than 1 percent) due to the storage of water in the sediment slurry deposited in the disposal area.

4.4.2 Regional Groundwater Impact

The unconsolidated sediment layer does not appear to provide much confinement or resistance to upward groundwater seepage due to its loose and soft nature. Thus, the removal of this layer by dredging is not anticipated to create any observable increase in upward seepage from the Floridan aquifer into the lake.

4.4.3 In-Lake Turbidity During Dredging and Return Water Discharge

In general, no turbidity problems are anticipated for the Lake Jesup dredging operations. The turbidities or suspended solids concentrations around cutter-head or auger-head hydraulic dredges are generally low compared to other types of dredging equipment. If any in-lake turbidity level increases are experienced near the dredge head during dredging, a mud shield can be used to reduce turbidity.

In addition, design of the confined disposal facility (CDF) will include appropriate retention time to control the turbidity of return water discharge. Coagulants (e.g., alum or polymer) will also be used in polishing ponds if necessary to reduce turbidity prior to discharge back into the lake.

4.4.4 In-Lake Contaminant Release During Dredging

As mentioned in Section 3.3.3, the results of the chemical tests (heavy metals, nutrients, pesticides, hydrocarbons, oil and grease, and other chemical tests) that were conducted on Lake Jesup sediment indicated no contamination. Also, based on research conducted by the U.S. Army Corps of Engineers (ACOE), there is no biologically significant release of these chemical constituents from typical dredged material to the water column during or after dredging or disposal operations (ACOE, 1983). For these reasons, no in-lake contaminant release is expected to occur.

4.4.5 Pollutants in Return Water from Confined Disposal Facility

The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers are responsible for developing environmental guidelines and enforcing Section 404 of the Clean Water Act. The *Inland Testing Manual* (EPA, 1998) contains the current guidelines, which provide the basis for evaluation of permit applications. The guidelines address contaminant-related impacts associated with the discharge of dredged material. In addition, the *Inland Testing Manual* addresses contaminant-related impacts to U.S. waters associated with dredged material runoff from CDFs. The guidelines do not address the impacts associated with the actual dredging activity.

The dredged sediment will be continuously inundated during disposal into the CDF. As a result, no significant changes in sediment pH, salinity, or oxidation are expected to occur. Also, as mentioned previously the CDF will be designed and operated so that the return water discharge will meet applicable water quality requirements.

4.4.6 Odor

Lake Jesup unconsolidated sediment contains high percentages of organic components. Oxidation of these components is expected to occur in the CDF during the drainage and drying/desiccation phase, which is expected to start after completion of sediment disposal and surface drainage. Effective reclamation and management of the CDF after sediment disposal will reduce the potential for odor impacts. Also, the Cameron/Little Ranch Site, where the CDF will be constructed, is far from residential areas.

4.4.7 Long-Term Chemical Changes

Most types of lake-bottom sediments are initially nearly neutral in pH. Non-calcareous sediments and those containing appreciable reactive iron and reduced sulfur compounds may become moderately to strongly acidic upon gradual drainage and subsequent oxidation as may occur during dewatering and consolidation in the CDF. No chemical characterization data for the Lake Jesup sediments exist that would either imply or refute the presence of reactive iron and reduced sulfur compounds. However, the presence of a thick, highly plastic, and impervious layer of clay beneath the Cameron/Little Ranch disposal area would prevent migration of sediment leachate from the disposal area into the surficial aquifer.

4.4.8 Protected Aquatic Wildlife

In general, dredging activities may impact aquatic wildlife in several ways, by:

- Changing habitat, sedimentation patterns, and ambient water quality (especially DO).
- Removing or entraining organisms from both the sediment and the water column.
- Noise impairment of migratory and nesting birds.
- Disrupting migration and spawning, and creating turbidity plumes of suspended solids that can affect fish and other organisms (ACOE, 1989; Ault et al., 1998; LaSalle et al., 1991; Reine and Clarke, 1998; Clarke and Wilber, 2000).

None of these potential impacts is expected to be a significant problem for protected wildlife at Lake Jesup. As discussed previously, in-lake and return water discharge water quality (including turbidity) will be controlled. Bird Island contains a designated rookery for several different bird species (primarily egrets and cormorants); however, dredging is not planned within the vicinity of Bird Island (a minimum setback of 500 feet is planned, as seen on Figure 4.1). A minimum 1500-foot setback will be maintained from active bald eagle nests (see discussion in subsection 5.3.2). Dredging is not listed as a cause of death for manatees (FMRI, 2000), so it is not expected to cause mortality or injury. However, it is imperative that dredging activities are conducted according to the guidelines set forth in the *Special Manatee Protection Conditions* issued by the Jacksonville District of the US Army Corps of Engineers (ACOE, 2000). Finally, alligators are expected to avoid the dredging areas.

4.4.9 Persistent and Transient Aquatic Wildlife

The potential impacts of dredging on persistent (resident) aquatic wildlife could be similar to those discussed for protected aquatic wildlife. The entrainment of fish and other aquatic organisms may cause direct mortality. The noise of the dredging operation may disturb the migration, nesting and feeding activities of some birds. The DO in the water may decrease as a result of anaerobic sediments being exposed and dispersed through the water column. Fish and other invertebrates that derive their oxygen from that which is dissolved in the

water would be at risk if the DO levels should drop below 4 ppm for extended lengths of time. The benthic macroinvertebrates that are directly entrained by the dredging will most certainly experience high levels of mortality. However, since dredging operation will take a long time to complete, recruitment from the surrounding undredged areas should allow the dredged areas to repopulate rapidly. In general, these potential temporary impacts will be more than offset by the long-term improvement in aquatic habitat and the health of the lake expected to result from dredging.

4.4.10 Wetland Habitat

The dredging operation will be conducted only within the open water area of the lake; no dredging would occur beyond the surveyed line of shoreline emergent vegetation (as shown in Figure 1.2). In addition, due to poor water clarity and the loose nature of its sediment, Lake Jesup does not support beneficial submerged aquatic vegetation (SAV), except for a small area of eelgrass *(Vallisnneria Americana)* that was planted around Bird Island, but did not successfully grow. For this reason, no impact to wetland SAV is expected due to dredging the lake's bottom sediment.

5 DISPOSAL SITE ASSESSMENT

5.1 Site Selection

For conservation purposes, the SJRWMD purchased four large properties surrounding Lake Jesup (see Figure 1.2). One of the properties, formerly known as the Cameron/Little Ranch (Cameron) Site, includes a large, cleared pasture land area at higher topographic elevation than many other sites surrounding the lake. Based on an agreement with the SJRWMD, the FWC has identified this property as the only parcel currently planned for disposal of sediment dredged from the lake. PB Water has developed this Phase I study based on direction from the FWC to use the Cameron Site for sediment disposal.

As a part of this study, a preliminary assessment of the Cameron Site was performed regarding its suitability as a sediment disposal area. Results of the preliminary site assessment are summarized in the following subsections.

5.2 Geographic Assessment

5.2.1 Site Description and Location

The Cameron Site (Figure 5.1) occupies a total of approximately 1,000 acres of land in Seminole County, located on the northeastern side of Lake Jesup and south of SR 46. As shown, two drainage canals (Cameron Ditch and Chub Creek Canal) leading to the lake effectively separate the site into southern, central, and northern portions. The southern portion is generally at a low elevation and borders the shoreline of Lake Jesup. The central and northern portions do not border the lake, with the former Futch property (also owned by the SJRWMD) located in between (see Figure 1.2). The central and northern portions have historically been used for pasture land, and have significant open areas covered with grasses.

5.2.2 Site Topography

The topography of the Cameron Site includes a gentle increase in grade from the south and east to the north and west, with ground surface elevations ranging from below 1 foot NGVD near the lake's edge (when water levels are low) to approximately 14 feet NGVD in the extreme western portion of the site. For this study and the subsequent design (Phase II), 1-foot topographic contours across the site (Figure 5.1) were obtained from SJRWMD geographic information system (GIS) data files. These topographic contours were based on an October 1988 aerial photogrammetric survey of the area (SJRWMD, 1988). The natural gravity drainage from the site is sheetflow and some channelized flow toward the lake.

5.3 Environmental Assessment

For environmental and ecological issues related to the Project, PB Water retained the services of Scheda Ecological Associates, Inc (SEA). As part of the preliminary site assessment, SEA reviewed currently available GIS-based data on wetlands, protected

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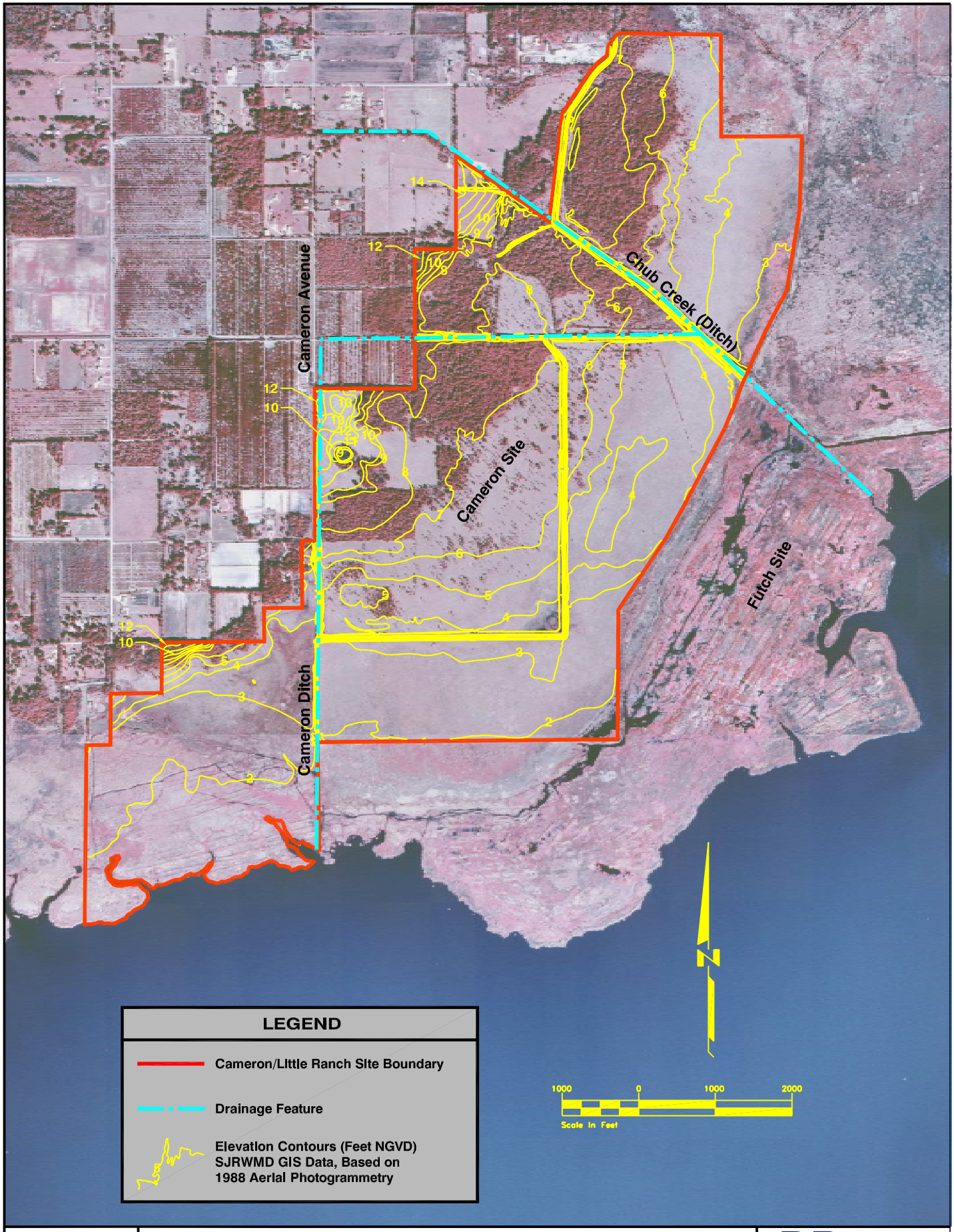

Figure 5.1

Cameron/Little Ranch Site Map with Topography

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species, soils, and lake flood plain. The results of this assessment are included in Appendix G and summarized below.

5.3.1 Wetlands and Sovereign Submerged Land

National Wetland Inventory (NWI) and Florida Land Use Cover and Forms Classification System (FLUCFCS) maps for the site, based on currently available NWI and FLUCFCS database information, are included in Appendix G. Most of the potential area of the site proposed for disposal is defined as "Wet Prairie" on the 1995 FLUCFCS map. The wooded areas along the western part of the site are generally defined as "Wetland Forested Mix," and disposal activities are proposed to remain outside of these densely wooded areas. Dominant species in the wooded area include Cabbage Palm and Live Oak.

Based on initial discussions with the SJRWMD and the FDEP, the FWC has provided direction to PB Water to design the sediment disposal areas within the open portions of the Cameron Site above sovereign submerged lands adjacent to the lake. The Lake Jesup ordinary high water level tends to inundate the sovereign submerged lands. Based on written direction from the FDEP (see Appendix H), the ordinary high water line for the lake is no greater than 3.0 feet NGVD. For this reason, the 3-foot contour line (Figure 5.1) will be used as a lower limit for location of sediment disposal.

5.3.2 Protected Species

A review of the current element occurrence records from the Florida Natural Areas Inventory (FNAI) and the Eagle Nest Location Database of the FWC indicated that the site does not show any occurrences of state and/or federally protected species. However, within a 1-mile buffer of the project area, one Eastern Indigo Snake location was shown just outside the southwest corner of the site, and three potential Bald Eagle Nest locations were indicated to the west of the site, at setback distances ranging from approximately 2000 to 3600 feet (see Appendix G).

5.3.3 Hydrologic Data

5.3.3.1 Soils

The *Soil Survey of Seminole County, Florida* (USDA-SCS, 1990) was reviewed to identify major soil units that may exist within the upper 6 feet below land surface at the Cameron Site. It should be noted that Soil Conservation Service (SCS) soil survey data are very general and should be used with judgment. As shown in Appendix G, the majority of the southern and eastern low-lying areas of the site nearest the lake are underlain by fine-grained, flood plain-type soils including Nittaw (Map Unit 22) and Basinger (Map Unit 23) soil. The seasonal high water table of these soils is within 0 to 1 foot of land surface. On the other hand, the northwestern wooded areas of the site are mainly underlain by transitional type soils, including Felda fine sand (Map Unit 15) and Wabasso fine sand (Map Unit 35).

5.3.3.2 Flood Plain

Currently available (1996) Federal Emergency Management Agency (FEMA) data were reviewed to determine flood plain coverage on the Cameron Site. A map showing the FEMA AE and X500 flood rate zones (two types related to the 100-year flood plain) is included in the SEA information (Appendix G). Also, as mentioned previously in Section 1.1, the SJRWMD has recently estimated the 100-year elevation of the lake at 9.98 feet NGVD, which based on topographic contour information from Figure 5.1, is approximately consistent with the FEMA map.

5.3.4 Historic Land Use

It is important to note that, although available maps may indicate wetland-type features, the portions of the Cameron Site proposed for disposal have historically been altered and separated from the flood plain of the lake through construction of dikes. These dikes have only recently been partially removed by the FWC. The dominant land use category for the site has been pasture land.

5.4 Cultural Resources Assessment

The FWC retained SouthArc, Inc. to perform a cultural resources assessment of the Cameron Site in the summer of 2002. This assessment report is included as Appendix I. The results of the study indicated no apparent prehistoric or historic cultural activity on the site, and the project archaeologists stated that in their opinion "the proposed muck removal and disposal will not impact any significant cultural resources" (Dickinson and Wayne, 2002).

5.5 Regional Hydrogeologic Assessment

The regional hydrogeologic setting of Lake Jesup and surrounding areas (including the Cameron Site) is comprised of the surficial aquifer, the intermediate semi-confining unit (usually known as the Hawthorn Group), and the Floridan aquifer. The Floridan aquifer is sometimes subdivided into an upper production zone (Upper Floridan aquifer) and a lower production zone (Lower Floridan aquifer), separated by a less permeable zone referred to as the middle semi-confining unit. A generalized east-west geologic cross section of East-central Florida, including the Lake Jesup area, is presented in Figure 5.2.

5.5.1 Surficial Aquifer

The surficial aquifer is the uppermost, unconfined, water-bearing unit. It is generally composed of Pliocene to Holocene-age sand, silt, clay, and crushed shell material. The thickness of the surficial aquifer system is highly variable, ranging from 10 feet to over 50 feet in high ridge areas of the East-central Florida region. With increasing depth, the surficial aquifer system sediments generally grade into less permeable clayey or silty sands that partially confine the Floridan aquifer in areas where the intermediate semi-confining unit is absent. Lateral movement of groundwater generally follows topography, moving from topographic high to topographic low areas such as rivers or springs. The water table can generally be found from land surface to more than 10 feet below land surface. Typical hydraulic conductivities observed for the surficial aquifer in this region can range from 5 to 80 feet per day (ft/d).

Recharge to the surficial aquifer is mostly derived from precipitation, with minor amounts from upwards seepage and irrigation. Discharge from the surficial aquifer includes seepage to lakes, streams, and ditches, evapotranspiration, pumpage, and downward leakage to the Floridan aquifer. Generally, few wells use the surficial aquifer due to its low yield and poor water quality.

5.5.2 Intermediate Semi-Confining Unit (Hawthorn Group)

The intermediate semi-confining unit separates the surficial and Floridan aquifer systems, except in areas where it has been eroded or breached (e.g., from sinkhole activity), leaving

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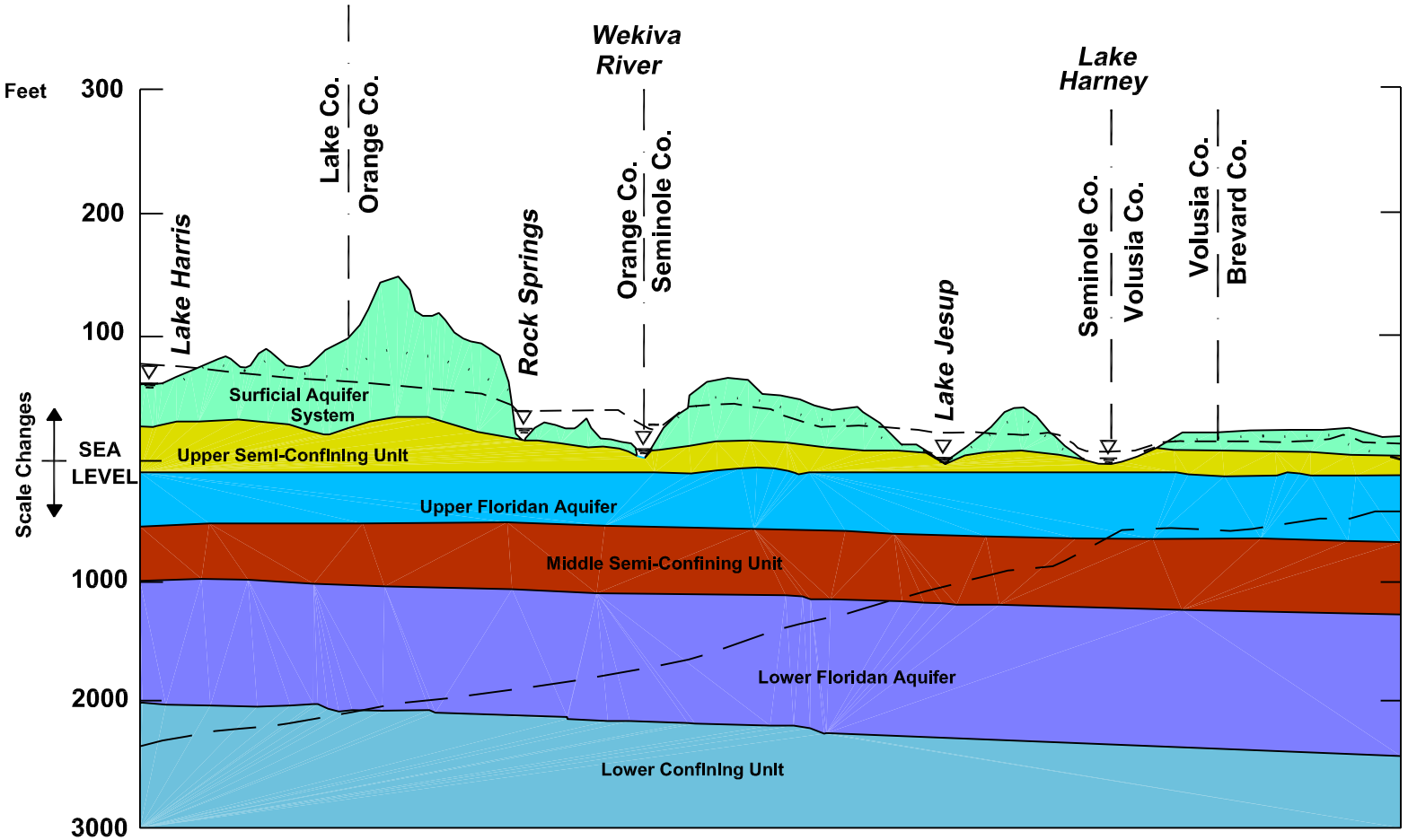

Vertical scale varies and is greatly exaggerated

0 5 10 15 Miles

0 5 10 15 Kilometers

Explanation

- Surface Water Level
- Water Table
- Upper Floridan Aquifer Potentiometric Surface
- Generalized Freshwater/ Saltwater Interface

Source: Figure modified from USGS Orlando Metropolitan Area Report (Murray and Halford, 1996)

Figure 5.2

Generalized East-West Hydrogeologic Cross-Section of East-Central Florida

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the surficial aquifer in direct connection with the Floridan aquifer. The typical thickness of this unit may average around 50 feet. This unit generally is composed of the Hawthorn Group sediments, although in some areas the low permeability strata of early Pliocene age sediments act as the confining unit. The vertical hydraulic conductivity of the semi-confining unit is variable, typically ranging from approximately $1x10^{-6}$ to $1x10^{-2}$ ft/d.

5.5.3 Floridan Aquifer System

The Floridan aquifer system consists of a sequence of carbonate rocks ranging in age from Paleocene (65 million years ago) to early Miocene (20 million years ago) that are hydraulically connected. The aquifer is located in parts of South Carolina, Georgia, Alabama, and all of Florida. The Floridan aquifer generally consists of a upper and lower zones of greater permeability, separated by less-permeable anhydrite beds within the lower Avon Park Formation. The Upper Floridan aquifer unit consists of the Ocala Limestone, and the upper part of the Avon Park Formation. The Upper Floridan aquifer can be unconfined, semi-confined or confined throughout the study area. Sinkholes are common in the unconfined and semi-confined areas and provide hydraulic connection between the surface and the Upper Floridan aquifer.

Recharge to the Floridan aquifer occurs through sinkholes and solution conduits that penetrate the aquifer; downward leakage from the surficial aquifer; and drainage wells. Natural discharge from the aquifer can be to springs, rivers, lakes, and areal discharge in areas where the potentiometric water level is higher than the overlying surficial aquifer system's water table. Wells that tap into the aquifer are a large source of potable withdrawal in the region.

The hydraulic properties of the Floridan aquifer system vary with location due to lithology, compaction, dissolution, recrystallization, and fractures. Transmissivity of the Floridan aquifer in the vicinity of Lake Jesup is estimated at approximately 10,000 to 50,000 ft/d.

Figures 5.3 and 5.4 show USGS 2001 potentiometric surface maps of the Floridan aquifer at the end of the dry and wet seasons, respectively, in the vicinity of Lake Jesup (Knowles, 2001; Knowles and Kinnaman, 2002). As shown, the potentiometric surface varies in elevation from approximately 12 to 20 feet NGVD beneath the Cameron Site throughout the year. These elevations are approximately 0 to 15 feet above the land surface elevations of the site (Figure 5.1), indicating a primarily artesian condition (upward gradient from the Floridan to the surficial aquifer). Floridan aquifer levels beneath the lake range from approximately 10 to 30 feet NGVD, indicating that upward discharge from the Floridan aquifer into Lake Jesup occurs whenever the lake level is below 10 feet (i.e., essentially all the time).

5.5.4 Inventory of Existing Wells

An inventory of all permitted wells located within a 5-mile radius around Lake Jesup that tap into the Upper and Lower Floridan aquifers was obtained from the current consumptive use permit database of the SJRWMD (as included in their current East-central Florida groundwater flow model). Figure 5.5 shows the locations of permitted wells around Lake Jesup, sorted by well use (i.e., agricultural, public water supply, or commercial/industrial). Agriculture accounted for approximately 87 percent of all of the permitted wells, while approximately 13 percent were public supply wells. Only one commercial/industrial well was identified in the study area.

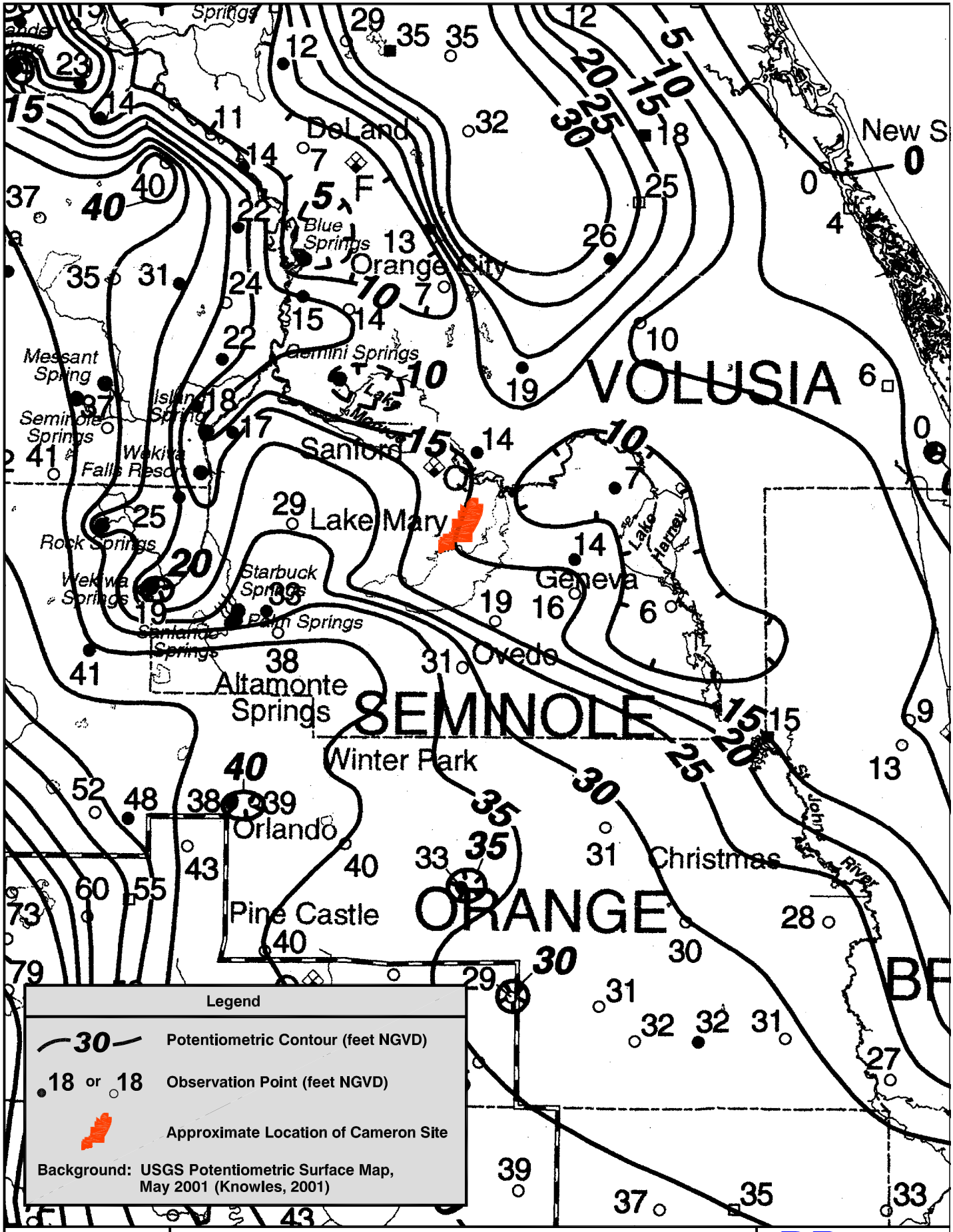

Figure 5.3

Floridan Aquifer Potentiometric Surface Elevations
May 2001

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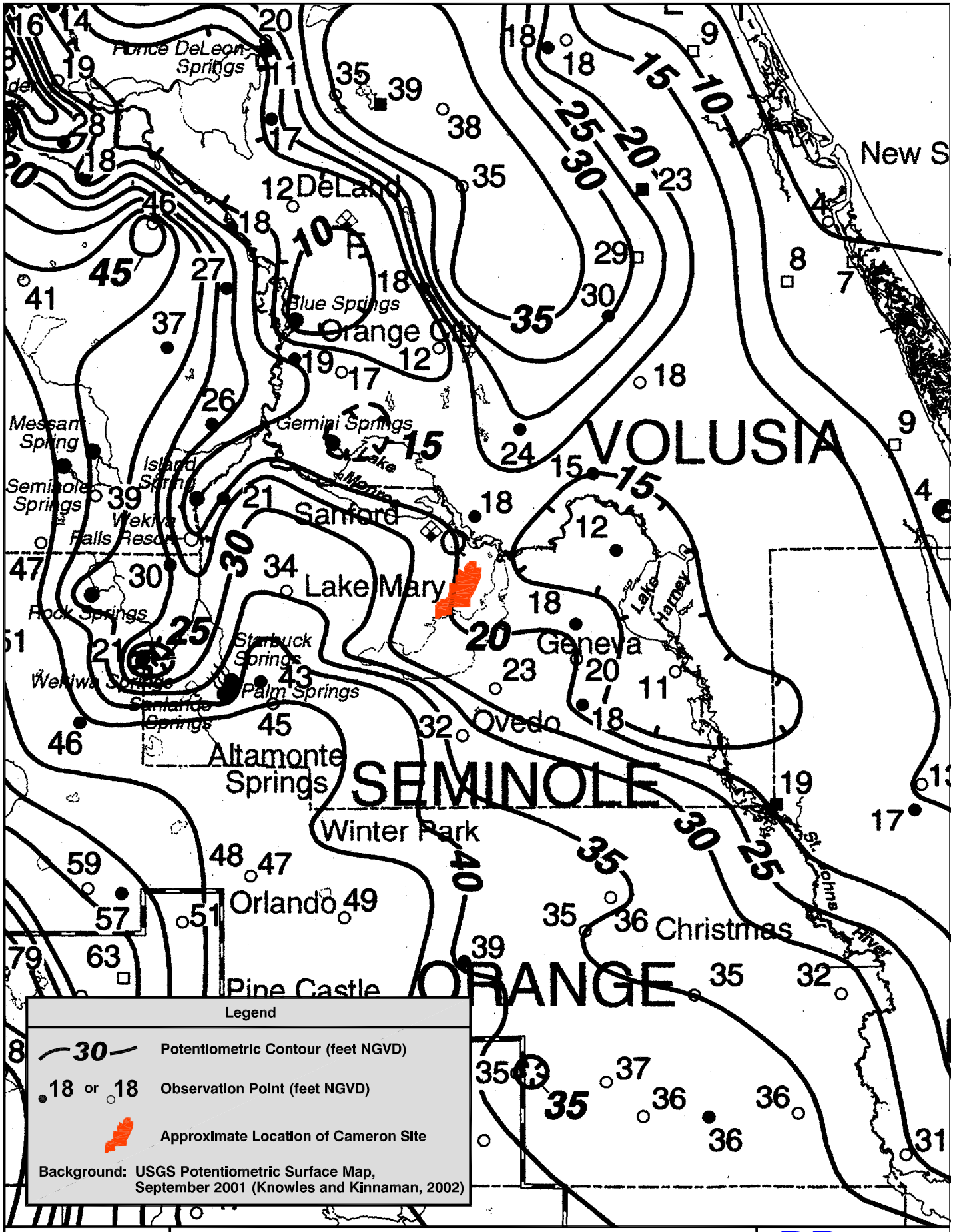

Figure 5.4

Floridan Aquifer Potentiometric Surface Elevations
September 2001

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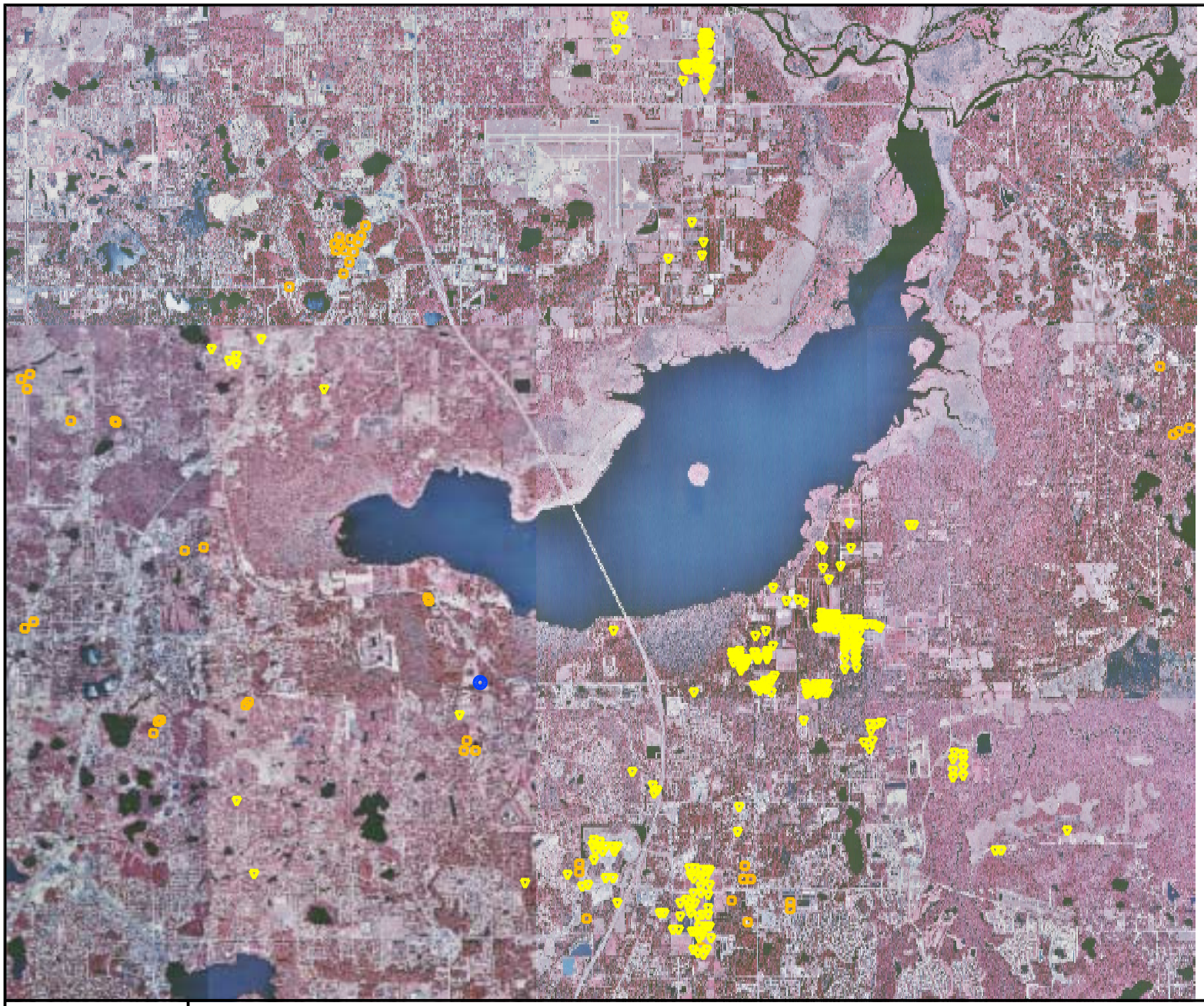

Figure 5.5

Existing Permitted Floridan Aquifer Well Locations Near Lake Jesup

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5.6 Site Subsurface Exploration and Laboratory Testing

5.6.1 Standard Penetration Test Borings

The shallow subsurface soil and groundwater conditions existing beneath the Cameron Site were explored in June 2002 by performing 18 standard penetration test (SPT) borings to depths of 20 to 25 feet. The borings were designated C-1 through C-18 and were drilled at the approximate locations shown in Figure 5.6. As shown, Borings C-1 through C-5, C-6 through C-14, and C-15 through C-18 were located within the northern, central and southern portions of the site, respectively. Due to the relatively impervious clayey soils encountered in the borings, the depth to the water table was not measured and each boring was grouted using soil cement after drilling.

Split spoons, containing disturbed soil samples, and corresponding SPT resistance (*N*-values, measured in blows per foot) were continuously obtained in the upper 10 feet and at 5-foot intervals thereafter. The samples were visually classified in the field by a licensed geologist. Also, a small but representative portion of each split-spoon sample was taken, placed, and sealed in an airtight jar for subsequent laboratory testing. In addition, five Shelby tubes, containing undisturbed soil samples, were obtained from Borings C-3, C-8, C-9, C-11, and C-15 at different depths.

5.6.2 Assessment of Subsurface Conditions

The subsurface soil profiles encountered within the penetration depths of the SPT borings are presented as individual boring logs in Appendix J. As shown, the soil profiles are very consistent and are comprised of the following main strata:

- Surficial topsoil (Stratum #2) that consists of dark gray to black organic silt and clay, with trace to some sand. The topsoil ranges in thickness from 4 inches to 2 feet.
- Gray to dark gray impervious and highly plastic clay (Stratum #4), occasionally mottled with yellowish brown silty to sandy clay and mixed with trace organic matter.
- Gray to dark gray, medium dense to dense, slightly clayey to clayey fine sand (Stratum #5) occasionally mottled with thin lenses of yellowish brown sandy clay.
- Gray to dark gray, medium dense to dense, slightly silty fine sand (Stratum #6).
- Light brown to white, dense to very dense, fine sand (Stratum #7) to the termination depths of the borings.

As shown on the soil profiles, the thickness of Stratum #4 decreases in depth approximately from 17-20 feet on the northern end of the site (Borings C-1 through C-5), to 4-20 feet on the central portion (Borings C-6 through C-14), and to 3-8 feet within the southern portion of the site (Borings C-15 through C-18). The SPT *N*-values of Stratum #4 vary from 1 to 5 blows per foot, indicative of soft clay to sandy clay soils. Also as shown in Appendix J, the upper few feet of soils found on the Cameron Site appear to change from clay to clayey sand as the site is traversed from north to south. It should be noted that variations in the subsurface conditions are expected, and may be encountered, below and around the borings. Also, whereas the borings indicate distinct strata breaks, the actual transition between the soil layers may be more gradual than shown on the boring profiles.

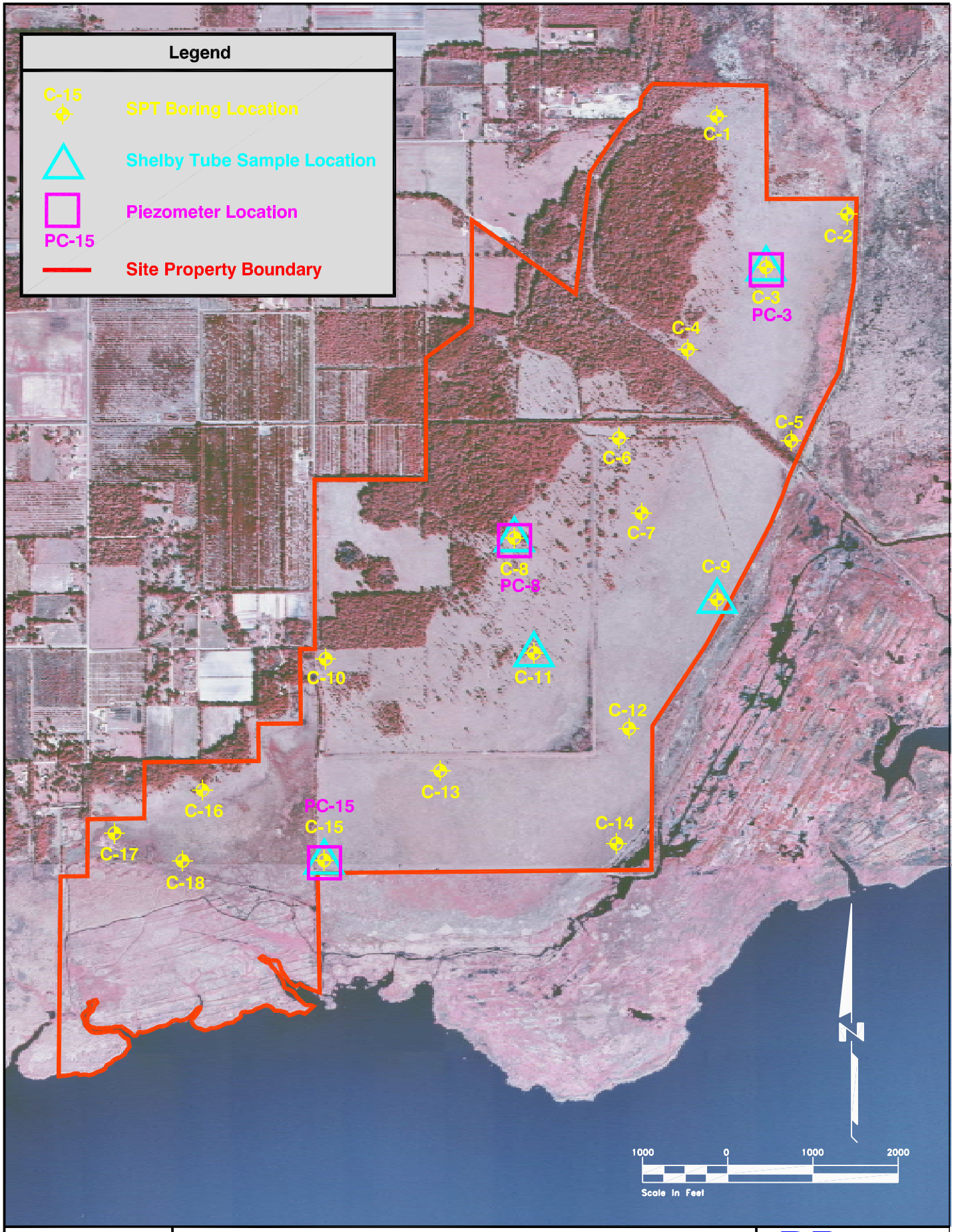

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Figure 5.6

Cameron/Little Ranch Site
Subsurface Exploration Locations

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5.6.3 Water Level Piezometers

Three water level piezometers were installed at different locations and depths to measure and monitor the depth of the water table across the Cameron Site. As shown in Figure 5.6, the piezometers (designated PC-3, PC-8, and PC-15) and were located near Borings C-3, C-8, and C-15 on the northern, central, and southern portions of the site, respectively. The piezometer construction details are included in Appendix J. As seen in the Appendix, PC-3 was installed 25 feet bls, while PC-8 and PC-15 were installed 20 and 10 feet bls, respectively. All piezometers were installed within Strata #5 and #6.

Each piezometer was installed using a 6-inch-diameter hollow stem auger that was advanced to the required depth. Subsequently, a 1.25-inch-diameter solid PVC pipe with a 5-foot long slotted section at its end was placed into each borehole. The annular space around the pipe was then filled with 20/30 silica sand to 2 feet above the slotted section and the rest of the annular space of the borehole was grouted to land surface using soil cement.

The water level was measured within each piezometer a few days after installation to allow water level stabilization. The water table was encountered approximately at 6.5 feet above land surface in PC-3 (artesian condition), 6.5 feet bls in PC-8, and 3.2 feet bls in PC-15. The presence of the water table below land surface in Piezometers PC-8 and PC-15 suggests that the artesian condition found in PC-3 appears to be localized, present in the deeper surficial aquifer strata in the northern portions of the site.

5.6.4 Laboratory Testing Program

All disturbed and undisturbed soil samples that were collected during the subsurface exploration program were brought to the M3S soil laboratory for analysis. The samples were then subjected to the laboratory testing program summarized below. The available results of the laboratory analysis are provided in Appendix K.

5.6.4.1 Visual Classification

All split-spoon samples were visually inspected and classified using the procedures outlined by the Unified Soil Classification System (ASTM D-2487). The results of the visual classification together with the field logs and the results of the following laboratory tests were used to identify and classify the different soil types shown on the SPT boring profiles.

5.6.4.2 Moisture Content Tests

A total of 36 moisture content tests were conducted on the second and third split-spoon samples that were obtained mainly from Stratum #4 within Borings C-1 through C-18. The second samples were obtained from 2 to 4 feet bls, while the third samples were obtained from 4 to 6 feet bls. The moisture content test results are shown in Appendix K and Table 5.1 below.

As shown in Table 5.1, the average moisture contents of the second (2-4 feet bls) samples are generally a little higher than those of the third (4-6 feet bls) samples, mainly due to frequent inundation of the Cameron site with rainfall and some lake water. Also, the average moisture contents of the second samples decreased from 42.0 percent (by weight) on the northern end of the Cameron Site, to 37.1 percent (by weight) on the central portion, to 24.3 percent (by weight) on the southern end of the site. These values are much higher than the optimal moisture contents required to achieve maximum dry densities for these soils, if used in dike construction. This makes it very difficult to compact these soils to the required densities unless the soils are excavated, temporarily stacked, and allowed to dry prior to embankment construction.

5.6.4.3 Organic Content Tests

A total of five organic content tests were conducted on the first split-spoon samples that were obtained mainly from Stratum #2 (topsoil) at 0 to 2 feet bls within Borings C-1, C-5, C-7, C-13, and C-14. The results of these tests are included in Appendix K and shown in Table 5.1. The organic content of the surficial topsoil ranged from 6.7 to 18.8 percent with an overall average of approximately 10 percent. These relatively high values make the surficial topsoil layer unsuitable for embankment construction, unless it is thoroughly mixed with other fill soils so that the average organic content of the embankment fill is less than 1 percent.

Table 5.1 – Summary of Laboratory Test Results on Cameron/Little Ranch Site Split-Spoon Soil Samples

Area of Site	Boring Location(1)	Moisture Content (%, by weight)		Fines Content(2) (%)	Organic Content (%)
		Depth (2'-4')	Depth (4'-6')	Depth (2'-4')	Depth (0'-2')
North	C-1	40.3	38.7	85.0	7.1
	C-2	45.6	43.8	79.0	--
	C-3	39.3	40.0	73.0	--
	C-4	34.4	31.7	70.1	--
	C-5	50.3	44.7	79.8	8.8
	Average	42.0	39.8	77.4	8.0
Central	C-6	41.3	41.4	68.2	--
	C-7	27.0	40.7	69.8	18.8
	C-8	36.2	38.1	69.1	--
	C-9	37.9	47.5	73.1	--
	C-10	21.4	23.8	52.4	--
	C-11	40.5	34.7	75.7	--
	C-12	42.2	36.7	69.0	--
	C-13	27.4	19.8	48.1	6.7
	C-14	60.3	47.9	86.9	9.7
	Average	37.1	36.7	68.0	11.7
South	C-15	25.7	25.5	38.8	--
	C-16	13.7	25.1	32.8	--
	C-17	34.3	29.8	55.0	--
	C-18	23.6	21.4	31.3	--
	Average	24.3	25.5	39.5	--

(1) See Figure 5.6.
(2) Percent by weight passing No. 200 U.S. Sieve.
-- Not analyzed

5.6.4.4 Fines Content Distribution Tests

A total of 18 fines content tests were conducted on the second split-spoon samples that were obtained mainly from Stratum #4 within Borings C-1 through C-18. The fines content represents the percent, by dry weight, of soil particles passing the No. 200 U.S. sieve size (0.074 mm). The fines content test results and included in Appendix K and summarized in Table 5.1.

The fines content of the soil samples generally increased as the moisture content increased, and vice versa. In a manner similar to the observed moisture content trend across the site, the average fines content decreased from 77.4 percent (indicative of clay to sandy clay soils) on the northern end of the site, to 68.0 percent (indicative of sandy clay soils) on the central portion, to 39.5 percent (indicative of clayey sand soils) on the southern end of the site. This observation is also supported by the results of the soil profiles shown in Appendix J.

Based on the above findings, it appears that the soils found within the southern end of the Cameron Site, due to their relatively low fines and moisture contents, may be easier to utilize for embankment construction than soils present in the central and northern portions of the site.

5.6.4.5 Permeability and Index Tests

As mentioned above, five undisturbed Shelby tube samples were obtained from Borings C-3, C-8, C-9, C-11, and C-15. The approximate depth intervals of these samples are shown on the corresponding SPT boring profiles in Appendix J. As shown, all samples were obtained from Stratum #4, except for the Shelby tube at C-15. The test results are shown in Appendix K and Table 5.2, and summarized as follows:

1. Unit weight or in-place density tests were conducted on all five samples. The total weight, volume, and average moisture content of soil within each Shelby tube were measured and used to calculate the total and dry unit weights or densities. As shown in Table 5.2, the dry densities of the clay samples ranged from 68.5 to 92.0 pounds per cubic feet (pcf), with an average of 76.9 pcf.

2. Constant-head permeability tests were conducted on three clay samples obtained from Borings C-3, C-9, and C-11 to determine the average permeability coefficient of the clay layer (Stratum #4) beneath the Cameron Site. Each test was conducted on a small but representative sub-sample. The sub-sample was encased with latex membrane, placed in a triaxial permeameter, and subjected to backpressure and induced water flow. The head difference and flow rate across the sub-sample was monitored with time until a constant flow rate was obtained. As shown in Table 5.2, the permeability coefficients of the clay samples were measured at very low values of 9.4×10^{-8}, 3.5×10^{-8}, and 4.8×10^{-8} centimeters per second (cm/sec). As a result, the natural clay layer (Stratum #4) existing beneath the Cameron Site is expected to act as an impervious liner beneath the sediment disposal area with negligible downward seepage or groundwater impact.

3. Full grain size distribution tests were conducted on all five Shelby tube samples. The tests were conducted for the soil fraction greater than 0.074 mm (No. 200 U.S. sieve size) using the wet sieve procedure. The grain size distribution curves for these

samples are presented in Figure 5.7. As shown, the fines contents of all the samples were in excess of 57.1 percent by dry weight, indicating that Stratum #4 consists primarily of clay to silty or sandy clay soils.

4. Atterberg limits, including liquid limit (LL), plastic limit (PL), and plasticity index (PI) were conducted on the three permeability samples. As shown in Table 5.2, all samples were determined to be highly-plastic inorganic clays.

Table 5.2 – Summary of Laboratory Test Results on Cameron/Little Ranch Site Shelby Tube Soil Samples

Boring Location(1)	Depth Interval (feet)	Stratum No. (2)	Soil Type	Dry Density (pcf)	Average Moisture Content (%, by weight)	Fines Content (%)	Permeability Coefficient (cm/sec)	Atterberg Limits (%)		
								LL	PL	PI
C-3	4 - 6	4	Sandy clay	69.6	33.2	67.0	9.4×10^{-8}	87	18	69
C-8	7 - 9	4	Sandy clay	76.4	43.2	89.6	--	--	--	--
C-9	6 - 8	4	Sandy clay	77.9	41.5	87.1	3.5×10^{-8}	120	21	99
C-11	12 - 14	4	Sandy clay	92.0	29.2	72.7	4.8×10^{-8}	101	19	82
C-15	12 - 14	4 & 6	Clay/Sand	68.5	49.5	57.1	--	--	--	--

(1) See Figure 5.6. Boring C-3 is in the north, C-8, C-9, and C-11 are in the central, and C-15 is in the south portion of site.
(2) See soil boring profiles in Appendix J for strata descriptions.

5.6.4.6 Compaction Tests

Modified Proctor compaction tests (ASTM D-1557-78) were conducted on two composite soil samples obtained from Borings C-1 through C-5 on the northern end of the Cameron Site (Composite Sample C1-C5) and Borings C-15, C-17, and C-18 on the southern portion of the site (Composite Sample C15-C18). Also, a Standard Proctor test (ASTM D-698-78) was conducted on a composite sample obtained from Borings C-6 through C-10 on the central portion of the site (Composite Sample C6-C10). Samples C1-C5 (north) and C6-C10 (central) were mainly obtained from Stratum #4 and were visually classified as gray fine sandy clay. Sample C15-C18 (south) was mainly obtained from Stratum #6 and was visually classified as gray slightly silty sand.

As shown in Appendix K, the maximum dry densities of Samples C1-C5 and C6-C10 (Stratum #4, sandy clay soils) were measured at 92.1 and 88.3 pcf at optimal moisture contents (by weight) of 18.3 and 18.6 percent, respectively. These optimal moisture contents are much lower than the average moisture contents for Stratum #4 (measured at 42.0 and 37.1 percent for the northern and central areas). As a result, it would be very difficult to compact these soils, if used in embankment construction, to the required compaction level of 95 percent of the Modified Proctor. On the other hand, the maximum dry density of Sample C15-C18 (Stratum #6, slightly silty sand) was measured at 107.6 pcf at an optimal moisture content of 13.4 percent.

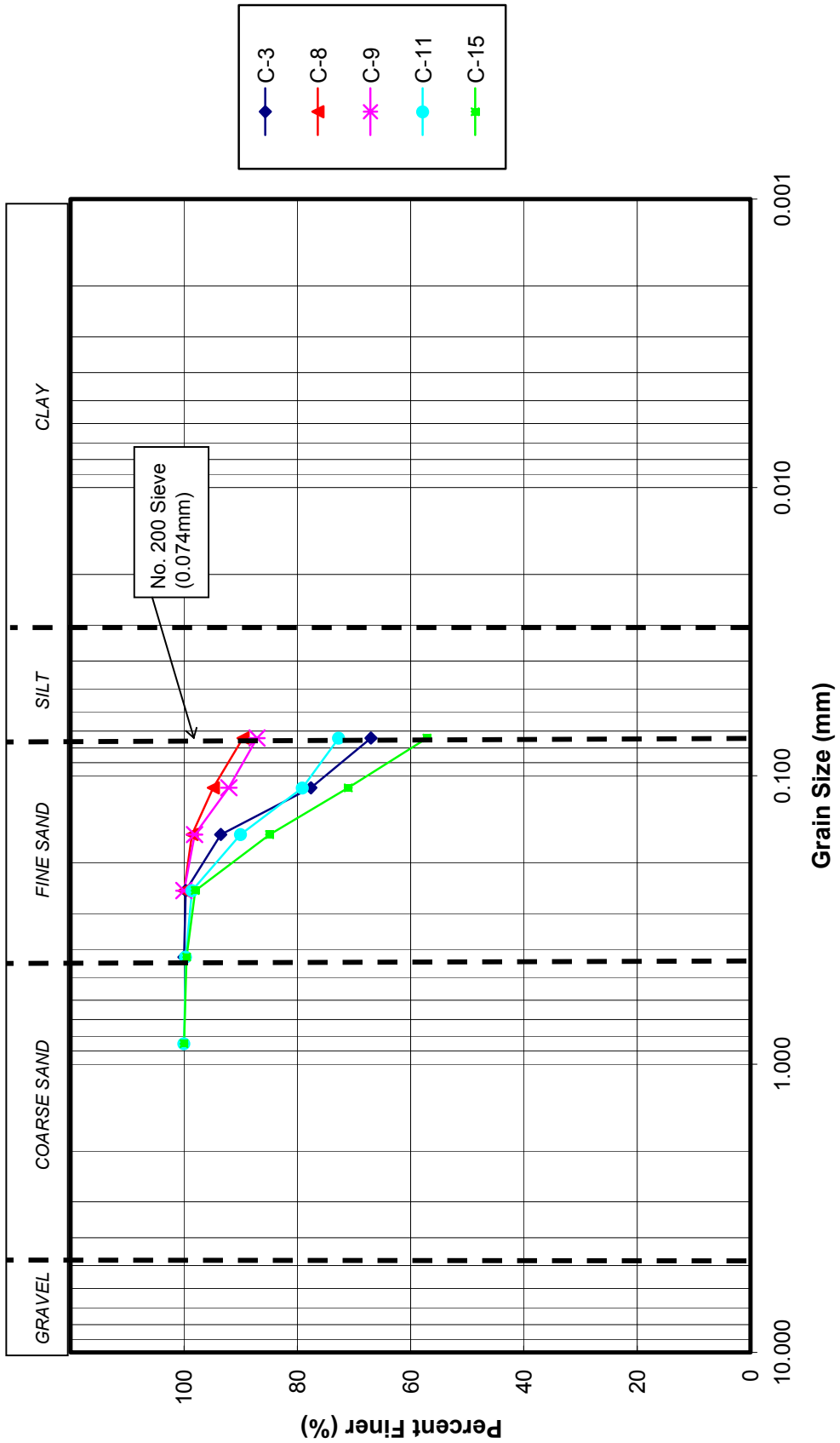

Figure 5.7 - Cameron/Little Ranch Site Soil Grain Size Distribution Results

Data Source: Laboratory Analysis of Soil Samples, M3S Laboratories, 2002

5.7 Selection of Sediment Disposal Area Footprint

Based on consideration of applicable constraints, two preliminary areas were identified for sediment disposal on the Cameron Site (Figure 5.8). As shown, the first disposal area footprint (Area A) is located on the northern end of the site and covers approximately 100 acres of land. The second area (Area B) occupies approximately 290 acres of land in the central portion of the site. A third open area (Area C), approximately 30 acres in size, may be used as a final polishing pond for return water.

The following physical and environmental constraints and site limitations were considered in the selection of the footprints of these areas:

- *Property Boundary*: The site property boundary was obtained from SJRWMD GIS data. A minimum 25-foot offset was maintained from the property boundary during selection of the sediment disposal and polishing area footprints.

- *FWC Survey of Available Area*: In May 2002, FWC staff performed a GPS survey of the open pasture areas of the Cameron Site (see Figure 5.8). This survey outlined the approximate limits of potential disposal areas within the site, delineating the available area between the western tree line and marsh land to the south and east.

- *Wetland and Sovereign Submerged Land:* The cleared areas of the Cameron Site have been used as pastureland and do not appear currently to have wetland vegetation. However, the low-lying areas of the site, adjacent to the lake, are considered marshland. The letter provided by the FDEP (Appendix H) indicates that the ordinary high water line of Lake Jesup is estimated at no more than +3.0 feet NGVD. As a result, the low-lying areas of the Cameron Site located below +3.0 feet NGVD are considered sovereign submerged land and are not proposed to be used for sediment disposal. However, the marshland may be used, if deemed necessary in the final design, to polish and filter the return water from the disposal areas prior to discharge into the lake.

- *Lake Jesup Flood Plain*: As mentioned previously, the SJRWMD has estimated the 100-year flood elevation of Lake Jesup at 9.98 feet NGVD. Thus, the majority of the Cameron Site is located within the lake's flood plain but was, until recently, diked off and separated from the lake. For this reason, the areas within the site proposed to receive dredged sediment were historically not an effective contributor to the Lake Jesup flood plain storage volume. The top elevations of the disposal and polishing area embankments will be above the 100-year flood elevation of the lake.

- *Wooded and Hammock Areas:* As seen in Figure 5.8, the upland portions of the Cameron Site are covered by healthy cabbage palm and hardwood trees. To avoid any impact, the western boundaries of the selected disposal area footprints were located a minimum of approximately 25 feet from the wooded areas.

- *Stormwater and Drainage Easements:* The Cameron Site includes crossings by the Chub Creek and the Cameron Avenue Ditches that appear to support, in some small areas, limited quantities of emergent wetland vegetation. The design of the disposal area will minimize impacts to these two ditches. However, in the final design, short

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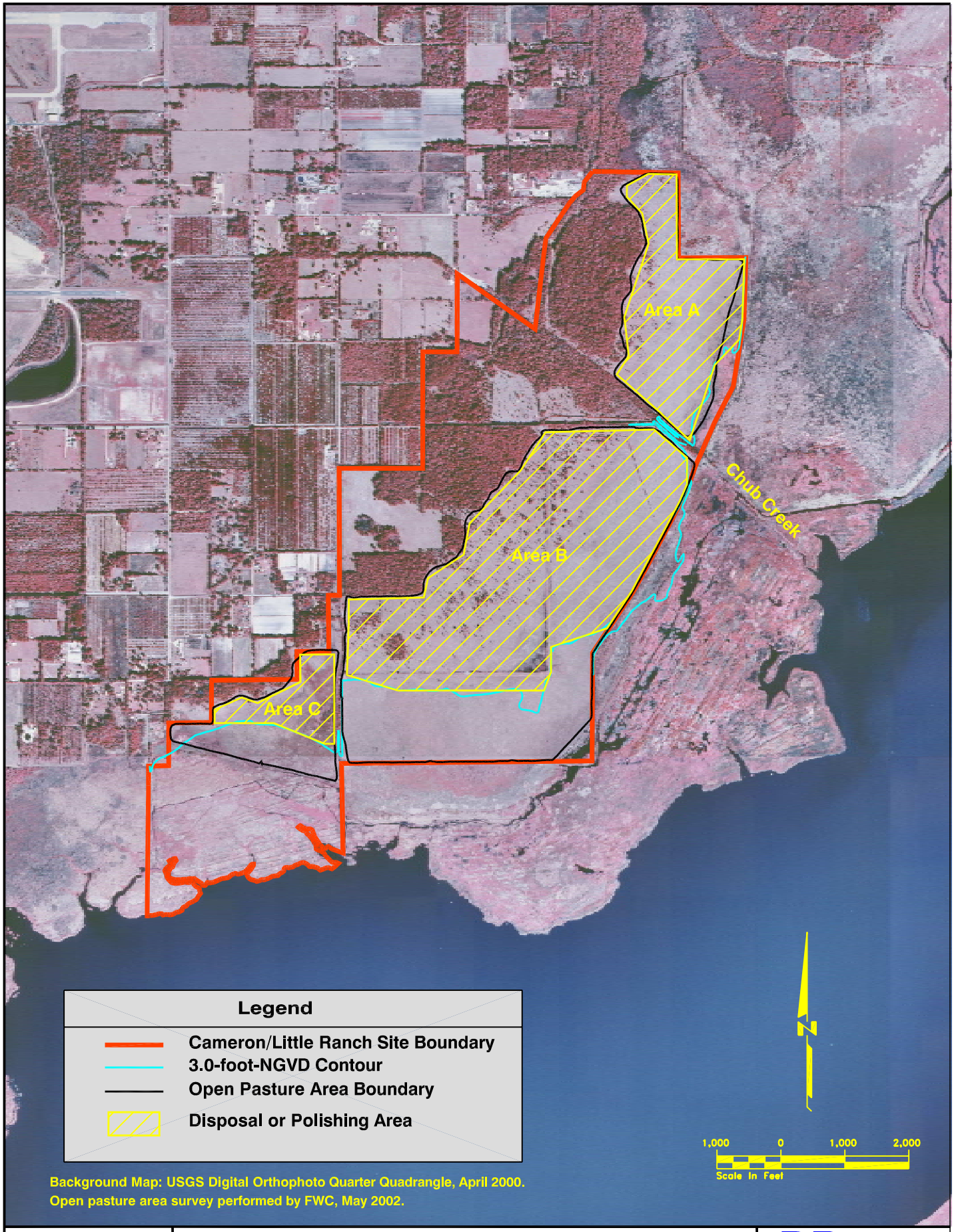

Background Map: USGS Digital Orthophoto Quarter Quadrangle, April 2000.
Open pasture area survey performed by FWC, May 2002.

Figure 5.8

Cameron/Little Ranch Site
Preliminary Sediment Disposal Area Footprints

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segments of each ditch may be crossed by buried culverts to achieve hydraulic connection of the disposal and polishing areas.

- *Utility Easements:* Available information for the Cameron Site does not indicate the presence of any utilities within the selected disposal areas of the site.

- *Sinkhole Areas*: The presence of a thick and impervious clay layer under the site as well as the regional hydrogeologic setting indicate that the Cameron Site has a very low potential for sinkhole development.

- *Protected Species*: SEA reviewed available protected species information and created an FNAI and Bald Eagle Nest Map (see Appendix G). This information indicates that the selected disposal areas do not support any endangered or threatened species; however, bald eagle's nests may be present in the areas west of the Cameron Site, at the approximate locations shown in Appendix G. No construction activities will be conducted within a minimum 1500-foot buffer area during the nesting period of the bald eagle.

- *Archaeological Sites:* As discussed previously, the FWC retained SouthArc, Inc. to complete a cultural resources assessment of the Cameron Site (Appendix I), the results of which indicated no areas of significant concern within the site.

The preliminary footprints for the two disposal areas and one polishing area (Figure 5.8) were selected based on the above constraints. In general, the areas are located within the property boundary; within the areas delineated by the FWC survey; outside the densely wooded area; and above the 3-foot contour. One exception is that the northern disposal area (Area A) extends easterly past the FWC-surveyed line, because this area is still above the 3-foot contour and within the property boundary.

As shown in Figure 5.8, the two disposal areas are separated by the Chub Creek stormwater ditch. Disposal Area B is separated from the polishing pond (Area C) by the Cameron Ditch. A large portion of Area B is located in cleared pastureland that previously had been diked off and separated from the flood plains of the lake. A minimum 25-foot buffer was used on all sides to the proposed outside toe of berm for the containment dikes.

The western boundary of each of the two disposal areas and the one polishing area are located approximately 25 feet from the tree line of the wooded areas seen along the west side of the site. The northern boundary of Area A approximately follows the property line, and the eastern boundary of Area A is along the property boundary or above a minimum elevation of +3.0 feet NGVD, whichever is more constraining. (The low-lying area of the site below a land surface elevation of +3.0 feet NGVD is considered sovereign submerged marshland.) Area B is bounded on the south and east by the more conservative of the 3-foot contour or the property boundary. The southern boundary of Area C is along the 3-foot contour, and the eastern boundary of this area is offset a minimum of approximately 25 feet from the Cameron Ditch.

6 PRELIMINARY DESIGN OF THE CONFINED DISPOSAL FACILITY

6.1 Concepts and Limitations of the Confined Disposal Facility

As shown in Figure 5.8, the selected sediment disposal facility on the Cameron/Little Ranch site consists of two main areas (Areas A and B), separated by a shallow ditch (Chub Creek). Area A covers a total area of about 100 acres, while Area B covers approximately 290 acres. To improve operation and management of the disposal facility, Area B will likely be divided into two parallel gravity-settling cells (Figure 6.1). The three settling cells will be contained by perimeter earthen embankments and divided by interior divider dikes. The CDF will also include a polishing cell (Area C) to treat supernatant water prior to discharge to Lake Jesup marshland.

The three settling cells will receive dredged sediment slurry from the dredge via a discharge pipeline. The coarse-grained sediment fractions, such as shells and sand, are anticipated to fall out of suspension and settle near the discharge locations of the pipeline, forming mounds. On the other hand, the fine-grained sediment fractions, such as silt and clay, are expected to gradually settle at greater distances and eventually fall out of suspension within the settling cells, forming a beach slope at a vertical to horizontal ratio of about 1:1,000 to 1:2,000. The clarified supernatant water accumulating at the far end of the settling cells will be released into the polishing area via overflow weirs, where it will be retained for further clarification and additional water quality treatment, if necessary. The supernatant water will be released into the marshland adjacent to Lake Jesup whenever the turbidity and water quality requirements of the project are met. The final design and configuration of the CDF will allow maximum flexibility for its management, operation, and final restoration.

6.2 Estimated Sediment Behavior During Dredging and Disposal

6.2.1 In-Situ Characteristics of Unconsolidated Sediment

Based on MEG laboratory analysis results, the average in-situ solids content (by weight) of the unconsolidated sediment layer increased with depth from 8.3 percent at 0.5 feet to 17.5 percent at 4.0 feet. An average in-situ solids content of 14.2 percent by weight was estimated for the upper 1 to 2 feet of unconsolidated sediment and used in preliminary sizing analysis of the CDF. Using the power formula correlation that was found between the solids and organic contents of unconsolidated sediment (Figure 3.5), and an average solids content of 14.2 percent, an average in-situ organic content of 26.0 percent was estimated for preliminary sizing analysis.

The average specific gravity of the solids for the unconsolidated sediment layer was measured at 1.63. Using an average in-situ solids content of 14.2 percent (by weight) and a specific gravity of the solids at 1.63, the overall in-situ total and dry densities of the upper 1 to 2 feet of unconsolidated sediment were estimated at 66.0 and 9.4 pcf, respectively, as detailed in Appendix L.

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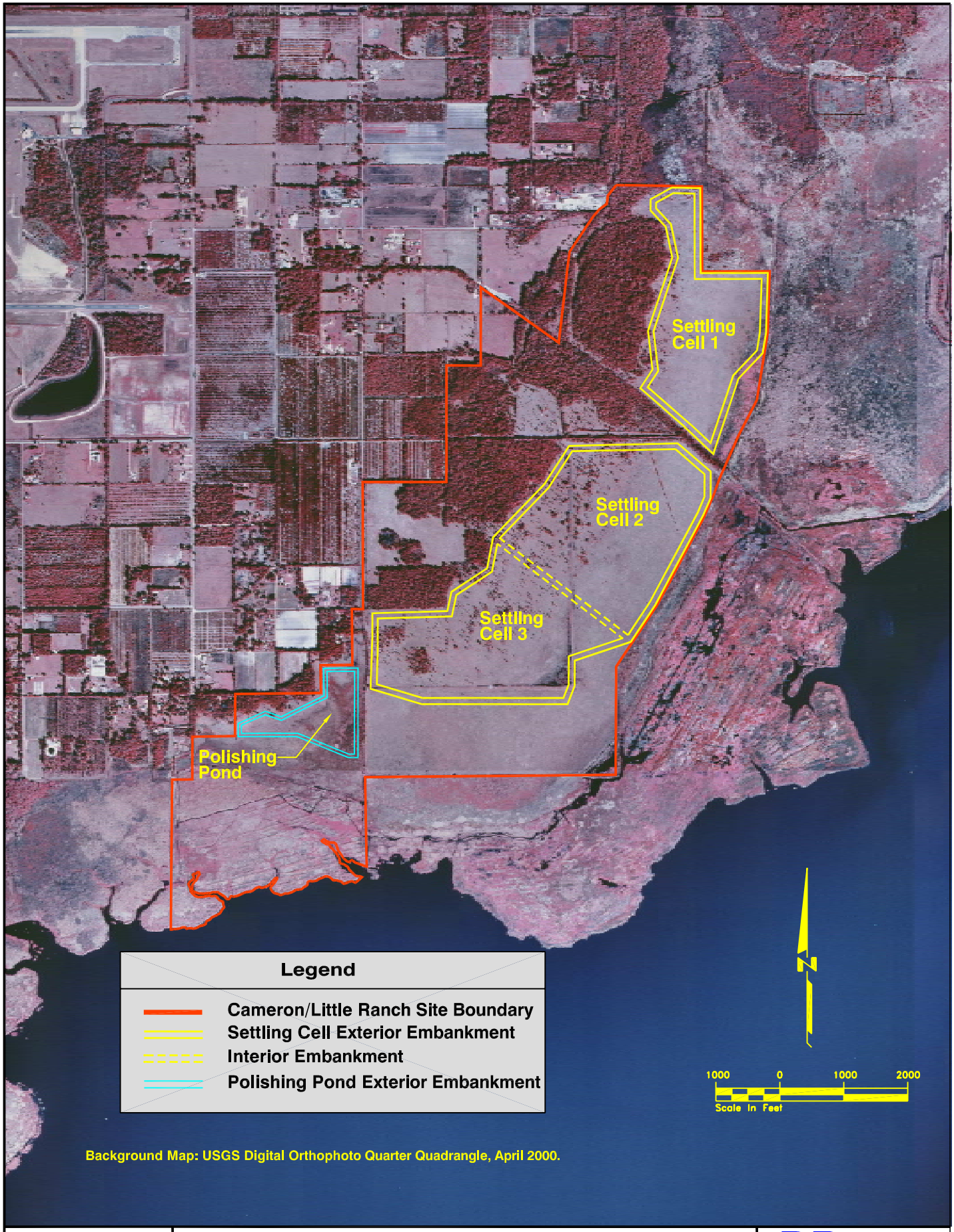

Figure 6.1

Cameron/Little Ranch Site Confined Disposal Facility Preliminary Layout

PB Water
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Certificate of Authorization Number: 00001462

6.2.2 Estimated Characteristics of Dredged Slurry

Sediment behavior during dredging depends mainly on the dredging equipment and conditions as well as unconsolidated sediment characteristics. Due to the relatively low in-situ solids content of the unconsolidated sediment layer, the solids content of the dredged slurry is expected to vary between 3 and 15 percent by weight. However, for design purposes the overall average solids content of the dredged slurry is expected to range from approximately 7 to 12 percent by weight (depending on location and depth). As a result, the total volume of the dredged slurry is anticipated to be 1.2 to 2.1 times the corresponding in-situ unconsolidated sediment volume (see Appendix L).

6.2.3 Estimated Settling Behavior of Dredged Slurry in the Disposal Area

The settling behavior of sediment slurry in the CDF can be estimated using the results of the settling and flocculation tests described in Sections 3.2 and 3.3 of this report. The settling tests indicated that the average solids content of settled sediment ranged from 8.1 to 10.8 percent (by weight) after 15 days of gravity settling. However, the solids contents of settled sediment at the bottom of the settling columns ranged from 14.1 to 16.9 percent (by weight) during the same period. As a result, an average solids content (by weight) of about 15 to 20 percent was selected at the end of dredging and sediment disposal, and used in the preliminary sizing of the CDF as detailed in Appendix L.

The settling tests also indicated that the turbidity of the supernatant water remained high after 15 days of gravity settling. Due to the relatively small size of the CDF with respect to the estimated unconsolidated sediment volume and the observed poor clarification behavior of supernatants, application of alum or polymers may be required for the supernatant water to meet the turbidity and water quality requirements of the Project prior to discharge. Alum or polymer may be applied using a dosing device at the water control structures between the settling cells and polishing pond. Alternatively, alum or polymer may be uniformly applied to the supernatant water within the polishing pond prior to discharge.

The flocculation test results described in Section 3.3.2 indicated that the turbidity levels of the supernatants decreased from a range of 122 to 214 NTU after 3 days of gravity settling without flocculation to about 47 NTU after 7 days without flocculation. The tests also indicated that the turbidity levels dropped to less than 10 NTU with the application of approximately 10 ppm of polymer or 150 ppm of alum (as aluminum sulfate). Assuming that the unit price of polymer is 2 to 3 times that of alum, use of the polymer would be 5 to 7.5 times less expensive than the use of alum to achieve similar turbidity improvement results. However, the application of alum may reduce concentrations of phosphorus and other nutrients, whereas the use of polymers would affect primarily turbidity alone.

6.2.4 Estimated Long-Term Consolidation Behavior of Settled Sediment

The long-term behavior of sediment in the disposal area depends mainly on the physical characteristics of sediment as well as the drainage and final restoration conditions of the CDF. The consolidation characteristics of sediment could be estimated by conducting specialty tests such as “slurry consolidation” on representative sediment samples. Using the results of those tests, the final heights of the settled sediment in the settling cells could be estimated using numerical codes such as the *SLURRY* program. The *SLURRY* program predicts the long-term consolidation behavior of slurried materials under different drainage conditions. Due to the very long durations of the tests and the fast-track schedule of this project, no slurry consolidation tests were conducted. However, based on our experience with similar highly organic soft sediment, we estimate that the final solids content of the

settled sediment will range between 25 and 35 percent, given the impervious bottom drainage condition anticipated at the Cameron disposal site.

Figure 6.2 shows the swelling and shrinkage ratio of the Lake Jesup unconsolidated sediment as a function of its solids content. As shown in the figure, an average swelling ratio of about 1.6 was estimated during dredging, while an average shrinkage ratio of 0.82 was estimated at the end of disposal if the settling sediment is kept under water during disposal. Also, a shrinkage ratio of about 0.54 to 0.37 was estimated at an average solids content of 25 to 35 percent by weight, respectively, indicating that after years of consolidation the settled sediment will only occupy approximately 40 to 50 percent of the original in-situ volume. Realizing the significant gain in the volume of dredged material that can be stored as a result of increased solids content, the operation and loading periods of the three settling cells will be varied to maximize the long-term consolidation and desiccation behavior of settled sediment.

Phase diagrams depicting representative "typical" Lake Jesup unconsolidated sediment samples and their relative weight/volume components, during a life-cycle that ranges from in-situ, to as-being-dredged (slurry), to end-of-dredging conditions, are presented in Figure 6.3. It can be seen in the figure that the solid (soil) component weight and volume remain constant throughout the dredging process, but the amount of water present in each sample changes depending on the process condition.

6.3 Preliminary Sizing Analysis of the Confined Disposal Facility

The CDF will be designed, operated, and managed in accordance with applicable State and Federal rules and design standards. Although no State of Florida rules specifically apply to this type of CDF, the Cameron Site CDF nonetheless will be designed, operated, and inspected according to the intent of FDEP Rule 62-672, of the Florida Administrative Code (FAC), which is applicable to phosphogypsum tailings dams. The CDF also will be designed in accordance with the design requirements of the following ACOE Engineering and Design Manuals:

- *Dredging and Dredged Material Disposal* (EM 1110-2-5025) (ACOE, 1983);
- *Confined Disposal of Dredged Material* (EM 1110-2-5027) (ACOE, 1987a);
- *Earth and Rock-Fill Dams – General Design and Construction Considerations* (EM 1110-2-2300) (ACOE, 1994);
- *Stability of Earth and Rock-Fill Dams* (EM 1110-2-1902) (ACOE, 1970); and
- *Beneficial Uses of Dredged Material* (EM 1110-2-5026) (ACOE, 1987b).

The CDF will be sized to retain all dredged slurry solids, while concurrently allowing release of supernatant water when meeting the turbidity and water quality requirements of Section 401 (water quality certification requirements) and Section 404 (dredging permit requirements) of the "Clean Water Act." To minimize or eliminate the use of alum or polymer, supernatant water will be retained in the settling cells to the extent practicable prior to discharge into the polishing pond. Also, the polishing pond will be designed to allow at least 1 week of additional retention prior to final discharge. To further reduce turbidity and nutrient concentrations, the supernatant water released from the polishing pond will be discharged into a shallow spreader swale to allow sheet flow and wetland filtration into the

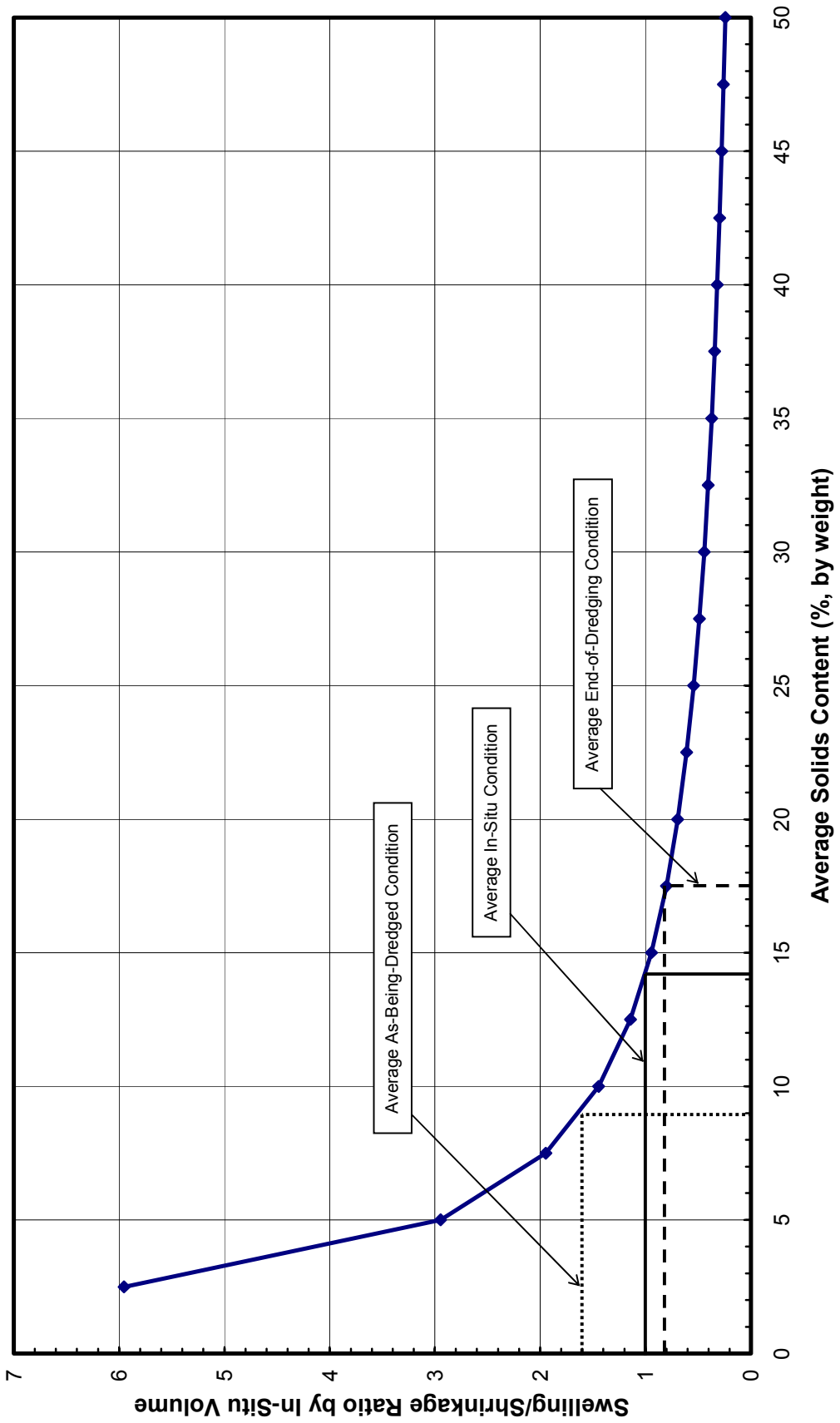
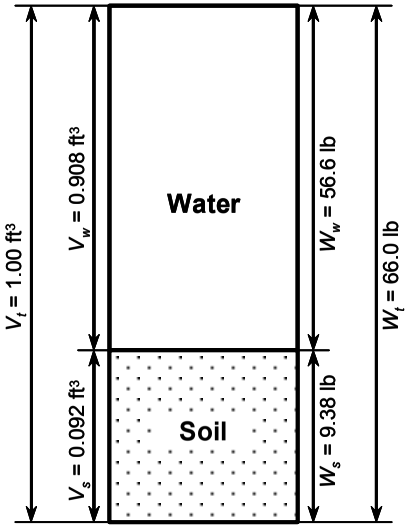


Figure 6.2 - Lake Jesup Unconsolidated Sediment Swelling/Shrinkage Ratio vs. Solids Content

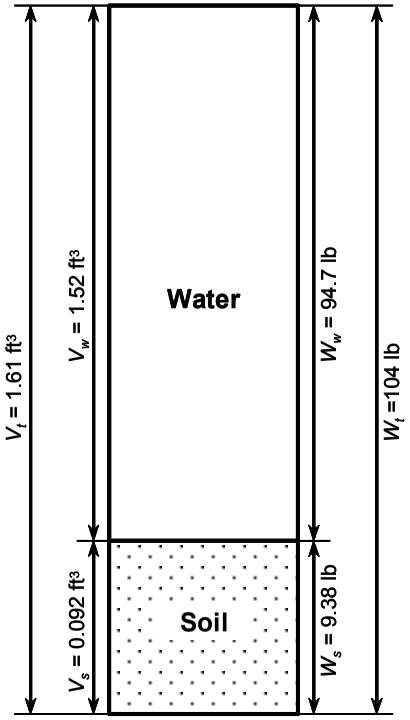


IN-SITU CONDITION

Estimated Average Solids Content

$$s = \frac{9.38\ \text{lb}}{66.0\ \text{lb}} = 14.2\%\ \text{(by weight)}$$

$$s_v = \frac{0.092\ \text{ft}^3}{1.00\ \text{ft}^3} = 9.2\%\ \text{(by volume)}$$

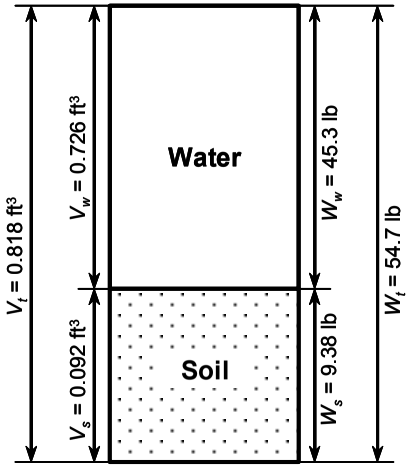


AS-BEING-DREDGED (SLURRY) CONDITION

Estimated Average Solids Content

$$s = \frac{9.38\ \text{lb}}{104\ \text{lb}} = 9.0\%\ \text{(by weight)}$$

$$s_v = \frac{0.092\ \text{ft}^3}{1.61\ \text{ft}^3} = 5.7\%\ \text{(by volume)}$$



END-OF-DREDGING CONDITION

Estimated Average Solids Content

$$s = \frac{9.38\ \text{lb}}{54.7\ \text{lb}} = 17.2\%\ \text{(by weight)}$$

$$s_v = \frac{0.092\ \text{ft}^3}{0.818\ \text{ft}^3} = 11.2\%\ \text{(by volume)}$$

Figure 6.3 - Lake Jesup Unconsolidated Sediment Typical Phase Diagrams During the Dredging Process

marshland adjacent to Lake Jesup prior to final return to the lake. It should be noted that sediment resuspension as a result of wind activity in the settling cells and polishing pond may cause higher levels of turbidity than the values estimated above in ideal laboratory conditions.

The freeboard of the CDF is a function of the hazardous potential of the CDF, which is based on the occurrence of an accidental dike breach. The hazardous potential of a CDF is categorized by the ACOE from high to low potential, depending on the size of the CDF and the land use and drainage characteristics of surrounding areas. Given the relatively small size and low hazardous potential of the Cameron Site CDF, a 3-foot freeboard (height of dike above the maximum operational water level) was estimated and used in the preliminary sizing analysis of the CDF. The heights of the perimeter embankments around the settling cells can be estimated using the following formula:

Total embankment height = *Height of settled sediment solids at end of disposal* + 3.0 feet (*freeboard*) ..... [6-1]

The height of settled sediment solids is a function of the settled solids content. In the absence of slurry consolidation tests, the overall solids content of the settled sediment was estimated at 15 to 20 percent (by weight) at the end of dredging and sediment disposal and used in the preliminary sizing of the CDF as detailed in Appendix L. The settled solids content was based on the results of the settling tests and our experience with similar projects.

Using Equation 6-1 above and the computations shown in Appendix L, Figure 6.4 was developed for different in-situ sediment volumes and varying heights of the settling cells. For example, a total embankment height of about 18 feet, which includes a 3-foot freeboard, would be required for the disposal of 10 MCY of in-situ sediment volume on about 340 acres of net settling area. The corresponding average height of settled sediment is estimated at approximately 15 feet.

6.4 Rapid Dewatering Options

Rapid dewatering of sediment is generally required in situations where insufficient land is available for sediment disposal and storage. Dewatering technology for lake sediment is still in the development stage. Only a few case studies are currently available about small-size projects. Dewatering techniques of lake sediment commonly utilize flocculation with polymers, gravity screening, and/or pressure filtration. The coarse fraction of sediment may be separated using hydro-cyclones prior to dewatering to reduce the use of chemicals.

Based on available information, the application of rapid dewatering may increase the solids content of the dredged sediment to 25 to 35 percent (by weight) depending on the dewatering technique. At these solids contents, the sediment would be difficult to stack in open areas. Thus, a CDF would be also required to store the dewatered sediment. Figure 6.2 shows that the dewatered sediment will reduce in volume to 0.54, 0.44, and 0.37 of its in-situ volume at 25, 30, and 35 percent solids, respectively. Assuming an average dewatered solids content of about 30 percent by weight, the storage volume required of the disposal area will be reduced to about 44 percent of the volume required for gravity settling. Water generated during the dewatering process would require treatment in polishing cell(s)

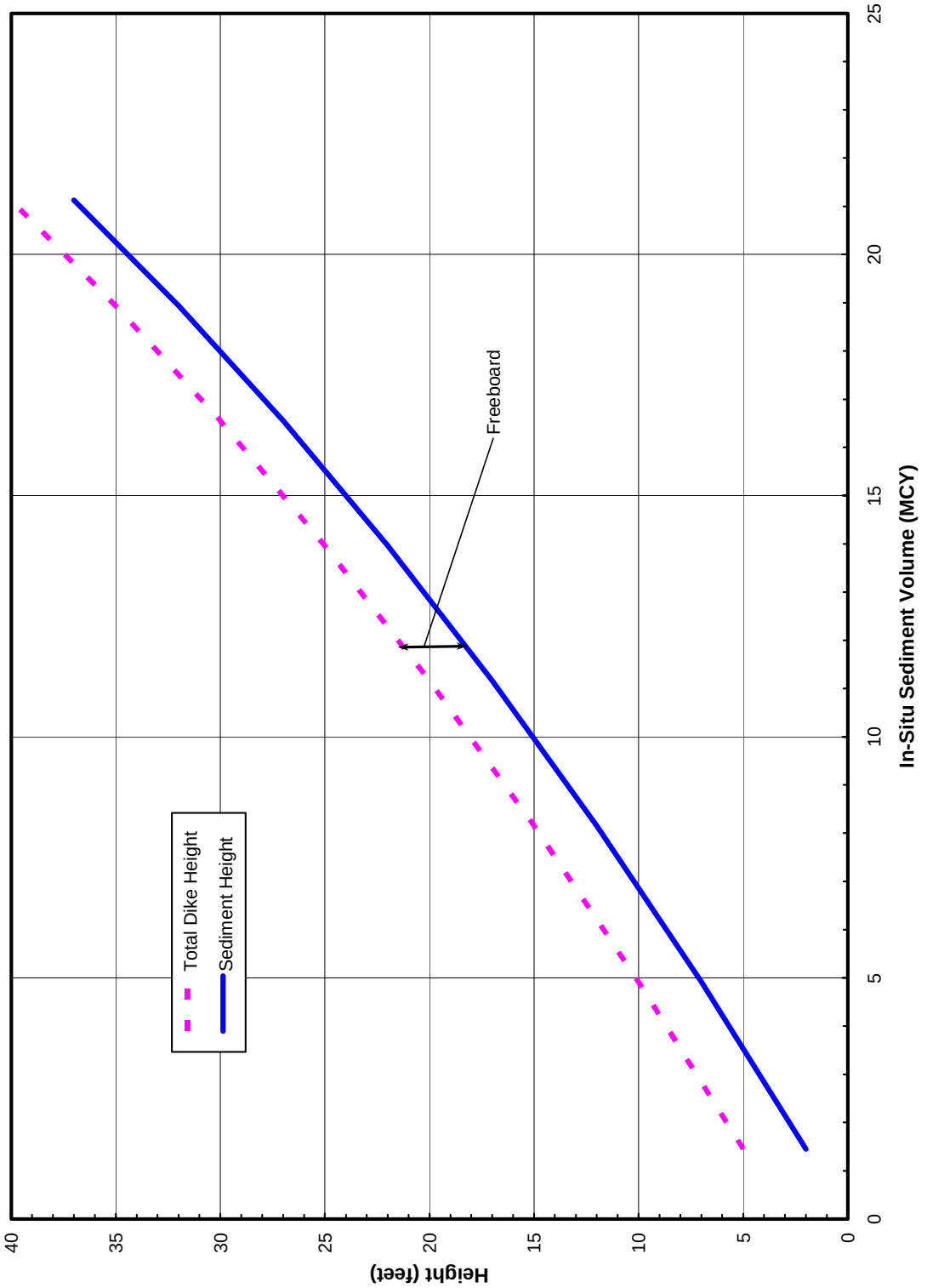


Figure 6.4 - Lake Jesup In-Situ Sediment Volume Stored vs. Confined Disposal Facility Total Dike Height and Sediment Height

prior to final release. The size of the polishing cell(s) associated with the dewatering facility may be larger than required for gravity settling, unless higher doses of chemical are added.

6.5 Beneficial Use of Sediment and Final Reclamation of the CDF

Initial assessment of the nutrient data indicates that the shells and coarse fraction of sediment could be used as base material and/or structural fill for road and embankment construction, maintenance work, landfill cover, or erosion control. Furthermore, the fine fraction of sediment could be used in soil amendment, nurseries, and landfill cover. As detailed information becomes available during the operation of the CDF, further investigation may be conducted to assess other beneficial uses of sediment for agricultural purposes.

In addition, the CDF could be restored following dredged material disposal to create a healthy ecological system on the site. Restoration alternatives for the disposal area, including the eventual creation of upland and/or wetland habitats, should be assessed.

6.6 Engineer's Opinion of Probable Construction Cost for the CDF

Based on our experience, the unit costs for embankment construction will likely increase as a function of increased dike height. Table 6.1 summarizes the estimated embankment volumes required for the CDF and the corresponding probable unit and total costs, as a function of selected embankment height. Additional costs will be required for miscellaneous civil items (e.g., control structures) and may be required for alum or polymer, if chemicals are needed for polishing.

Table 6.1 – Engineer's Opinion of Probable Cost for Cameron/Little Ranch Confined Disposal Facility Major Construction Items

Item	Dike Height (feet)	Probable Unit Cost	Units	Embankment Volume (CY)	Probable Embankment Construction Cost
Mobilization of Equipment	N/A	$100,000	Each	N/A	$100,000
Embankment Construction	10	$3.00	CY	396,700	$1,200,000
	15	$3.25		790,200	$2,600,000
	20	$3.25		1,309,700	$4,300,000
	25	$3.50		1,952,100	$6,800,000

Notes:
Costs shown are in Year 2002 dollars.
N/A = not applicable
CY = cubic yards

6.7 Summary and Recommendations

6.7.1 Phase I Summary

Based on the information, data, and analyses that have been collected and presented in this report, the following conclusions are made:

- The Project primarily will include hydraulic dredging and upland disposal of the uppermost unconsolidated nutrient-rich sediment layer existing within the open water area of the lake.

- The Project is intended to reduce the lake's sediment resuspension, internal nutrient loading, and potential export to the St. Johns River. Subsequently, the Project is anticipated to improve the water quality and the aquatic habitats of the lake. However, the watershed nutrient sources (i.e., surface runoff, bank seepage, and effluent discharges from existing wastewater treatment plants and on-site sewage disposal systems) must be controlled in order to maintain long-term water quality improvement. Also, the SR 46 causeway should be altered to improve lake circulation and flushing patterns.

- Based on the results of the 2002 hydrographic survey, the total volume of unconsolidated sediment within the entire lake was estimated at 10.6, 14.5, 17.1, and 20.3 MCY at 1, 1.5, 2, and 6 feet, respectively. The average thickness of unconsolidated sediment across the lake bottom was measured at 1.62 feet.

- Due to uneven sediment distribution and depositional patterns of Lake Jesup, as well as the relatively large volume of unconsolidated sediment, the open water area of the lake was divided into seven zones (Figure 4.1). The total in-situ volumes of unconsolidated sediment within the East, South, Northeast, Northwest, West Central, West, and Central Zones were estimated at 2.2, 2.9, 2.2, 3.5, 5.2, 3.4, and 0.9 MCY, respectively. These volumes correspond to average in-situ thicknesses of ranging from 0.5 feet (Central Zone) to 3.1 feet (West Central Zone).

- Based on the 1997 UF study (Cable et al.), the cumulative storage of organic matter in unconsolidated sediment within the entire lake was estimated at 0.29, 0.44, 0.55, and 0.67 million tons at 1, 1.5, 2, and 3 feet, respectively. Also, the total cumulative storage of TP was estimated at 890, 1,220, 1,560, and 1,870 tons at 1, 1.5, 2, and 3 feet, respectively. The cumulative storage of TN was estimated at 13,000, 19,000, 23,000, and 27,000 tons at 1, 1.5, 2, and 3 feet, respectively.

- The seven zones were ranked with respect to dredging priority based upon depositional classification/location; estimated in-situ unconsolidated sediment volume; and estimated TP storage. The ranking results indicated that the East and South Zones may be given the highest priority followed by the Northeast, West, West Central, and Northwest Zones. Because it is a scour zone and contains a relatively thin layer of unconsolidated sediment, the Central Zone may not require dredging.

- Preliminary assessment of the Cameron Site identified a total of approximately 390 acres of land available for potential storage of dredged sediment, and an addition 30-acre area to be used for final polishing of return water. The potential disposal and

polishing areas are underlain by a relatively thick layer of fine-grained soil, which should behave as a natural clay liner beneath the deposited sediment.

- A summary of the volume and average thickness of unconsolidated sediment that would be removed from each of the lake dredging zones, along with the probable cost and estimated minimum time required to dredge those volumes, is provided in Table 6.2 as a function of selected maximum dredging depth.

6.7.2 Recommendations for Future Project Phases

The following recommendations are provided for future phases of the Lake Jesup Aquatic Enhancement Project. The FWC may elect to use this information as a basis for the final design and construction of the in-lake dredging and CDF components of the Project.

6.7.2.1 In-Lake Dredging

- The entire volume of Lake Jesup unconsolidated sediment does not have to be removed to provide significant improvement to the health of the lake. Removal of the top 1.5 to 2.0 feet of unconsolidated sediment will result in exposure of clean, consolidated sediment over a majority of the lake bottom area.

- Dredging of the following maximum thicknesses would result in removal of 15 MCY of unconsolidated sediment, which is approximately 75 percent of the total volume present in the lake, and approximately 96 percent of the total volume present in the priority East, South, and Northeast Zones:
  - Uppermost 2.0 feet within the East Zone (2.01 MCY);
  - Uppermost 2.0 feet within the South Zone (2.84 MCY);
  - Uppermost 2.0 feet within the Northeast Zone (2.11 MCY);
  - Uppermost 2.0 feet within the Northwest Zone (3.07 MCY);
  - Uppermost 1.5 feet within the West Zone (2.62 MCY); and
  - Uppermost 1.5 feet within the West Central Zone (2.30 MCY).

- The lateral limits of dredging may extend to the shoreline vegetation surrounding Lake Jesup, as delineated by the FWC in May 2002 (Figure 1.2).

- During dredging operations, the following minimum setbacks are recommended:
  - 50 feet from highway bridge piers (SR 417 and SR 46);
  - 10 feet from boat ramps, docks, and other similar structures; and
  - 20 feet from sea walls.

- The following average unconsolidated sediment properties, derived from the field and laboratory testing programs, are recommended for final design:
  - In-situ condition solids content, 14.2 percent (by weight);
  - As-being-dredged (slurry) condition solids content, 7 to 12 percent (by weight);
  - End-of-dredging condition solids content, 15 to 20 percent (by weight); and
  - Specific gravity of solids, 1.63.

Table 6.2 – Estimated Volume, Thickness, Dredging/Pumping Cost and Time vs. Maximum Dredging Depth for Lake Jesup Unconsolidated Sediment

Zone [1] and Probable Unit Cost [2]	Maximum Dredging Depth (feet)	Unconsolidated Sediment Volume (MCY)	Average Unconsolidated Sediment Thickness (feet)	Probable Dredging/ Pumping Cost [3]	Estimated Time to Dredge [4] (days)
East	0.5	0.67	0.49	$1,170,000	64
	1.0	1.26	0.92	$2,200,000	119
$1.75/CY	1.5	1.71	1.25	$3,000,000	163
	2.0	2.01	1.47	$3,520,000	191
	2.5	2.13	1.55	$3,720,000	202
	3.0	2.15	1.57	$3,770,000	205
South	0.5	1.04	0.49	$1,830,000	99
	1.0	1.97	0.92	$3,440,000	187
$1.75/CY	1.5	2.60	1.22	$4,560,000	248
	2.0	2.84	1.33	$4,960,000	270
	2.5	2.89	1.35	$5,060,000	275
	3.0	2.90	1.36	$5,080,000	276
Northeast	0.5	0.75	0.44	$1,310,000	71
	1.0	1.39	0.82	$2,430,000	132
$1.75/CY	1.5	1.88	1.12	$3,280,000	178
	2.0	2.11	1.27	$3,700,000	201
	2.5	2.16	1.29	$3,770,000	205
	3.0	2.16	1.30	$3,780,000	205
West	0.5	0.98	0.48	$2,210,000	94
	1.0	1.87	0.91	$4,220,000	178
$2.25/CY	1.5	2.62	1.27	$5,890,000	249
	2.0	3.11	1.51	$6,990,000	295
	2.5	3.31	1.60	$7,440,000	314
	3.0	3.38	1.64	$7,600,000	321
West Central	0.5	0.80	0.48	$1,800,000	76
	1.0	1.57	0.94	$3,520,000	149
$2.25/CY	1.5	2.30	1.37	$5,170,000	219
	2.0	2.99	1.79	$6,740,000	285
	2.5	3.65	2.18	$8,210,000	347
	3.0	4.25	2.54	$9,550,000	404
Northwest	0.5	0.91	0.48	$1,590,000	86
	1.0	1.75	0.93	$3,060,000	166
$1.75/CY	1.5	2.48	1.32	$4,340,000	236
	2.0	3.07	1.63	$5,370,000	292
	2.5	3.40	1.81	$5,960,000	324
	3.0	3.54	1.88	$6,190,000	336

(1) Refer to Figure 4.1.
(2) Refer to Table 4.5.
(3) Engineer's opinion, based on Year 2002 dollars, excluding mobilization costs, and subject to changes in fuel costs.
(4) Assumes 4,000-gpm slurry production rate, 7-percent slurry solids content by weight, and continuous 24-hour/7-day operation at 75-percent efficiency

- To complete dredging operations within a reasonable time frame, a peak slurry production rate of approximately 4,000 gpm is recommended during dredging. This rate may be achieved by the use of two 8 to 10-inch auger-head dredges operating simultaneously, or an equivalent alternative.

- With a peak slurry production rate of 4,000 gpm, and assuming 7-percent slurry solids content by weight, 24-hour/7-day per week operation, and 75 percent efficiency, a minimum production rate of 3.84 MCY per year is anticipated for removal of in-situ sediment. At this rate, approximately 4 years would be required to dredge the 15 MCY of sediment recommended above (1.5-2.0 feet within six zones).

6.7.2.2 Confined Disposal Facility

- Three sediment settling cells and one final polishing pond are recommended for the Cameron Site CDF (see Figure 6.1).

- The following minimum setbacks are recommended for locating the outer toe of settling cell embankments:
  - 25 feet from property boundary;
  - 25 feet from existing western tree line (as surveyed by FWC in May 2002); and
  - At or above the existing 3-foot-NGVD topographic contour.

- Settling cell embankment heights on the Cameron Site should not exceed a maximum reasonable height of approximately 15 to 20 feet. Construction of embankments higher than this would require excavation within the storage area to a depth that could breach the existing natural clay liner.

- To avoid potential inundation, settling cell and polishing pond embankment crest elevations should be set higher than anticipated flood elevations of the lake. As a minimum, the embankments should be higher than the 10-year flood elevation of 7.15 feet NGVD estimated by the SJRWMD.

- The recommended 15 MCY of unconsolidated sediment dredging from Lake Jesup likely will not fit within the identified Cameron Site disposal areas at the embankment height limits listed above. It is recommended that the FWC continue to investigate possibilities for additional disposal areas.

- For berm stability, a minimum slope of 2.5:1 (horizontal to vertical) is recommended for settling cell and polishing pond embankments. A minimum embankment crest width of 12 feet is recommended.

- Native soil should be removed from the interior of bermed areas to provide the fill required for embankment construction. In this way, additional storage volume will be obtained. A cut/fill balance should be used for embankment earthwork, to the extent practicable.

- A minimum of 3 feet of freeboard is recommended for the settling cells.

- The final polishing pond should be sized for a minimum of 7 days of retention (including a minimum a 2 feet of freeboard). At a peak slurry production rate of

4,000 gpm, approximately 200,000 CY of storage volume would be required beneath the freeboard level. Given the identified polishing pond area from Figure 6.1, a total interior embankment height of approximately 7.5 feet is required to provide this storage volume.

- For the Cameron Disposal Site, it is recommended that the FWC investigate the feasibility of long-term restoration alternatives, which could return the site to a healthy ecological condition following dredging and disposal.

- Considering the current disposal area and budget limitations for the Project, the following minimum plan is recommended:
  - Construct the Cameron Site CDF, including three settling cells at a total storage height of approximately 15 feet and one polishing pond at a total height of approximately 8 feet, at a probable construction cost of about $2.9 million ($2.6 million for settling cells, $0.2 million for polishing pond, and $0.1 million for mobilization); and
  - Dredge the uppermost 2.0 feet of unconsolidated sediment from the East, South, and Northeast Zones (total of 7.0 MCY), at a probable cost of about $12.7 million ($12.2 million for dredging/pumping, and $0.5 million for mobilization). This volume of sediment is anticipated to fit within the CDF size recommended above.

- If additional disposal volume remains within the Cameron CDF, or if additional disposal sites are located, and if sufficient budget remains, the FWC may continue to dredge as much of the remainder of the lake as is feasible.

- In-lake dredging contract documents should include language that provides schedule and volume flexibility, allowing the FWC to halt dredging operations as necessary. A unit rate bid format may be the most appropriate.

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APPENDIX A

Schematic Diagrams of Lake Jesup Water and Nutrient Budgets for the Period from 1980 through 1990
Water and Air Research, Inc., 1992

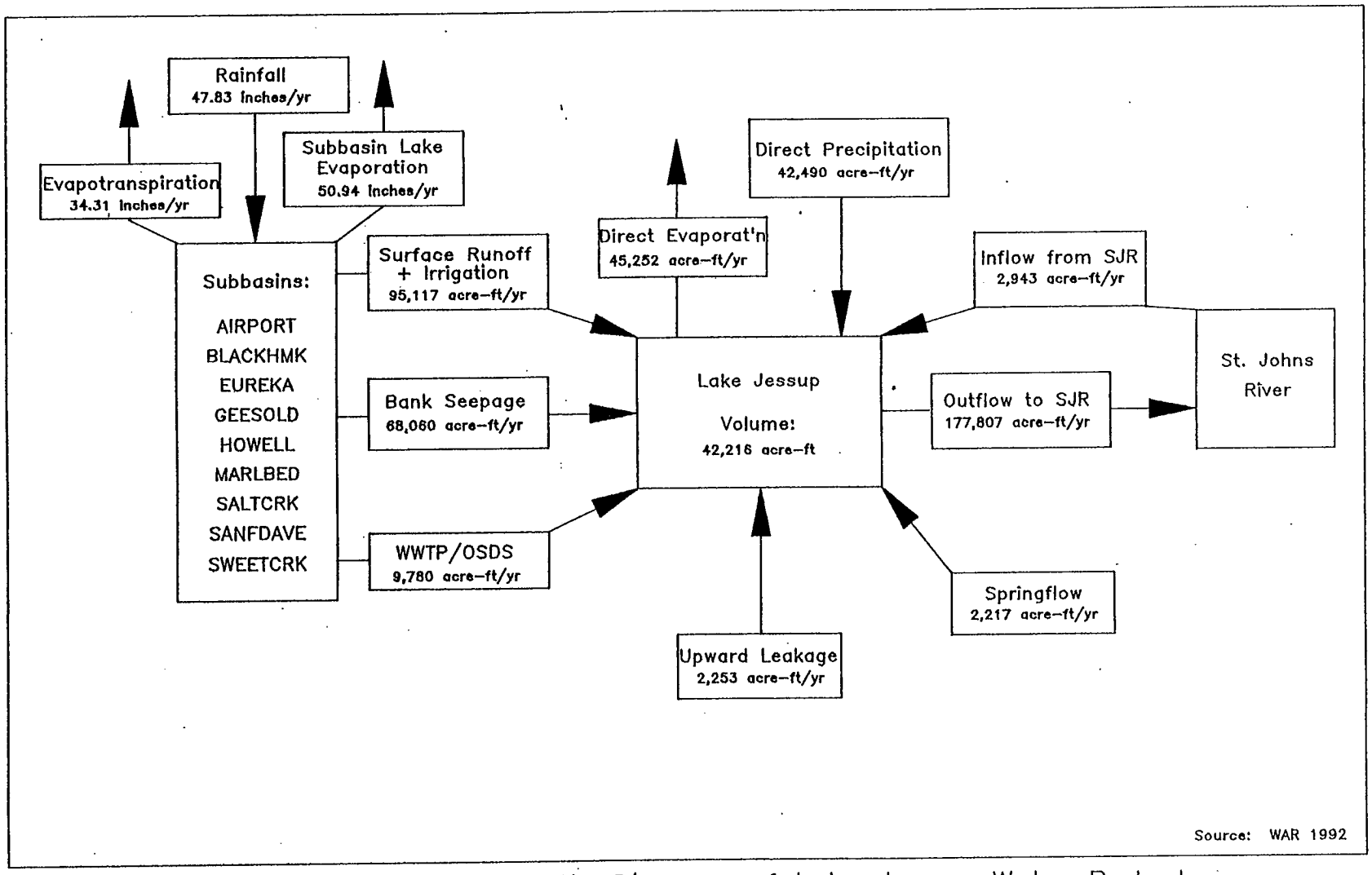

FIGURE 3.2-1. Schematic Diagram of Lake Jessup Water Budget Components with Average Annual Flows (acre-ft/yr) and Volumes (acre-ft), for 1980 through 1990.

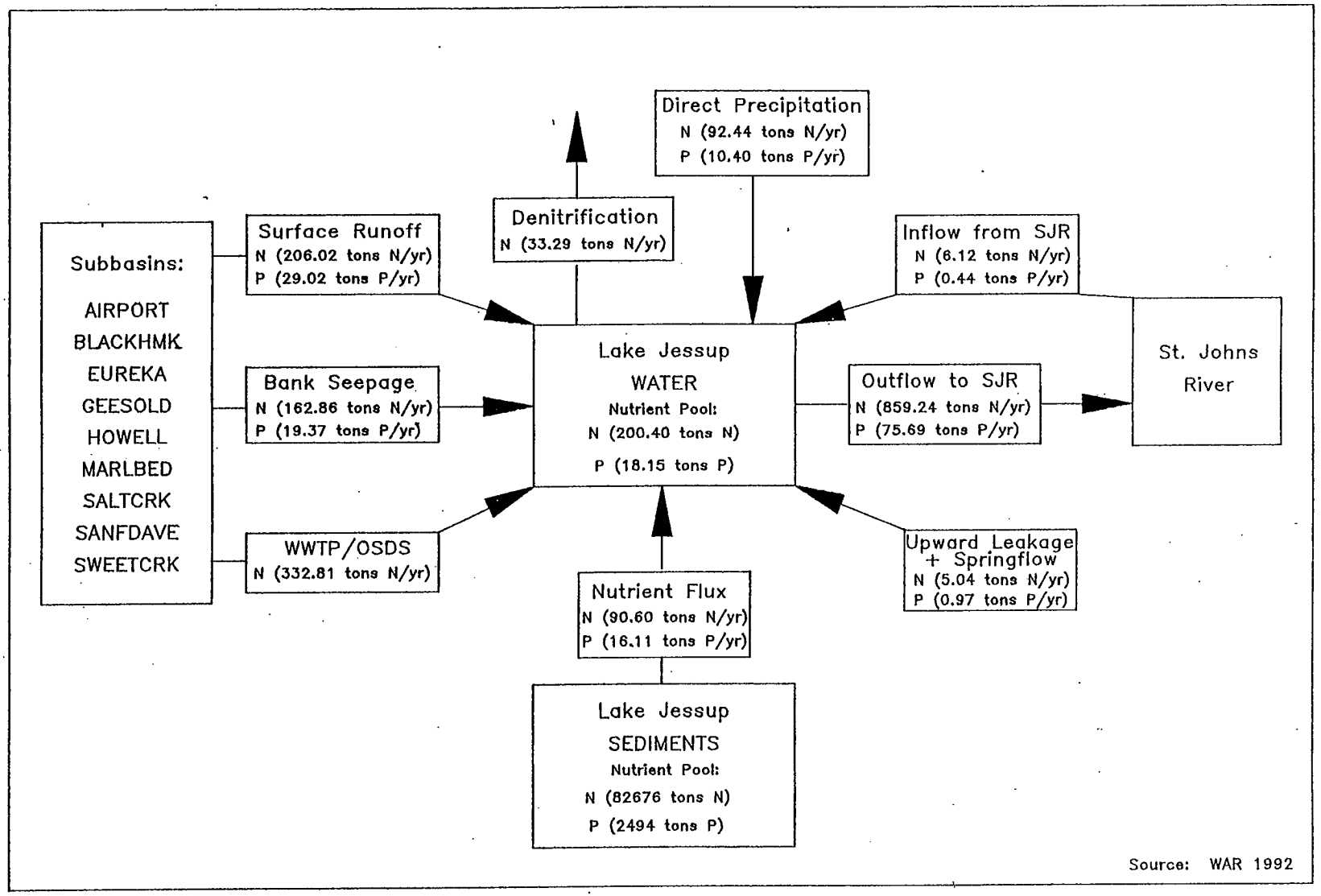

FIGURE 4.2–1. Schematic Diagram of Lake Jessup Nutrient Budget Components with Average Annual Fluxes (tons N,P/yr) and Pools (tons N,P). for 1980 through 1990.

APPENDIX B

Hydrographers Report for Bathymetric Survey and Mapping of Lake Jesup
Arc Surveying & Mapping, Inc., 1996

HYDROGRAPHERS REPORT

FOR:

BATHYMETRIC SURVEY AND MAPPING
OF
LAKE JESUP
LOCATED IN
SEMINOLE COUNTY, FLORIDA

MARCH 5, 1996
REVISED APRIL 4, 1996

PREPARED FOR:

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
DISTRICT HEADQUARTERS, EXECUTIVE BUILDING
HIGHWAY 100 WEST
PALATKA, FLORIDA 32117

PREPARED BY:

ARC SURVEYING AND MAPPING, INC.
5202 SAN JUAN AVENUE
JACKSONVILLE, FLORIDA 32210

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SECTION TWO:	CONTROL SURVEY
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SECTION FOUR:	MARSH SURVEY
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SECTION SIX:	APPENDIX B: GPS CONTROL MONUMENT DESCRIPTIONS
SECTION SEVEN:	APPENDIX C: WATER SURFACE READINGS AND GAGE LOCATION SKETCHS
SECTION EIGHT:	APPENDIX D: SURVEY VESSEL TRACK PLOT
SECTION NINE:	APPENDIX E: STATIC GPS SURVEY RESULTS
SECTION TEN:	APPENDIX F: STAGE-AREA RELATIONSHIPS HYPSOGRAPHIC CURVES AND REDUCED CHARTS.

SECTION ONE: INTRODUCTION

During September 1995, Arc Surveying & Mapping, Inc. (Arc) was awarded a contract (#95K271) with the St. Johns River Water Management District (District) to provide bathymetric surveying and mapping services at Lake Jesup, located in central Seminole County in east-central Florida. Lake Jesup, a large shallow water lake, is connected to the St. Johns River by a channel located at the northern extreme and bound by State Road 46 bridge. The Lake encompasses an area of approximately 10,700 acres of open water during normal river stages and in general is nine and one half (9.5) miles long with a varying width of one half(0.5) miles to three (3) miles.

The purpose of the survey was to obtain accurate measurements of the existing lake bottom topography to be utilized by the District to create a computational grid for a three-dimensional hydrodynamic model of Lake Jesup. In addition, publication quality maps of the bathymetric survey were required to be produced by Arc for the Districts use.

A schedule of the survey events including field efforts and mapping requirements was initiated by Arc and submitted to the District in early November, 1995. The primary field survey tasks associated with the project were determined and discussed during a pre - work negotiation meeting between District and Arc personnel.

These tasks consisted of:

1.) **Control Survey**

Establish three(3) new horizontal and vertical control monuments within easy access to the existing lake perimeter. All new control would be located horizontally by Static Global Positioning System (GPS) survey techniques along with latitude and longitude positions. The National Geodetic Vertical Datum (NGVD) for each monument would be established conventionality

from existing bench marks available within Seminole County's vertical control data base.

2.) **Hydrographic Survey**

Collect soundings along a 300 foot grid pattern within the open water areas of Lake Jesup. Survey vessel positioning would be determined by Differential GPS (DGPS) survey techniques and soundings measured with a recording survey quality fathometer. Establish two water level staff gages within the lake boundary and monitor during hydrographic survey operations.

3.) **Marsh Survey**

Collect bathymetry data in the marsh area along the east shore of Lake Jesup and south of SR 46 in Section 1, Township 20S, Range 31E. Survey vessel positioning would be determined by DGPS survey techniques and soundings measured by conventional pole sounding techniques.

Additional tasks included providing the District with maps of contours generated from the hydrographic survey data at one half (0.5) meter intervals and one (1) foot intervals along with all associated digital files. These digital files would contain the x, y, and z coordinates for all data collection points. From this data Arc would also generate elevation-area-volume and stage-area relationships for Lake Jesup at one (1) foot intervals and one half (0.5) meter intervals.

To begin work, Arc assigned personnel experienced with each specific task. Overall Project management was assigned to Richard Jenkins, PLS, with field operations assigned to Richard Sawyer. GPS surveying management was performed by Terry Durden, PLS.

SECTION TWO: CONTROL SURVEY

During mid October 1995, a crew was mobilized to Lake Jesup to begin setting control for support of the hydrographic survey operations. Supplied with bench mark data from Seminole County, gathered by the District and supplied to Arc, the control crew began reconnaissance around the perimeter of Lake Jesup to determine locations suitable for monumentation. Primary considerations were;

1. To establish at least one control monument at the upper and lower regions of Lake Jesup for placement of water level staff gages.

2. Determine if location is suitable for Static GPS surveying methods (easy accessibility, no obstruction or possible multipath sources, and at least 20-degree satellite visibility above the horizon).

3. Close proximity to existing bench marks to eliminate excessive conventional differential leveling.

Three sites were selected and standard concrete monuments with aluminum caps were set. Monument descriptions with sketches are included in **Appendix A.**

Conventional differential leveling techniques were used for establishing NGVD elevations at each control monument. Refer to **Table A** for elevation summary of new control monuments.

During the Control Survey Task, two(2) water level staff gages were set from newly established control monuments. Monument Jessup 3 was used for setting the gage Number one (1) at the Northern region of Lake Jesup. This gage was set in the vicinity

of State Road (S.R.) 46 bridge on an existing private dock, adjacent to the public boat ramp on S.R 46. The second gage (gage No. 2) was set in the Southern region of Lake Jesup at the Black Hammock Fish Camp. Monument Jesup 1 was used to establish this gage. Both water level staff gages were controlled by conventional differential leveling techniques and set to NGVD vertical datum. Visual checks were made to a pre-established water level gage found on the S.R. 46 bridge and consistently recorded the same water elevations as the new water level staff gages set for the hydrographic survey.

CONTROL MONUMENT ELAVATION SUMMARY

New Control Monument Designation	NGVD Elevation in Feet	Seminole County Bench Mark Elevation Establish From	NGVD Elevation in Feet
Jesup 1 - SJRWMD 1996	9.83	2126301	19.47
Jesup 2 - SJRWMD 1996	21.52	2391801	46.82
Jesup 3 - SJRWMD 1996	15.29	13	21.49

TABLE A

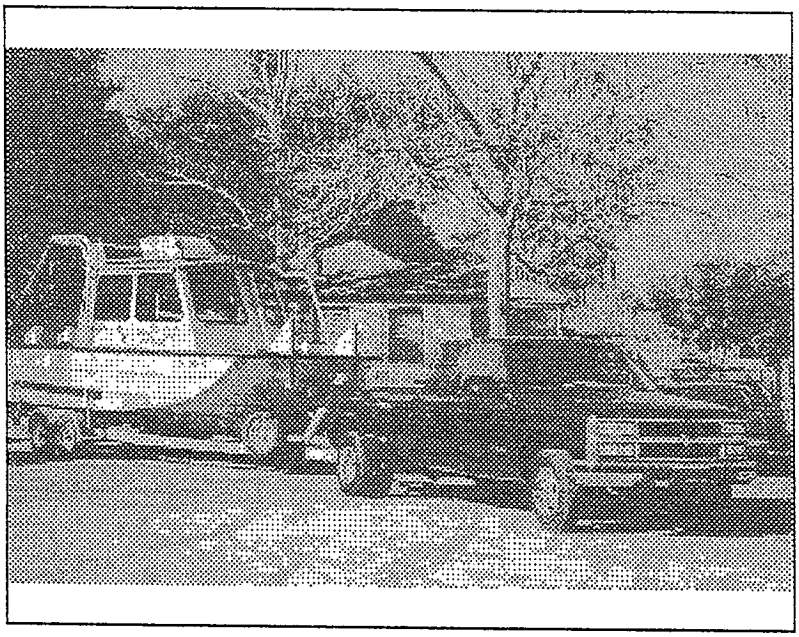
Horizontal positions were established for each new control monument by static GPS survey procedures. Static GPS surveying is perhaps the most common method of densifying project network control. A series of GPS receivers were used to acquire simultaneous data, which when processed, measured a vector baseline distance between each receiver. The station coordinate differences were calculated in terms of a 3D earth-centered coordinate system that utilizes x, y, and z values based on the WGS 84 geocentric ellipsoid model. From the 3d baseline vector distances, local or geodetic coordinates were computed.

In order to successfully perform a static GPS survey, occupation of known control points are required during the survey. A search of the National Geodetic Survey (NGS) data sheets CD, with a five mile radius around the center of Lake Jesup, revealed six possible control candidates suitable for use in densifying the project. From the six possibilities, two control monuments were found to be excellent for GPS surveying. These included control points "V007" and "I4 71 A14". Both of these points had previously been utilized for GPS surveying as noted on the descriptions for each. (**Appendix B**)

The network consisted of two (2) control points "V007", "I4 71 A14" and three new (unknown) points "Jesup 1", "Jesup 2", and "Jesup 3". The GPS equipment utilized were four (4) *Trimble Navigation* 4000SE series single frequency units. The observation times (sessions) were 60 minutes in length, with data being collected at 15 second intervals (epochs), with an elevation mask of 15 degrees above the horizon. The survey data was downloaded to a PC using *Timble Navigation's*, Trimble 4000 series receivers Download / Datalogging Software Version 2.00 in order to process the vectors and adjust the network.

GPS vectors were computed using *Trimble Navigation's* GPSurvey Single Frequency Processor Version 1.10 software. Network adjustments were performed using GPSurvey Trimnet Plus Version 1.10 software. The network was constrained in the horizontal to NAD 1983 geographic coordinates at stations "V007" (PID AK7053), and "I4 71 A14" (PID AK0205). Final state plane coordinates were computed using CORPSCON VERSION 4.0.

SECTION THREE: HYDROGRAPHIC SURVEY



In late October 1995, the hydrographic field party mobilized to Lake Jesup equipped with a 23 foot *Sea Ark* survey vessel to perform the open water portion of the project. The vessel was configured with a *Trimble Navigation* model 4000SE GPS navigation unit for vessel positioning. To assure that vessel positioning was within the three (3) meter accuracy range, an *ACCQPOINT* FM DGPS receiver was chosen to provide differential corrections to the *Trimble* GPS unit. This data receiver is designed to receive differential GPS data carried by FM radio signals. The data receiver outputs differential GPS corrections on its RS-232 serial connector in a standard format, RTCM-SC104, suitable for input to a wide variety of GPS navigation products.

For lake bottom depth measurements, a *Knudsen* 320M recording fathometer configured with a 200kHz transducer was used. During the survey, the analog records were annotated with automatic event marks logged with time, vessel state plane coordinates, depths, digital file name and header information. In addition, daily bar check calibrations of the fathometer were recorded on the analog record at the beginning and end of each survey day to verify that the fathometer was reading true depths. The purpose of a bar check calibration are best described the U.S. Army Corps of Engineers Hydrographic Surveying Manual (EM 1110-2-1003, 31 Oct. 1994) and states, "The bar check effectively

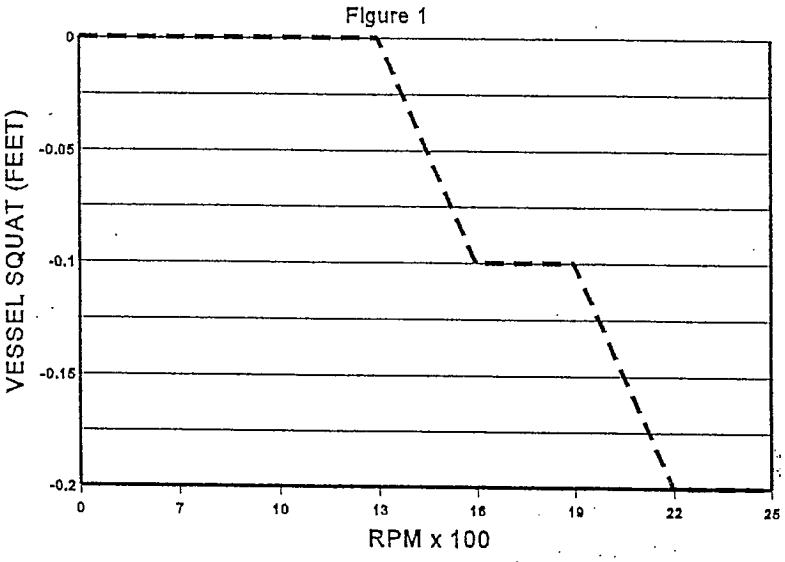
measures for the following systematic errors inherent in depth recording systems: instrumental errors--index, mechanical, and electrical; velocity of sound errors due to temperature, salinity, or other suspended or dissolved sediment variations; and static draft fluctuations resulting from varying vessel displacement caused by fuel and personnel loads." Bar check procedures followed recommendations from this manual.

As required by the scope, the layout of planned track lines for hydrographic data collection were computed at a 300 foot grid pattern running due east and west across Lake Jesup. Quadrangle maps were obtained and used for digitizing the limits and the boundary of Lake Jesup. The boundary and planned cross section lines were combined into a digital file and compiled to the same state plane coordinate system. This file was used for vessel navigation within *HYPACK*, a hydrographic data collection and processing software package. *HYPACK* is powerful PC based software allowing users to perform vessel navigation and tracking while integrating sounding and positioning devices. During the survey operations, *HYPACK* time tagged positioning data with sounding data and logged all results to the on board computer system for later processing and mapping.

Lake water surfaces were monitored at two separate locations during each day of data collection. During the eight days of open water data acquisition the water surface at Lake Jesup gradually dropped from an elevation of 6.3 NGVD on October 25, 1995, to 6.1 NGVD on November 5. 1995.(**Appendix C**) These water surfaces were applied to the depth measurements acquired during the survey along with vessel squat. As a vessel's velocity increases, it generally settles ("squats") into a lower profile in the water, causing an error in depth measurement that must be corrected. The squat of the vessel was calculated by differential leveling techniques and the results are shown in **Figure 1**.

23' SeaArk Squat Table

Figure 1



The squat test was performed in the St. Johns River during the month of September 1995. The test are performed bi-annually on all of Arc's survey vessels. Refer to **Table B** for squat test data collected for the vessel used on Lake Jesup.

VESSEL SQUAT TEST DATA

Vessel RPM	Upstream Rod	Downstream Rod	Water Surface Elevation	Vessel Squat
Static	10.9	10.9	1.5	0
700	10.9	10.8	1.5	0
1000	10.9	10.8	1.5	0
1300	10.9	10.9	1.5	0
1600	11.0	10.9	1.5	-0.1
*1900	11.0	11.0	1.5	-0.1
2200	11.1	11.0	1.5	-0.2
2500	11.1	11.1	1.5	-0.2

TABLE B

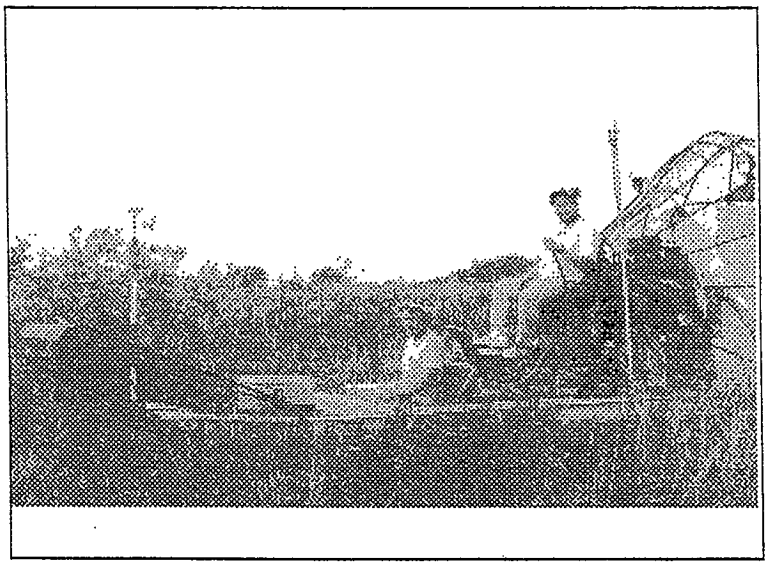
* Maxim Survey RPM

** Rod is placed directly above transducer for all readings.

A total of 106 transect lines were required to completely survey the open water portion of Lake Jesup. (**Appendix D**) Soundings were collected from bank to bank with the majority of survey lines ending at the edge of thick vegetation. In most cases the lake bottom elevation at the edge of thick vegetation fell short of the zero (0) foot contour. Where there was no vegetation, water depths were successfully collected in one half (0.5) feet of water.

Hydrographic data processing was performed with specific routines available within *HPACK'S* data processing modules. Vessel squat and water surface elevations were combined with time tagged coordinates and depth measurements to produce a digital file containing corrected lake bottom elevations. Approximately 100,000 data points were logged and processed for mapping and analysis use.

SECTION FOUR: MARSH SURVEY



An area of dense marsh lying just south of State Highway 46 and extending approximately one and one half (1.5) miles south into Lake Jesup was surveyed during the month of January, 1996. Arc personnel again mobilized to the project outfitted with the necessary equipment to complete this portion of the field requirements. Water surface elevations were in excess of three(3) feet above zero (0) NGVD which allowed for use of a eighteen (18) foot airboat for transecting pre-defined survey lines. As with the open water portion of the project, a 300 foot grid pattern was required for data density.

A *Trimble* DSM GPS unit was installed on board the vessel and once again differential corrections were received by an *ACCQPOINT* FM DGPS receiver. These corrections coupled with the GPS unit provided positioning accuracies of better than three (3) meters. Vessel positions were automatically transmitted to an onboard laptop PC for tracking and navigation.

Due to the thick vegetation, manual pole sounding methods were utilized to determine the water depths within the marsh area. As the airboat traversed along planned track lines, water depths were logged at twenty five (25) foot intervals and time tagged with positioning data recorded on the laptop PC.

Water surface elevations were monitored at the S.R. 46 bridge during all data collection operations.

Water depths acquired during the marsh survey were combined with vessel positions and lake surface elevations to generate the digital files. These files contained the northing and easting coordinate values along with the adjusted NGVD elevation for the data sampled. This data was combined with the open water survey soundings to create the working data set used in the mapping and stage area relationships for Lake Jesup.

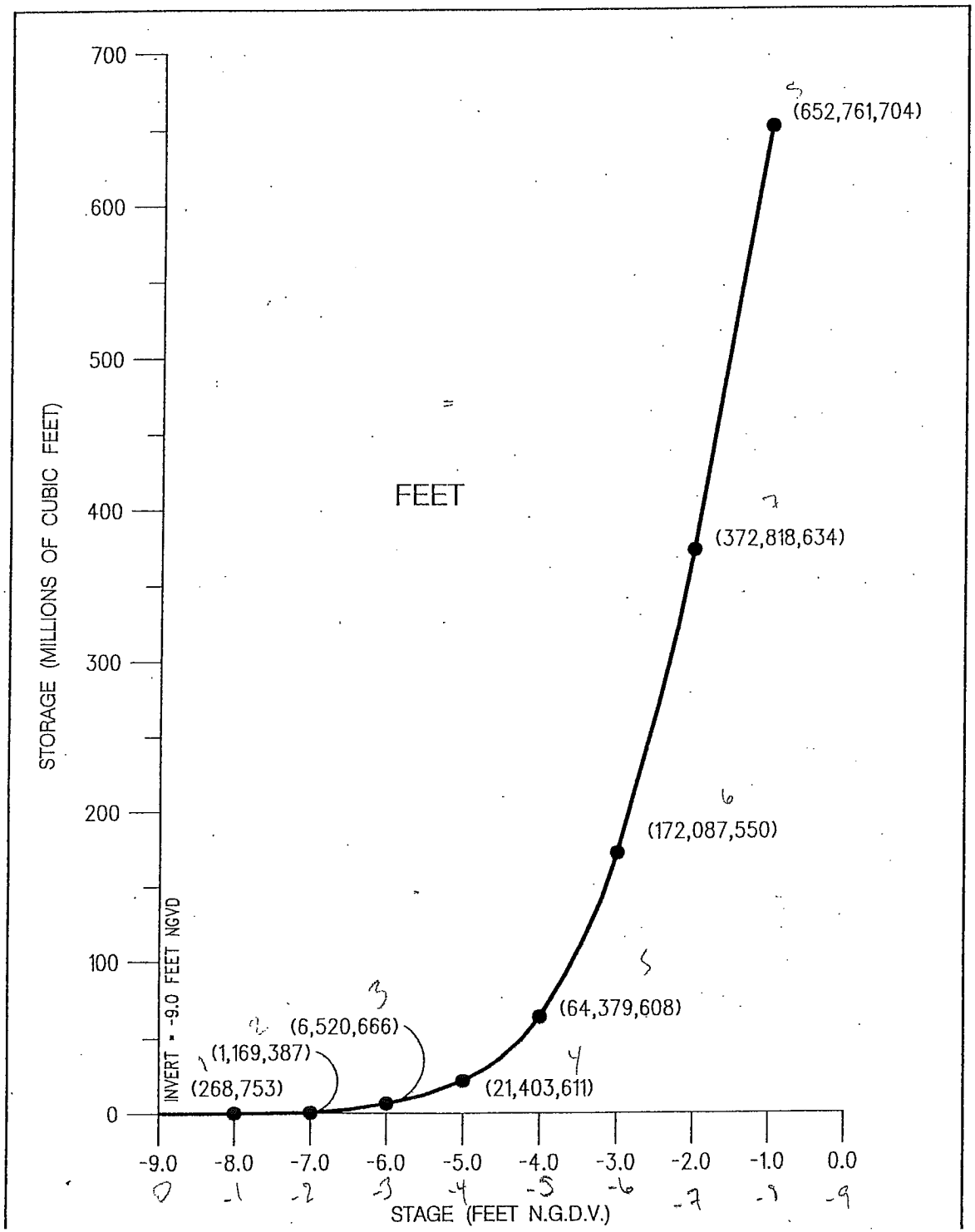
LAKE JESUP WATER SURFACE READINGS
Gage 1 - SR 46 Bridge
Gage 2 - Black Hamock Fish Camp

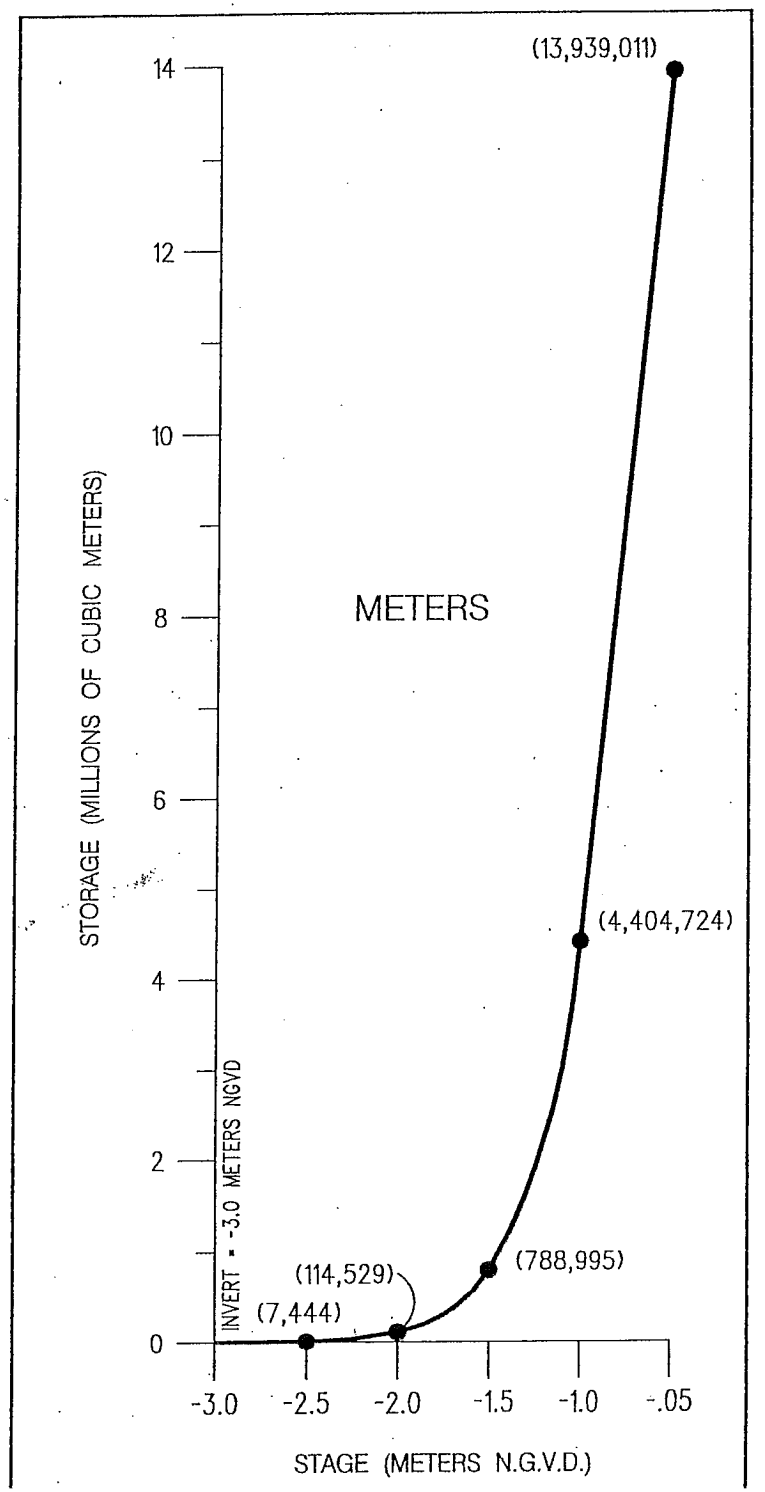
DATE	TIME	GAGE 1 - NGVD	GAGE 2 - NGVD
10-24-95	8:00 AM	6.3	6.3
	12:00 PM	6.3	6.3
	5:30 PM	6.3	6.3
10-25-95	8:00 AM	6.3	6.3
	12:00 PM	6.3	6.3
	5:30 PM	6.3	6.3
10-26-95	8:00 AM	6.3	6.3
	12:00 PM	6.3	6.3
	6:00 PM	6.3	6.3
10-30-95	3:30 PM	6.2	6.2
	5:30 PM	6.2	6.2
10-31-95	8:00 AM	6.2	6.2
	12:00 PM	6.2	6.2
	5:30 PM	6.2	6.2
11-03-95	8:00 AM	6.1	6.1
	12:00 PM	6.1	6.1
	5:30 PM	6.1	6.1
11-04-95	8:00 AM	6.1	6.1
	12:00 PM	6.1	6.1
	5:30 PM	6.1	6.1

LAKE JESUP WATER SURFACE READINGS - CON'T

DATE	TIME	GAGE 1 - NGVD	GAGE 2 - NGVD
11-05-95	8:00 AM	6.1	6.1
	12:00 PM	6.1	6.1
	14:00 PM	6.1	6.1
01-23-96	8:00 AM	3.6	-----
	5:30 PM	3.6	-----
01-24-96	8:00 AM	3.6	-----
	5:30 PM	3.6	-----
01-25-96	8:00 AM	3.5	-----
	3:00 PM	3.5	—

STAGE STORAGE RELATIONSHIPS





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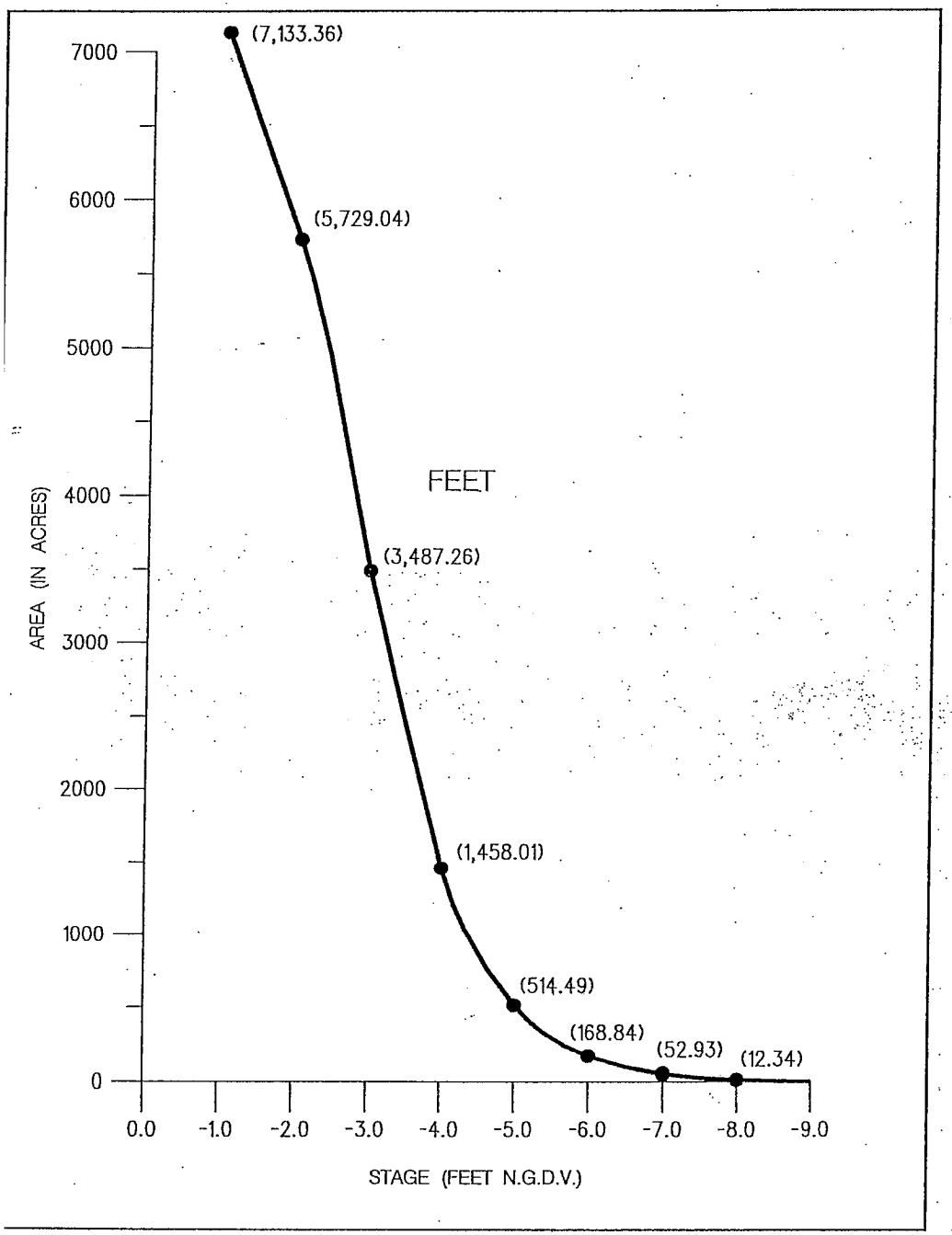
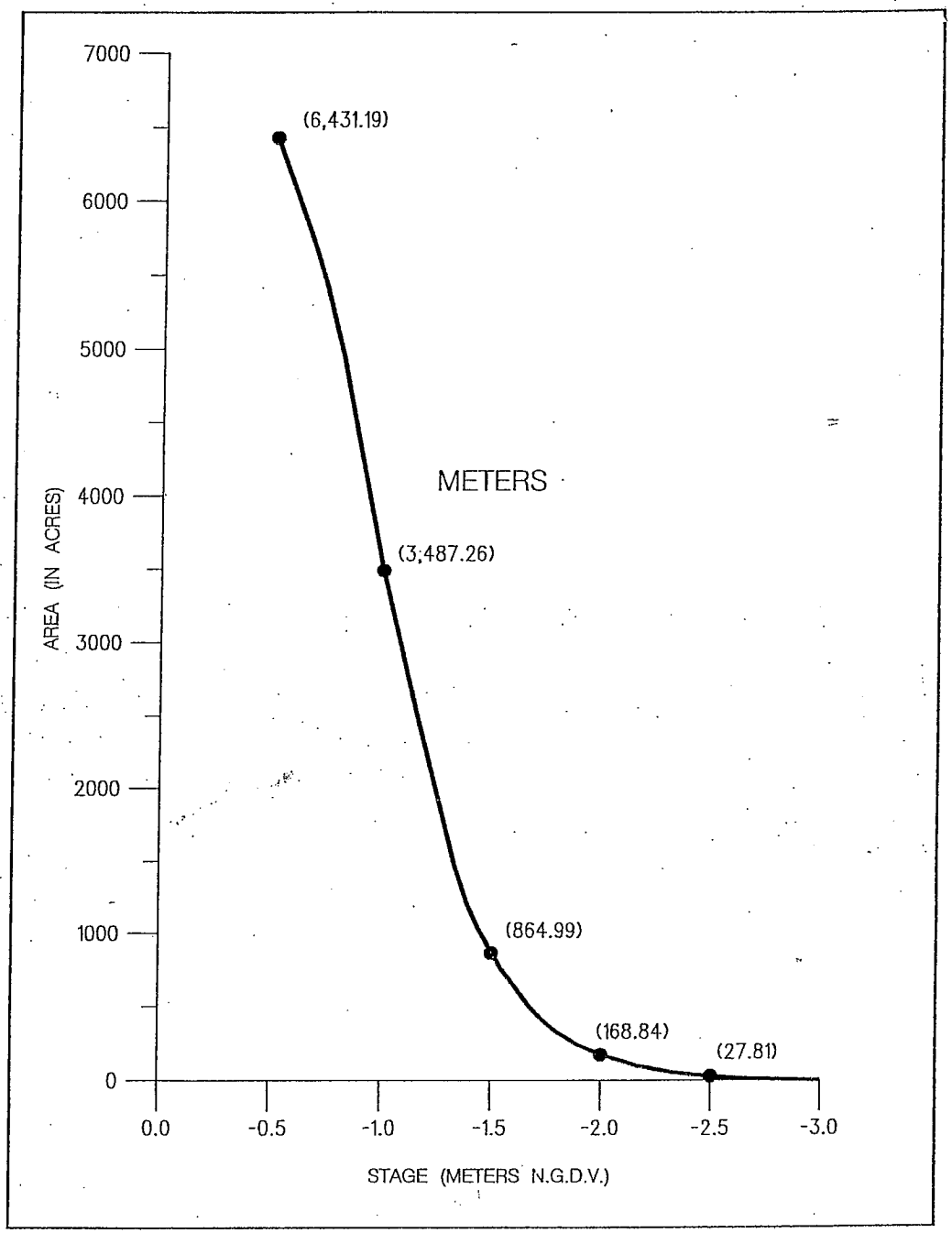
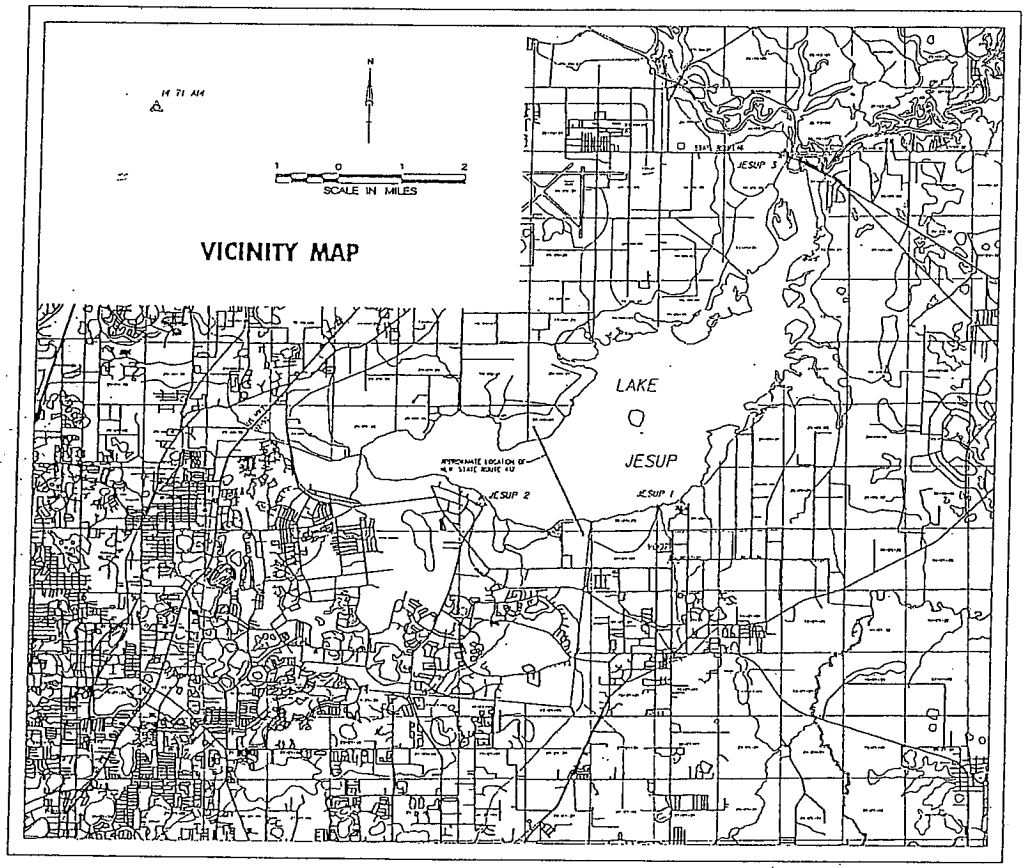
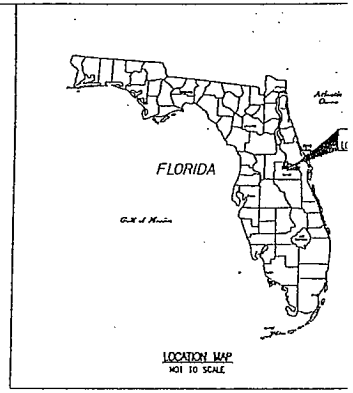


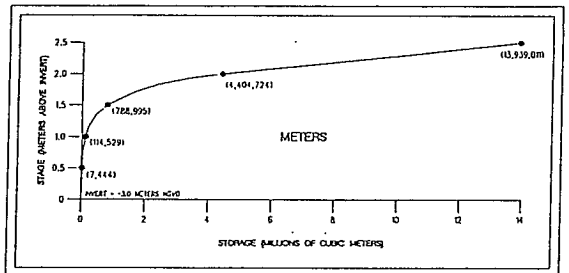


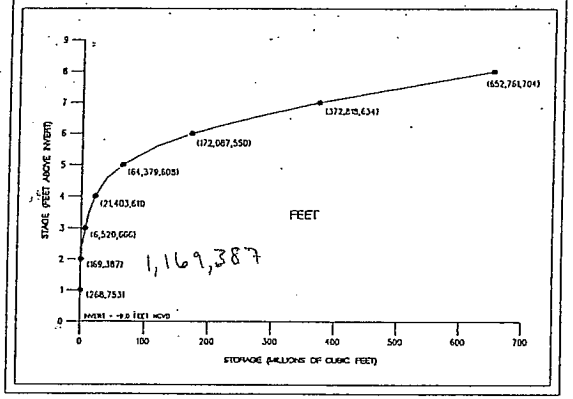
A HYDROGRAPHIC SURVEY OF LAKE JESUP
LYING IN
TOWNSHIP 20 SOUTH, RANGES 30 & 31 EAST,
SEMINOLE COUNTY, FLORIDA





STAGE STORAGE RELATIONSHIPS





CONTROL TABULATION

DESIGNATION	NORTHING	EASTING	ELEV. (FEET)	LATITUDE*	LONGITUDE
JCSUP 1	1,586,692.1277	433,715.4816	9.83	28° 42'15.76421"N	081° 12'23.61806"W
JCSUP 2	1,586,969.7171	417,159.8899	21.52	28° 42'18.19413"N	081° 15'29.52237"W
JCSUP 3	1,618,501.4148	441,683.9256	15.29	28° 47'11.03460"N	081° 10'54.61710"W
SC2126301			19.47		
SC2391801			46.82		
SC13			21.49		
V007	1,584,153.7489	433,061.1524		28° 41'31.21421"N	081° 12'30.65582"W
M 71 AM	1,622,097.9487	389,221.1059	99.66	28° 47'45.49234"N	081° 20'44.35222"W

SURVEY NOTES:

1.) REFER TO SURVEY NO. 95-08-10.

2.) THIS SURVEY WAS PERFORMED OCTOBER 1995 THRU JANUARY 1996.

3.) SOUNDINGS ARE IN FEET AND TENTHS AND REFER TO THE NATIONAL GEODETIC VERTICAL DATUM, NGVD, 1929.

4.) WATER SURFACE REDUCTIONS WERE MADE FROM CONTROL MONUMENTS JESUP NO.1 AND JESUP NO.3.

5.) PLANE COORDINATES ARE BASED ON THE FLORIDA STATE PLANE, EAST ZONE, NAD 1927, U.S. SURVEY FOOT. MAPS WERE COMPILED TO BOTH FLORIDA STATE PLANE, EAST ZONE, NAD 1927 AND UNIVERSE TRANSVERSE MERCATOR, UTM 1927, METERS.

6.) EXISTING AND NEW CONTROL STATIONS WERE VERIFIED AND ESTABLISHED BY STATIC GLOBAL POSITIONING SYSTEM (GPS) METHODS.

7.) THE HYDROGRAPHIC SURVEY WAS PERFORMED UTILIZING DIFFERENTIAL GPS (DGPS) SURVEYING METHODS.

8.) THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.

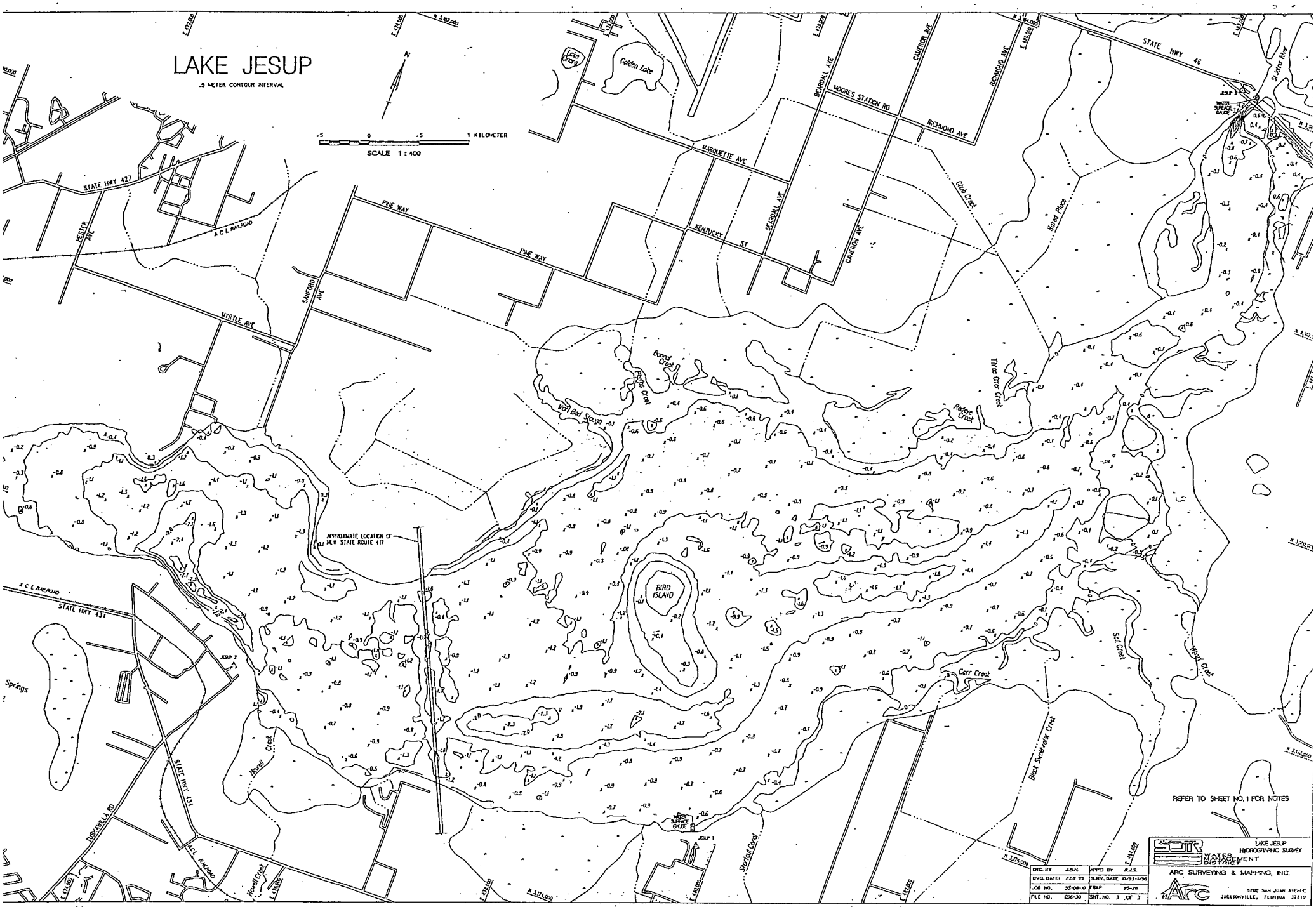
CERTIFICATION
I HEREBY CERTIFY THAT THE ABOVE SURVEY WAS MADE UNDER MY RESPONSIBLE SUPERVISION AND DIRECTION AND THAT THE SURVEY SHOWN HEREON MEETS THE MINIMUM TECHNICAL STANDARDS IN CHAPTER 61G17-6, FLORIDA ADMINISTRATIVE CODE.

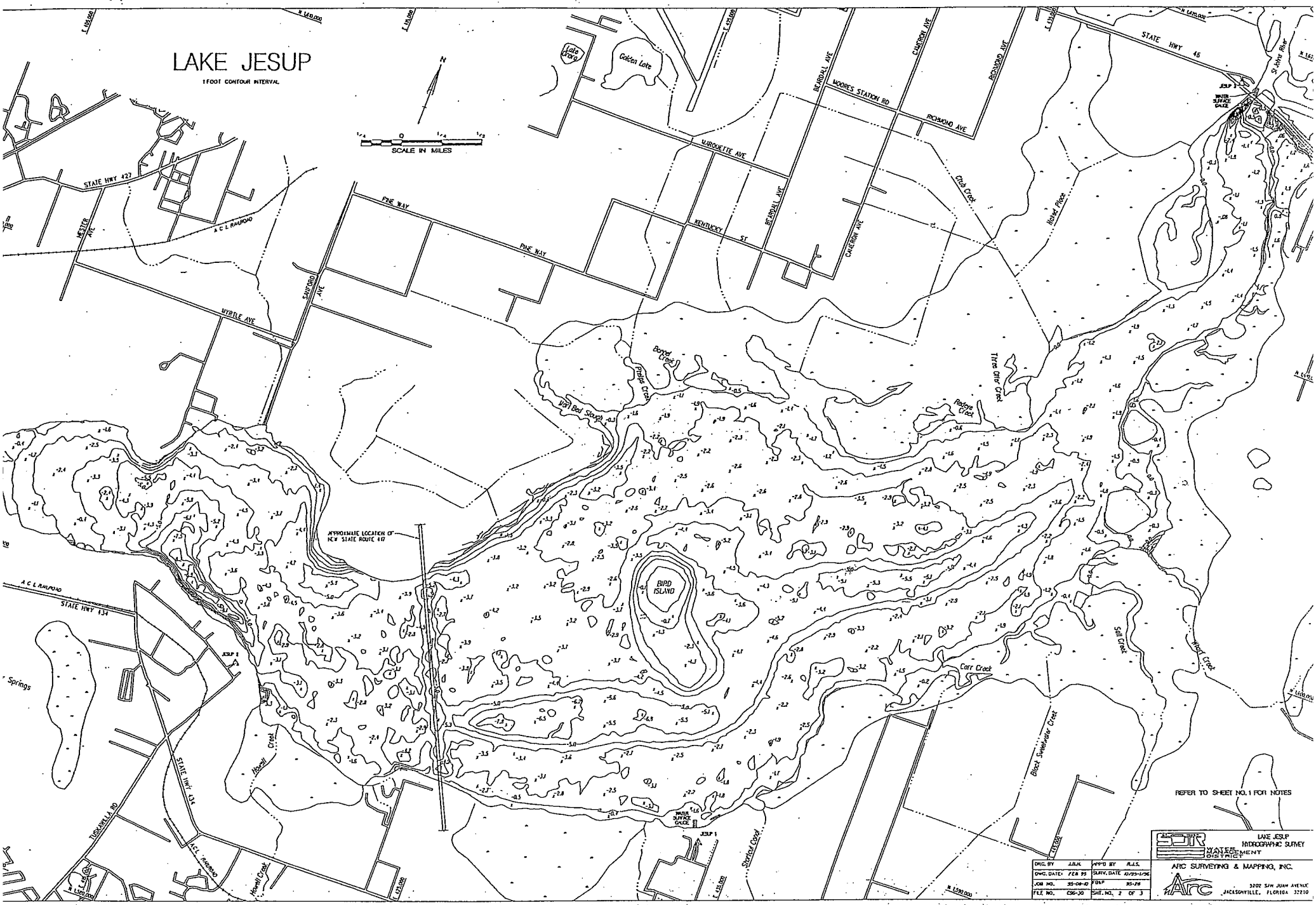
RICHARD J. JENKINS
FLORIDA REG. CERT. NO. 4421
DATE:
SURVEY NOT VALID WITHOUT EMBOSSED SEAL

SJR WATER MANAGEMENT DISTRICT
LAKE JESUP HYDROGRAPHIC SURVE

ARC SURVEYING & MAPPING, INC.
3102 SAN JUAN AVEN
JACKSONVILLE, FLORIDA 322

DRG. BY	J.B.K.	APP'D BY	R.J.S.
DWG. DATE	FEB 96	SURV. DATE	10/95-1/96
JOB NO.	95-08-10	FB#	95-28
FILE NO.	E95-30	SHT. NO.	1 OF 3


LAKE JESUP
.5 METER CONTOUR INTERVAL
SCALE 1:400
.5 0 .5 1 KILOMETER
STATE HWY 46
MOORES STATION RD
MARQUETTE AVE
RICHMOND AVE
CAMERON AVE
BEARDALL AVE
KENTUCKY ST
PINE WAY
MYRTLE AVE
SANFORD AVE
NESTER AVE
STATE HWY 427
A C L RAILROAD
Lake Jesup
Golden Lake
Club Creek
Howell Place
Bonnet Creek
Reeds Creek
Wet Bed Slough
Tyree Otter Creek
APPROXIMATE LOCATION OF NEW STATE ROUTE 417
BIRD ISLAND
STATE HWY 434
Springs
Howell Creek
TUSKAWILLA RD
Starkel Cove
Carr Creek
Salt Creek
Black Swamp Creek
West Creek
St Johns River
WATER SURFACE GAGE
REFER TO SHEET NO. 1 FOR NOTES
LAKE JESUP
HYDROGRAPHIC SURVEY
WATER MANAGEMENT DISTRICT
ARC SURVEYING & MAPPING, INC.
8202 SAN JUAN AVENUE
JACKSONVILLE, FLORIDA 32210
DRC. BY JSM
APP'D BY R.L.S.
DWG. DATE FEB 95
SURV. DATE 10/93-1/94
JOB NO. 95-08-10
F.B.&P. 95-26
FILE NO. E96-30
SHT. NO. 3 OF 3


LAKE JESUP
1 FOOT CONTOUR INTERVAL
SCALE IN MILES
STATE HWY 46
WOODS STATION RD
RICHMOND AVE
CAMERON AVE
BEARDALL AVE
MARQUETTE AVE
KENTUCKY ST
PINE WAY
MYRTLE AVE
SANFORD AVE
STATE HWY 417
A C L RAILROAD
Golden Lake
Lake Sylvia
Club Creek
Hotel Place
Three Mile Creek
Prairie Creek
Bonita Creek
Wall Bed Slough
APPROXIMATE LOCATION OF NEW STATE ROUTE 417
BIRD ISLAND
STATE HWY 434
Howell Creek
Starke Canal
Salt Creek
Black Sweetwater Creek
Corr Creek
REFER TO SHEET NO. 1 FOR NOTES
LAKE JESUP
HYDROGRAPHIC SURVEY
ARC SURVEYING & MAPPING, INC.
3202 SAN JUAN AVENUE
JACKSONVILLE, FLORIDA 32210

APPENDIX C

Geotechnical Laboratory Investigation Report
Lake Jesup Laboratory Analysis
Madrid Engineering Group, Inc., June 2002

Madrid Engineering Group, Inc.

Geotechnical Laboratory Investigation Report

Lake Jesup Laboratory Analysis

Prepared for: PB Water

The Earth is our Business[SM]

Prepared by:

MADRID ENGINEERING GROUP, INC.
175 East Summerlin Street - PO Box 2506
Bartow, FL 33831

Project No. 3181.01
June 2002

Larry D. Madrid, P.E. No. 39559
7/9/02

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8.0 Sample Collection Point Locations 18

MADRID ENGINEERING GROUP, INC.
P.O. Box 2506
Bartow, FL 33831
863/533-9007 FAX 863/533-8997

MOISTURE CONTENT / SOIL DESCRIPTION

Client: PB water
MEG Project No.: 3181.01
MEG Project Name: Lake Jesup Sediment

Tested By: MWC
Date Tested: 4/24/02

Sample Number	Solids Content (percent)	Moisture Content (percent)	SOIL DESCRIPTION
1 (0-6")	7.2%	1288.5%	black organic muck
2 (0-6")	4.9%	1947.3%	black organic muck
2 (6-12")	11.4%	779.9%	black organic muck
2 (1-2')	14.3%	597.0%	black organic muck
2 (2-3')	18.6%	436.3%	black organic muck
2 (3-3.5')	49.3%	103.0%	black sandy organic muck with minor shell
2 (3.5-4')	18.4%	444.5%	black sandy organic muck with minor shell
3 (0-6")	5.7%	1662.0%	black mucky water
3 (6-12")	12.5%	702.2%	black organic muck
3 (1-2')	13.4%	643.8%	black organic muck
3 (2-3')	57.6%	73.7%	black organic muck with minor shell
4 (0-6")	8.0%	1150.0%	black mucky water
4 (6-12")	16.8%	493.8%	black organic muck
4 (1-2')	16.5%	507.1%	black organic muck
4 (2-3')	55.1%	81.4%	gray sandy organic muck
5 (0-6")	8.2%	1122.8%	black mucky water
5 (6-12")	10.7%	838.4%	black organic muck
5 (1-2')	18.8%	430.8%	black organic muck
5 (2-3')	24.3%	311.2%	gray sandy organic muck
6 (0-6")	4.1%	2330.1%	black mucky water
6 (6-12")	8.8%	1042.4%	black organic muck
6 (1-2')	17.4%	476.3%	black organic muck
6 (2-3')	13.9%	621.3%	black organic muck
6 (3-4')	13.4%	647.4%	black organic muck
7 (0-6")	1.9%	5112.2%	black mucky water
7 (6-12")	11.4%	777.1%	black organic muck
7 (1-2')	15.1%	562.1%	black organic muck with minor broken shell
7 (2-3')	40.4%	147.8%	gray sandy organic muck with minor broken shell
8 (0-6")	2.3%	4286.3%	black mucky water
8 (6-12")	12.9%	673.4%	black organic muck
8 (1-2')	8.8%	1037.6%	black fibrous organic muck
8 (2-3')	9.1%	998.1%	black fibrous organic muck
9 (0-6")	9.4%	961.7%	black organic muck
9 (6-12")	9.6%	941.3%	black organic muck
9 (1-2')	67.4%	48.4%	blue/green clay

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Bartow, FL 33831
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MOISTURE CONTENT / SOIL DESCRIPTION

Client: PB water
MEG Project No.: 3181.01
MEG Project Name: Lake Jesup Sediment

Tested By: MWC
Date Tested: 4/24/02

Sample Number	Solids Content (percent)	Moisture Content (percent)	SOIL DESCRIPTION
10 (0-6")	23.0%	335.5%	black mucky water with minor shell
10 (6-12")	23.5%	325.9%	gray sandy organic muck
10 (1-1.5')	21.5%	365.1%	gray sandy organic muck
11 (0-8")	11.2%	790.7%	black mucky water with minor shell
11 (8-12")	39.2%	155.2%	gray sandy organic muck with broken shell
12 (0-9")	11.4%	776.7%	black organic muck
12 (9-12")	71.6%	39.7%	black clay
13 (0-18")	11.9%	737.8%	black organic muck
13 (18"-2')	55.1%	81.4%	gray sandy muck with minor shell
14 (0-15")	10.7%	832.8%	black organic muck
14 (15"-2')	53.6%	86.7%	gray sandy muck with minor shell
15 (0-6")	3.8%	2528.2%	black mucky water with minor shell
15 (6-12")	14.3%	598.7%	black organic muck
15 (1-2')	25.9%	285.4%	gray fibrous organic muck with shells
16 (0-6")	9.6%	937.5%	black organic muck
16 (6-12")	21.0%	375.6%	black organic muck
16 (1-2')	27.1%	269.1%	black organic muck
16 (2-3')	31.4%	218.0%	black organic muck
16 (3-4')	69.6%	43.6%	gray clay
17 (0-6")	7.3%	1264.4%	black mucky water
17 (6-12")	12.3%	714.4%	black organic muck
17 (12-16")	9.5%	956.9%	brown fibrous peat with minor shell
18 (0-4")	67.1%	49.0%	black organic muck with minor shell
19 (0-1')	3.8%	2526.9%	black mucky water
19 (1-2')	12.5%	700.0%	black organic muck
19 (2-3')	12.5%	698.6%	black organic muck
19 (3-4')	13.1%	663.2%	brown/black fibrous organic muck
20 (0-6")	36.2%	176.1%	black organic muck with minor shell
20 (6-12")	34.1%	193.4%	gray organic muck
21 (0-1')	5.3%	1799.5%	black mucky water
21 (1-2')	14.3%	600.9%	black organic muck with minor shell

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MOISTURE CONTENT / SOIL DESCRIPTION

Client: PB water
MEG Project No.: 3181.01
MEG Project Name: Lake Jesup Sediment

Tested By: MWC
Date Tested: 4/24/02

Sample Number	Solids Content (percent)	Moisture Content (percent)	SOIL DESCRIPTION
22 (0-6")	3.4%	2807.9%	black mucky water
22 (6-12")	6.8%	1380.3%	black organic muck
22 (1-2')	10.2%	882.0%	black organic muck
22 (2-3')	8.7%	1046.7%	brown organic muck
22 (3-4')	14.9%	569.1%	black organic muck with minor shell
23 (0-1')	5.0%	1883.8%	black mucky water
23 (1-2')	14.0%	613.8%	black organic muck with shell
23 (2-3')	8.9%	1021.9%	black organic muck
23 (3-4')	7.8%	1184.2%	brown organic muck
24 (0-6")	7.3%	1263.3%	black mucky water
24 (6-12")	8.8%	1035.4%	black organic muck
24 (1-2')	10.5%	848.8%	black organic muck
24 (2-3')	11.4%	780.6%	black organic muck
24 (3-4')	13.3%	649.2%	black organic muck with minor broken shell
25 (0-6")	30.9%	223.8%	black fibrous organic muck with minor broken shell
25 (6-12")	70.4%	42.0%	black sand with minor organics
26 (0-1')	8.9%	1022.1%	black organic muck
26 (1-2')	35.4%	182.5%	black sand with minor organics
26 (2-3')	64.4%	55.3%	black sand with minor organics
27 (0-6")	12.5%	701.8%	black organic muck
27 (6-12")	12.3%	716.1%	black organic muck
27 (1-2')	14.5%	591.4%	black organic muck
27 (2-3')	67.9%	47.4%	black sand with minor organics
28 (0-6")	11.1%	801.4%	black organic muck
28 (6-12")	23.9%	319.3%	sandy black organic muck
28 (1-2')	70.2%	42.4%	gray sand
29 (0-6")	5.7%	1668.8%	black mucky water
29 (6-12")	12.5%	701.0%	black organic muck with minor shell
29 (1-2')	8.7%	1055.3%	black fiborous organic muck
29 (2-3')	21.3%	369.9%	black organic muck
29 (3-4')	13.1%	661.8%	black organic muck
30 (0-6")	8.5%	1080.6%	black mucky water
30 (6-12")	16.8%	496.0%	black organic muck
30 (1-2')	13.7%	630.2%	black organic muck
30 (2-3')	8.6%	1058.3%	black organic muck
30 (3-4')	29.1%	244.1%	black organic muck

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MOISTURE CONTENT / SOIL DESCRIPTION

Client: PB water
MEG Project No.: 3181.01
MEG Project Name: Lake Jesup Sediment

Tested By: MWC
Date Tested: 4/24/02

Sample Number	Solids Content (percent)	Moisture Content (percent)	SOIL DESCRIPTION
bucket 1 (2-3')	6.3%	1493.4%	Black Organic Sediment
bucket 2 (2-5')	10.7%	838.1%	Black Organic Sediment
bucket 3 (0-2.5')	5.4%	1765.2%	Black Organic Sediment
bucket 4 (0-2')	11.6%	765.0%	Black Organic Sediment
bucket 5 (2.5-4')	5.6%	1696.3%	Black Organic Sediment
bucket 6 (1-3.5')	7.3%	1267.3%	Black Organic Sediment
bucket 7 (3.5-5.5')	7.0%	1327.2%	Black Organic Sediment
bucket 8 (2.5-4.5')	7.6%	1221.2%	Black Organic Sediment
bucket 9 (0-1')	5.7%	1646.7%	Black Organic Sediment
bucket 11 (0-8")	12.2%	722.5%	Black Organic Sediment
bucket 12 (2-2.5')	15.9%	528.0%	Black Organic Sediment
bucket 13 (3-4.5')	8.1%	1137.3%	Black Organic Sediment
bucket 14 (3.5-4.5')	8.7%	1047.2%	Black Organic Sediment
bucket 15 (3-4')	11.1%	799.2%	Black Organic Sediment
bucket 16 (6"-3')	19.0%	425.9%	Black Organic Sediment
bucket 17 (3.5-4.5')	10.6%	847.4%	Black Organic Sediment
bucket 19 (5-7')	7.1%	1303.8%	Black Organic Sediment
bucket 21(7-8.5')	6.1%	1526.9%	Black Organic Sediment
bucket 22 (1-4')	6.0%	1557.1%	Black Organic Sediment
bucket 23 (5-7')	6.9%	1358.5%	Black Organic Sediment
bucket 24 (0-2')	7.0%	1330.5%	Black Organic Sediment
bucket 25 (0-6")	21.4%	366.7%	Black Organic Sediment
bucket 26 (4.4-6.4')	8.1%	1135.2%	Black Organic Sediment
bucket 27 (4.4-5.4')	14.1%	609.2%	Black Organic Sediment
bucket 28 (5-6')	7.5%	1237.9%	Black Organic Sediment
bucket 29 (1-4')	7.2%	1297.8%	Black Organic Sediment
bucket 30 (1-3')	8.8%	1040.9%	Black Organic Sediment

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MOISTURE CONTENT On %-#40

Client: PB water
MEG Project No.: 3181.01
MEG Project Name: Lake Jesup Sediment

Tested By: MWC/HB
Date Tested: 5/28/02

Sample Number	$W_C + S_W$ (grams)	$W_C + S_D$ (grams)	W_C (grams)	Solids Content (percent)	Moisture Content (percent)
#2 (2-3')	118.09	26.96	8.51	16.8%	493.9%
#5 (6-12")	76.52	18.48	8.73	14.4%	595.3%
#6 (1-2')	107.35	20.89	9.41	11.7%	753.1%
#7 (1-2')	50.68	16.37	9.41	16.9%	493.0%
#10 (6-12')	95.55	27.33	8.45	21.7%	361.3%
#13 (0-18")	113.49	21.60	9.19	11.9%	740.5%
#16 (6-12")	82.38	24.37	8.54	21.4%	366.5%
#17 (0-6")	149.14	19.54	8.44	7.9%	1167.6%
#20 (6-12")	Not enough sample - substitute #20 (0-6")				
#22 (6-12")	73.38	12.97	8.55	6.8%	1366.7%
#23 (2-3')	118.81	39.21	8.39	27.9%	258.3%
#25 (0-6")	57.26	31.92	8.63	47.9%	108.8%
#27 (1-2')	140.62	32.76	9.29	17.9%	459.6%
#29 (6-12")	Not enough sample - substitute #29 (1-2')				
#20 (0-6")	41.89	14.18	8.58	16.8%	494.8%
#29 (1-2')	66.48	12.93	8.36	7.9%	1171.8%

MADRID ENGINEERING GROUP, INC.
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Bartow, FL 33831
863/533-9007 FAX 863/533-8997

MOISTURE CONTENT / % Passing #200

Client: PB water
MEG Project No.: 3181.01
MEG Project Name: Lake Jesup Sediment

Tested By: MWC/HB
Date Tested: 4/25/02

Sample Number	$W_C + S_W$ (grams)	$W_C + S_D$ (grams)	W_C (grams)	Solids Content (percent)	Moisture Content (percent)	$W_C + S_D$ (grams)	-#200 (percent)
bucket 1	345.37	30.72	9.30	6.4%	1469.0%	17.05	63.8%
bucket 6	320.27	31.96	9.30	7.3%	1272.3%	11.34	91.0%
bucket 7	318.12	31.37	8.54	7.4%	1256.0%	11.50	87.0%
bucket 8	303.46	32.16	9.21	7.8%	1182.1%	11.69	89.2%
bucket 9.	305.33	25.92	8.49	5.9%	1603.0%	11.50	82.7%
bucket 11	313.35	35.23	8.42	8.8%	1037.4%	28.41	25.4%
bucket 12	311.97	51.53	8.63	14.1%	607.1%	36.92	34.1%
bucket 16	321.25	63.10	9.25	17.3%	479.4%	45.67	32.4%
bucket 19	300.40	30.52	8.37	7.6%	1218.4%	12.74	80.3%
bucket 21	300.34	26.54	8.41	6.2%	1510.2%	12.28	78.7%
bucket 24	284.07	26.68	8.33	6.7%	1402.7%	10.39	88.8%
bucket 26	250.09	32.33	8.21	10.0%	902.8%	14.59	73.5%
bucket 30	295.46	31.95	8.56	8.2%	1126.6%	11.58	87.1%

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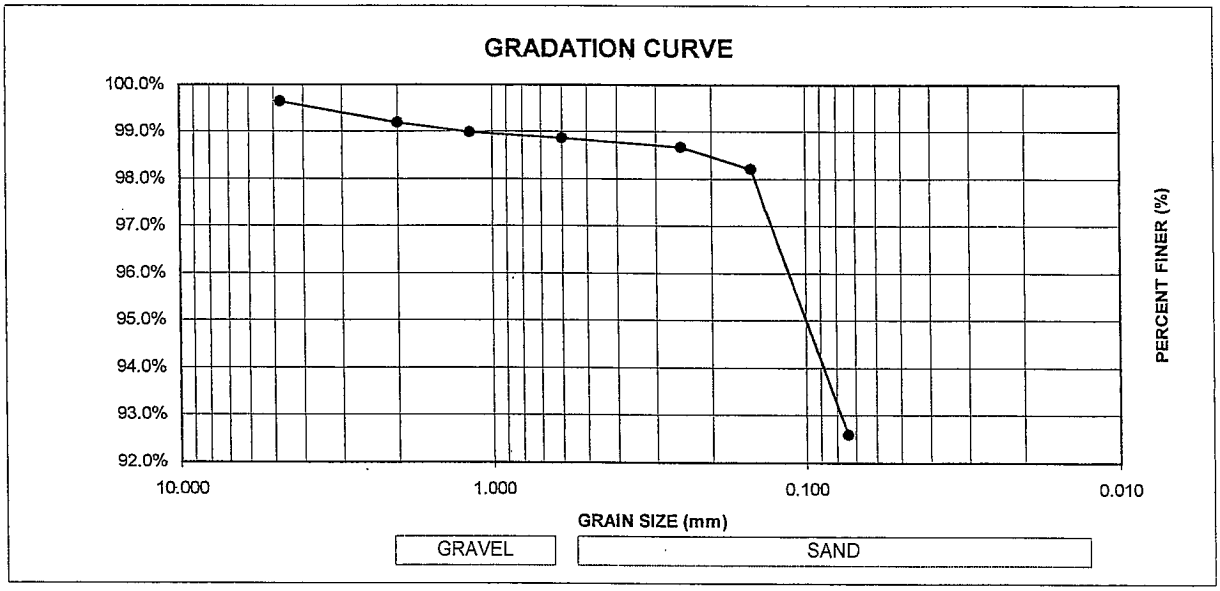
GRADATION ANALYSIS

PROJECT NAME:	Lake Jesup	**SAMPLE NO.:**	Bucket #2
PROJECT NO.:	3181	**DATE PERFORMED:**	05/17/02
SOIL DESCRIPTION:	Lake Sediment	**PERFORMED BY:**	hb

Wt. dry soil before wash (g) 74.05

Sieve Number	Opening (mm)	W_c + Soil	W_c	Accum Wt.	Percent Finer
4	4.750	8.60	8.34	0.26	99.6%
10	2.000	9.69	9.36	0.59	99.2%
16	1.180	8.75	8.59	0.75	99.0%
30	0.600	8.43	8.34	0.84	98.9%
60	0.250	8.53	8.39	0.98	98.7%
100	0.149	8.75	8.41	1.32	98.2%
200	0.074	12.54	8.38	5.48	92.6%
PAN		68.57	0.00	74.05	0.0%



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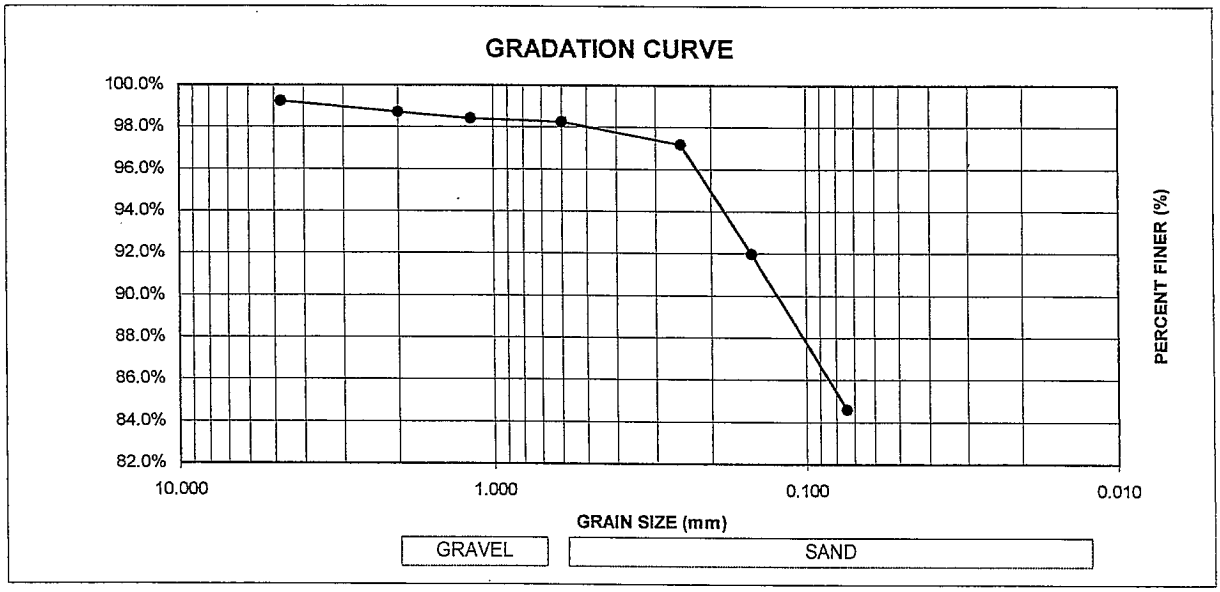
GRADATION ANALYSIS

PROJECT NAME:	Lake Jesup	**SAMPLE NO.:**	Bucket #13
PROJECT NO.:	3181	**DATE PERFORMED:**	05/17/02
SOIL DESCRIPTION:	Lake Sediment	**PERFORMED BY:**	hb

Wt. dry soil before wash (g) 33.70

Sieve Number	Opening (mm)	W_c + Soil	W_c	Accum Wt.	Percent Finer
4	4.750	8.55	8.29	0.26	99.2%
10	2.000	9.30	9.13	0.43	98.7%
16	1.180	8.49	8.38	0.54	98.4%
30	0.600	9.22	9.17	0.59	98.2%
60	0.250	8.80	8.44	0.95	97.2%
100	0.149	11.13	9.38	2.70	92.0%
200	0.074	11.04	8.55	5.19	84.6%
PAN		28.51	0.00	33.70	0.0%



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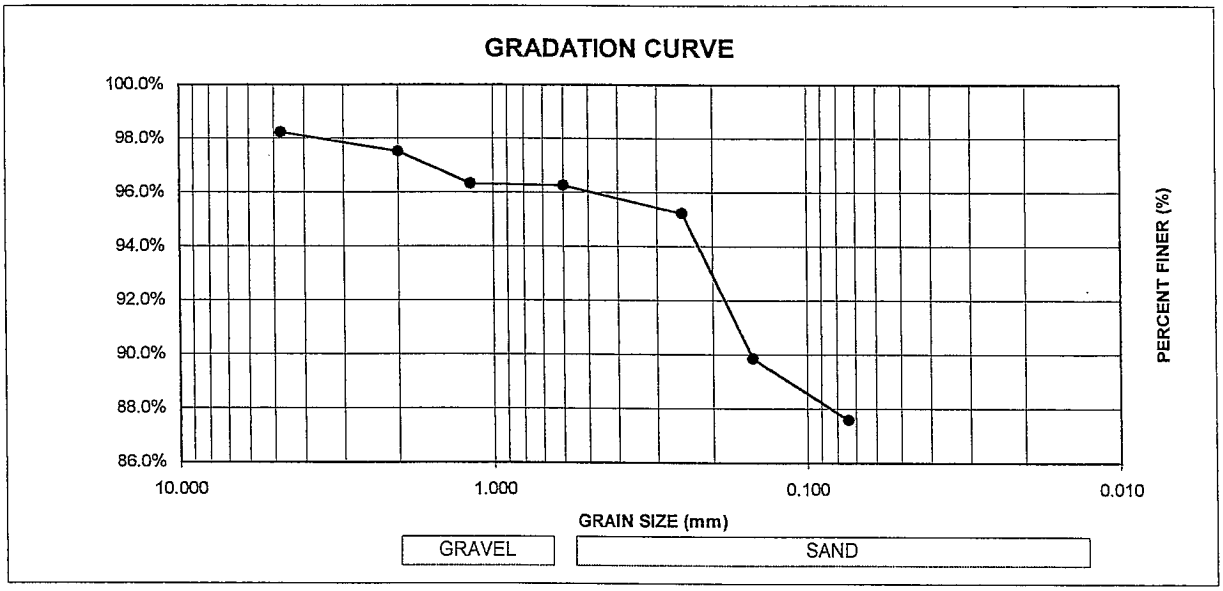
GRADATION ANALYSIS

PROJECT NAME:	Lake Jesup	**SAMPLE NO.:**	Bucket #22
PROJECT NO.:	3181	**DATE PERFORMED:**	05/17/02
SOIL DESCRIPTION:	Lake Sediment	**PERFORMED BY:**	hb

Wt. dry soil before wash (g) 30.00

Sieve Number	Opening (mm)	W_c + Soil	W_c	Accum Wt.	Percent Finer
4	4.750	8.82	8.29	0.53	98.2%
10	2.000	9.34	9.13	0.74	97.5%
16	1.180	8.74	8.38	1.10	96.3%
30	0.600	9.19	9.17	1.12	96.3%
60	0.250	8.80	8.49	1.43	95.2%
100	0.149	10.91	9.30	3.04	89.9%
200	0.074	9.23	8.55	3.72	87.6%
PAN		26.28	0.00	30.00	0.0%



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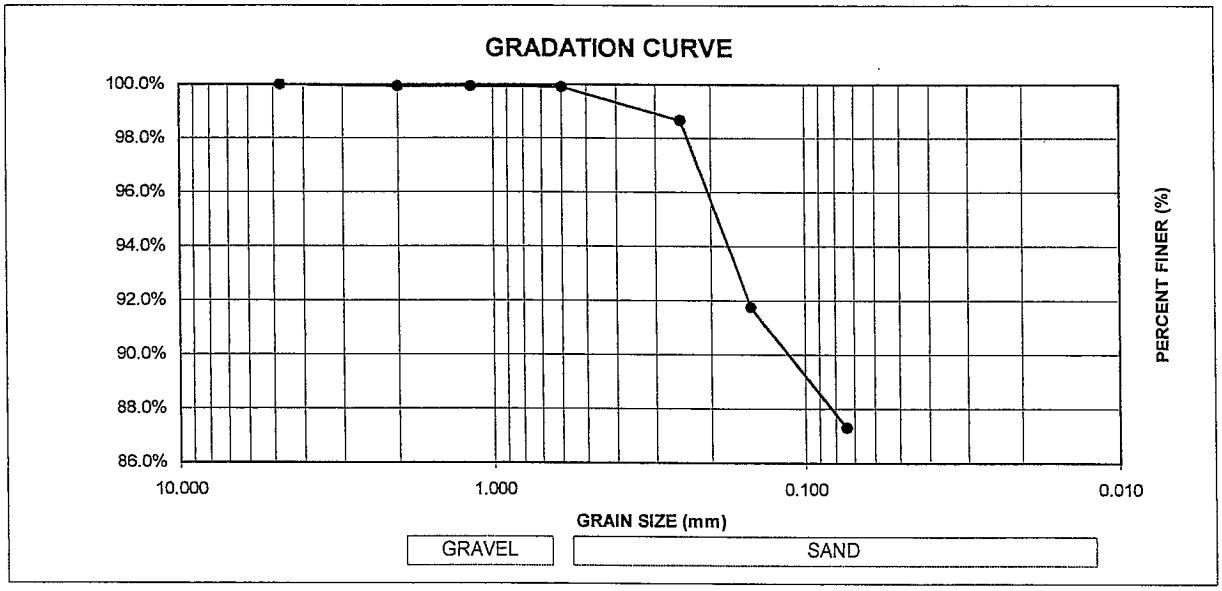
GRADATION ANALYSIS

PROJECT NAME:	Lake Jesup	**SAMPLE NO.:**	Bucket #23
PROJECT NO.:	3181	**DATE PERFORMED:**	05/17/02
SOIL DESCRIPTION:	Lake Sediment	**PERFORMED BY:**	hb

Wt. dry soil before wash (g) 113.15

Sieve Number	Opening (mm)	W_c + Soil	W_c	Accum Wt.	Percent Finer
4	4.750	0.00	0.00	0.00	100.0%
10	2.000	8.37	8.30	0.07	99.9%
16	1.180	8.40	8.39	0.08	99.9%
30	0.600	9.14	9.10	0.12	99.9%
60	0.250	9.84	8.44	1.52	98.7%
100	0.149	17.18	9.37	9.33	91.8%
200	0.074	13.53	8.49	14.37	87.3%
PAN		98.78	0.00	113.15	0.0%



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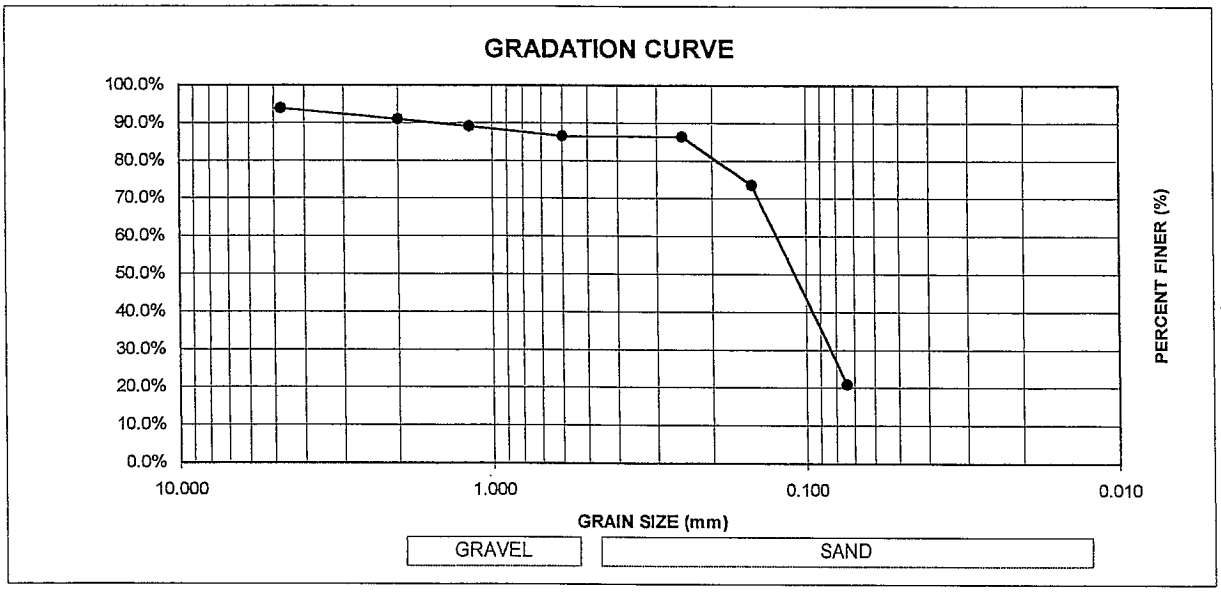
GRADATION ANALYSIS

PROJECT NAME:	Lake Jesup	**SAMPLE NO.:**	Bucket #25
PROJECT NO.:	3181	**DATE PERFORMED:**	05/17/02
SOIL DESCRIPTION:	Lake Sediment	**PERFORMED BY:**	hb

Wt. dry soil before wash (g) 63.82

Sieve Number	Opening (mm)	W_c + Soil	W_c	Accum Wt.	Percent Finer
4	4.750	12.32	8.41	3.91	93.9%
10	2.000	10.27	8.40	5.78	90.9%
16	1.180	10.29	9.14	6.93	89.1%
30	0.600	10.14	8.54	8.53	86.6%
60	0.250	9.64	9.44	8.73	86.3%
100	0.149	16.53	8.42	16.84	73.6%
200	0.074	41.90	8.32	50.42	21.0%
PAN		13.40	0.00	63.82	0.0%



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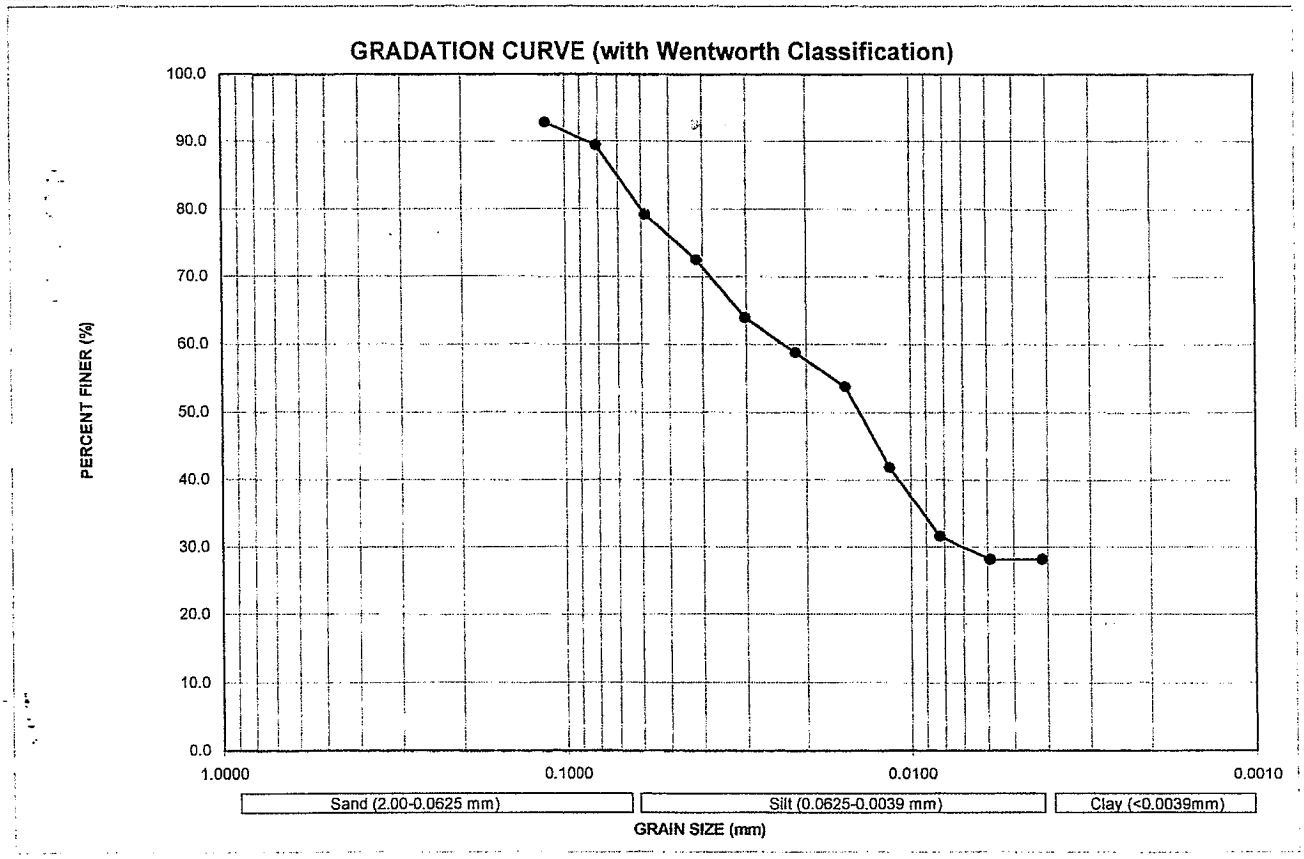
HYDROMETER ANALYSIS WORKSHEET

CLIENT: PB Water
PROJECT #: 3181.01
PROJECT NAME: Lake Jesup

DATE TESTED: 5/31/02
TESTED BY: MWC/HB

Sample No.: bucket #2
Gs : 1.58
Dry weight of soil, Ws (g) : 50.00
Meniscus correction, Fm : 1
Zero correction, Fz : 5
Specific Gravity Correction, a: 1.70

Elapsed Time (min)	Temp C	Hydrometer Reading, R	Temp Correction	R_{cp}	Percent Finer	R_{cL}	L* (cm)	K*	D (mm)
0.25	25	31.0	1.3	27.30	92.8	32.0	11.1	0.0171	0.1139
0.5	25	30.0	1.3	26.30	89.4	31.0	11.2	0.0171	0.0809
1	25	27.0	1.3	23.30	79.2	28.0	11.7	0.0171	0.0585
2	25	25.0	1.3	21.30	72.4	26.0	12.0	0.0171	0.0419
4	25	22.5	1.3	18.80	63.9	23.5	12.5	0.0171	0.0302
8	25	21.0	1.3	17.30	58.8	22.0	12.7	0.0171	0.0215
16	25	19.5	1.3	15.80	53.7	20.5	13.0	0.0171	0.0154
30	25	16.0	1.3	12.30	41.8	17.0	13.5	0.0171	0.0115
60	25	13.0	1.3	9.30	31.6	14.0	14.0	0.0171	0.0083
120	25	12.0	1.3	8.30	28.2	13.0	14.2	0.0171	0.0059
240	25	12.0	1.3	8.30	28.2	13.0	14.2	0.0171	0.0042



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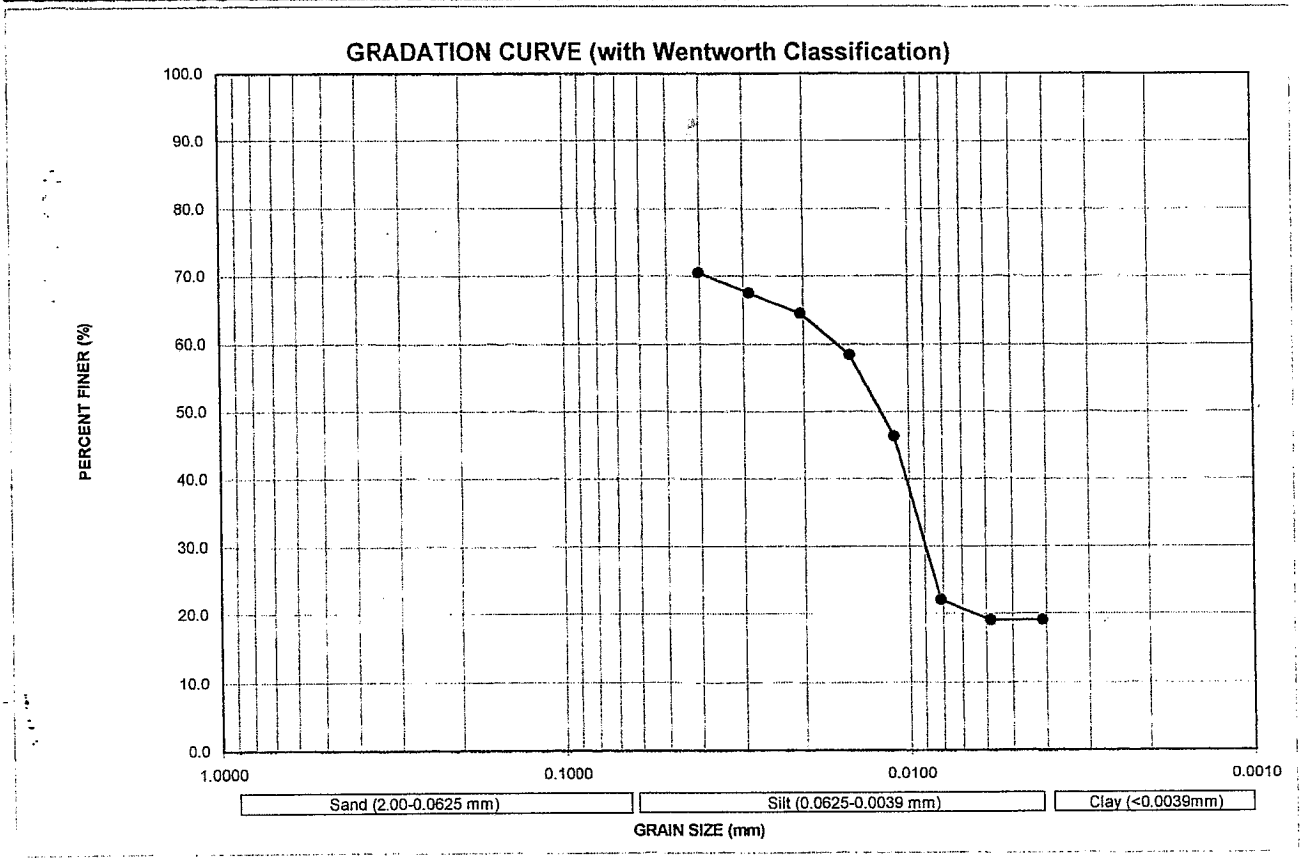
HYDROMETER ANALYSIS WORKSHEET

CLIENT: PB Water
PROJECT #: 3181.01
PROJECT NAME: Lake Jesup

DATE TESTED: 5/31/02
TESTED BY: MWC/HB

Sample No.: **bucket #13**
Gs : **1.70**
Dry weight of soil, Ws (g) : **50.00**
Meniscus correction, Fm : **1**
Zero correction, Fz : **5**
Specific Gravity Correction, a: **1.51**

Elapsed Time (min)	Temp C	Hydrometer Reading, R	Temp Correction	R_{cp}	Percent Finer	R_{cL}	L* (cm)	K*	D (mm)
2	25	27.0	1.3	23.30	70.5	28.0	11.7	0.0167	0.0404
4	25	26.0	1.3	22.30	67.4	27.0	11.9	0.0167	0.0288
8	25	25.0	1.3	21.30	64.4	26.0	12.0	0.0167	0.0205
16	25	23.0	1.3	19.30	58.4	24.0	12.4	0.0167	0.0147
30	25	19.0	1.3	15.30	46.3	20.0	13.0	0.0167	0.0110
60	25	11.0	1.3	7.30	22.1	12.0	14.3	0.0167	0.0082
120	25	10.0	1.3	6.30	19.1	11.0	14.5	0.0167	0.0058
240	25	10.0	1.3	6.30	19.1	11.0	14.5	0.0167	0.0041



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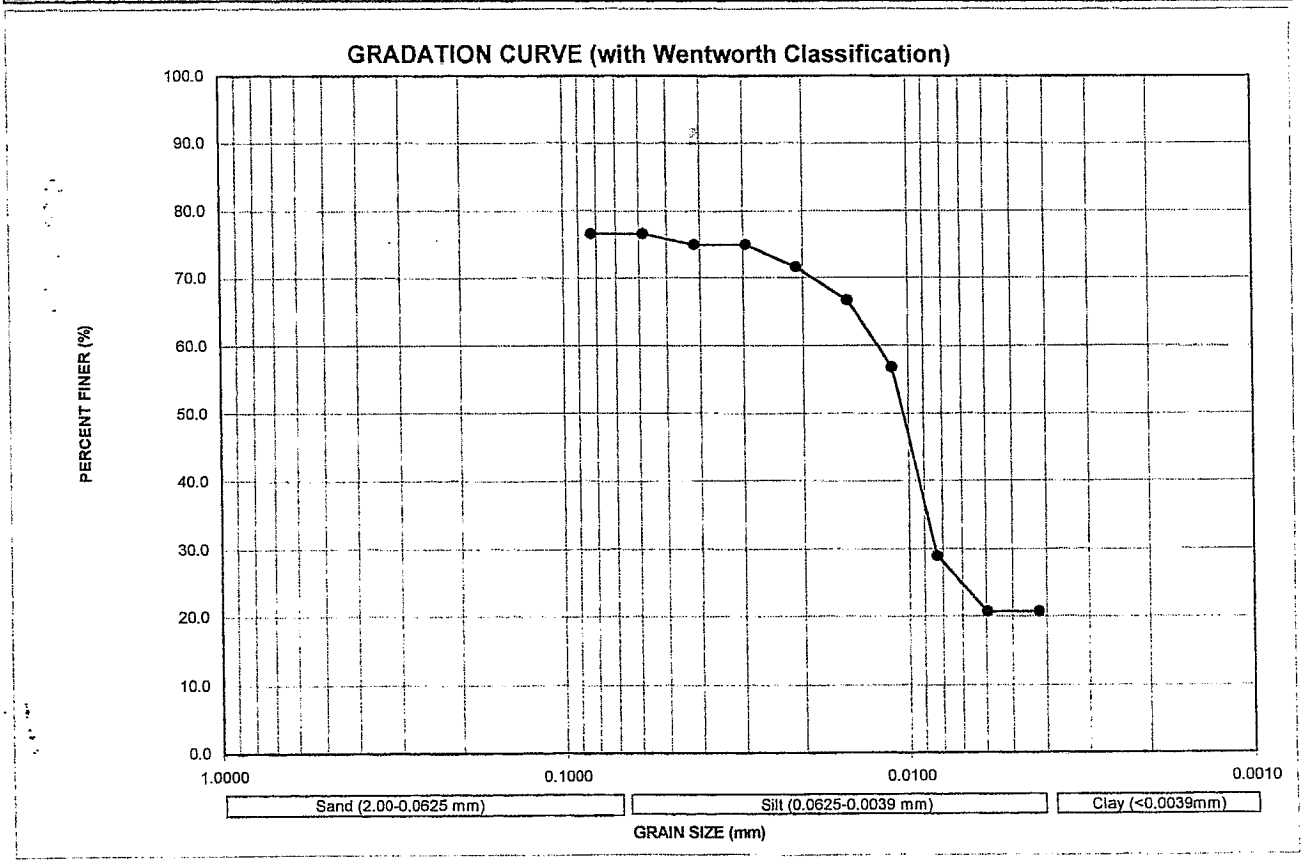
HYDROMETER ANALYSIS WORKSHEET

CLIENT: PB Water
PROJECT #: 3181.01
PROJECT NAME: Lake Jesup

DATE TESTED: 5/31/02
TESTED BY: MWC/HB

Sample No.: bucket #23
Gs : 1.61
Dry weight of soil, Ws (g) : 50.00
Meniscus correction, Fm : 1
Zero correction, Fz : 5
Specific Gravity Correction, a: 1.64

Elapsed Time (min)	Temp C	Hydrometer Reading, R	Temp Correction	R_{cp}	Percent Finer	R_{cL}	L* (cm)	K*	D (mm)
0.50	25	27.0	1.3	23.30	76.6	28.0	11.7	0.0171	0.0827
1.0	25	27.0	1.3	23.30	76.6	28.0	11.7	0.0171	0.0585
2	25	26.5	1.3	22.80	74.9	27.5	11.9	0.0171	0.0417
4	25	26.5	1.3	22.80	74.9	27.5	11.9	0.0171	0.0295
8	25	25.5	1.3	21.80	71.6	26.5	12.0	0.0171	0.0209
16	25	24.0	1.3	20.30	66.7	25.0	12.2	0.0171	0.0149
30	25	21.0	1.3	17.30	56.8	22.0	12.7	0.0171	0.0111
60	25	12.5	1.3	8.80	28.9	13.5	14.2	0.0171	0.0083
120	25	10.0	1.3	6.30	20.7	11.0	14.5	0.0171	0.0059
240	25	10.0	1.3	6.30	20.7	11.0	14.5	0.0171	0.0042



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Atterburg Limits - Carbonate Content - Specific Gravity

PROJECT NAME: Lake Jesup
PROJECT NO.: 3181
SOIL DESCRIPTION: Lake Sediment
DATE PERFORMED: 06/12/02
PERFORMED BY: MWC/Pembroke

Sample ID (Bucket #)	Atterburg Limits		Carbonate Content (mg/l)	Specific Gravity (Dry)
	Liquid Limit	Plastic Limit		
2	NP	NP	<.1	1.58
13	NP	NP	0.60	1.70
22	NP	NP	1.40	1.63
23	NP	NP	0.39	1.61
25	NP	NP	0.28	1.14

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MOISTURE CONTENT / PERCENT ORGANIC CONTENT

Client: P B WATER

MEG Project No.: 3181.01 Date Tested: 5/3/2002

Project Name: LK Jesup Tested By: MWC

SOLIDS/MOISTURE CONTENT								ORGANIC CONTENT					
Sample Number	c ID	W_C (grams)	W_C + SW (grams)	W_C + SD (grams)	S_D (grams)	Solids Content (percent)	Moisture Content (percent)	fC ID	W_{fC} (grams)	Wfc + S_D (grams)	W_{fc+} S_{FD} (grams)	Organic Loss (grams)	Organic Content (percent)
2 2'-3'	AA	9.28	93.04	24.20	14.9	17.8%	461.4%	1	50.76	63.66	60.66	3.0	23.26
5 6" -12"	BB	9.26	101.58	24.31	15.1	16.3%	513.4%	2	52.25	64.80	61.54	3.3	25.98
6 1'-2'	CC	8.51	94.13	22.34	13.8	16.2%	519.1%	3	52.93	61.63	59.67	2.0	22.53
7 1' - 2'	DD	9.18	122.37	36.05	26.9	23.7%	321.3%	4	50.62	68.47	65.27	3.2	17.93
10 6" -12"	EE	8.5	91.35	27.5	19.0	23.0%	335.4%	1	50.8	70.33	66.0	4.3	22.07
13 0 -18"	FF	8.4	89.28	18.0	9.6	11.9%	743.6%	2	52.3	62.11	59.5	2.6	26.37
16 6" -12"	GG	8.6	79.06	23.0	14.4	20.4%	389.4%	3	52.9	67.80	64.7	3.1	20.65
17 0 -6"	II	8.2	116.56	16.9	8.7	8.0%	1150.8%	4	50.6	59.62	56.7	2.9	32.33
20 6" -12"	JJ	8.4	55.31	21.9	13.4	28.7%	249.0%	1	50.8	64.45	62.3	2.2	16.07
22 6" -12"	KK	8.3	95.0	14.1	5.8	6.7%	1400.7%	2	52.3	58.10	55.6	2.5	42.22
23 2' -3'	MM	8.5	110.7	32.9	24.4	23.9%	318.5%	3	52.9	77.54	72.6	4.9	20.07
25 0 -6"	NN	8.4	102.7	42.5	13.8	36.1%	176.6%	4	50.6	84.45	78.7	5.7	16.88
27 1' -2'	OO	8.5	103.6	22.8	26.9	15.0%	565.8%	1	50.8	65.91	61.9	4.0	26.47
29 6" -12"	PP	8.5	70.3	16.6	26.9	13.0%	666.5%	2	52.3	60.75	58.0	2.8	32.35

W= Weight C= Container S= Soil W=Wet D= Dry f= furnace

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MOISTURE CONTENT / PERCENT ORGANIC CONTENT

Client: PB Water

MEG Project No.: 3181

Project Name: Lake Jessup

Date Tested: 6/24/02

Tested By: AMM

SOLIDS/MOISTURE CONTENT								ORGANIC CONTENT					
Sample Number	C ID	W_C (grams)	W_C + SW (grams)	W_C + SD (grams)	S_D (grams)	Solids Content (percent)	Moisture Content (percent)	fC ID	W_{fC} (grams)	Wfc + S_D (grams)	W_{fc+} S_{FD} (grams)	Organic Loss (grams)	Organic Content (percent)
Bucket 2		16.92	483.50	55.43	38.5	8.3%	1111.6%		52.25	110.05	93.09	17.0	29.34
Bucket 13		16.72	494.30	57.82	41.1	8.6%	1062.0%		50.64	112.72	96.26	16.5	26.51
Bucket 22		17.59	510.60	51.83	34.2	6.9%	1339.9%		52.95	110.01	90.60	19.4	34.02
Bucket 23		17.66	473.5	49.74	32.1	7.0%	1320.9%		50.74	109.94	90.47	19.5	32.89
Bucket 25		16.6	617.4	139.3	122.8	20.4%	389.4%		50.6	103.50	93.7	9.8	18.54

W= Weight C= Container S= Soil W=Wet D= Dry f= furnace

Lake Jesup Aquatic Enhancement Project
RFP Number FWC 01/02-17
PB Project Number 25508A

Field Sediment Sample Collection Points
Final Core Locations

Location ID	State-Plane Coordinates NAD27 in feet Florida East Zone		State-Plane Coordinates NAD83 in feet Florida East Zone		UTM Coordinates NAD83 in meters Zone 17		Sediment and Water Samples Collected				
	Northing (feet)	Easting (feet)	Northing (feet)	Easting (feet)	Northing (meters)	Easting (meters)	5-Gallon Sediment Buckets for Physical Testing [1],[2] (each)	1-Pt Jar Sediment Sub-samples for Physical Testing [1] (each)	5-Gallon Sediment Buckets for Elutriate Testing [3] (each)	5-Gallon Water Buckets for Elutriate Testing [3] (each)	Sediment Jars for Beneficial Use Analysis Chemical Testing [4] (each)
1	1,616,452	442,535	1,616,618	598,772	3,183,710	482,512	1	1			2
2	1,613,538	443,536	1,613,704	599,773	3,182,822	482,817	1	6			
3	1,610,062	442,447	1,610,228	598,683	3,181,763	482,485	1	4			
4	1,607,791	439,168	1,607,957	595,405	3,181,071	481,486	1	4	1	1	
5	1,607,519	441,383	1,607,684	597,620	3,180,988	482,161	1	4			
6	1,604,798	443,667	1,604,964	599,904	3,180,159	482,857	1	5			
7	1,602,868	439,079	1,603,034	595,316	3,179,571	481,459	1	4			
8	1,599,600	441,091	1,599,765	597,328	3,178,575	482,072	1	4			
9	1,600,699	434,964	1,600,865	591,200	3,178,910	480,205	1	3			
10	1,598,664	435,939	1,598,830	592,175	3,178,290	480,502	0	3			
11	1,597,010	438,807	1,597,176	595,044	3,177,786	481,376	1	2	1	1	2
12	1,603,272	431,363	1,603,438	587,600	3,179,694	479,108	1	2			
13	1,600,666	430,461	1,600,832	586,698	3,178,900	478,833	1	2			
14	1,596,469	431,876	1,596,634	588,112	3,177,621	479,264	1	2			
15	1,593,804	434,970	1,593,969	591,207	3,176,809	480,207	1	3			
16	1,601,756	426,972	1,601,921	583,209	3,179,232	477,770	1	5			2
17	1,590,893	434,498	1,591,058	590,734	3,175,922	480,063	1	3			
18	1,595,619	424,288	1,595,784	580,524	3,177,362	476,952	0	1			
19	1,593,249	426,674	1,593,415	582,910	3,176,640	477,679	1	4			
20	1,592,031	430,458	1,592,197	586,694	3,176,269	478,832	0	2			
21	1,590,249	426,132	1,590,415	582,369	3,175,726	477,514	1	2			
22	1,590,719	423,507	1,590,884	579,743	3,175,869	476,714	1	5	1	1	
23	1,590,489	419,716	1,590,654	575,952	3,175,799	475,559	1	4			
24	1,588,566	420,737	1,588,731	576,973	3,175,213	475,870	1	5	1	1	
25	1,588,054	419,352	1,588,219	575,588	3,175,057	475,448	1	2			2
26	1,592,291	417,327	1,592,456	573,563	3,176,348	474,831	1	3			
27	1,595,576	415,781	1,595,741	572,017	3,177,349	474,360	1	4			
28	1,593,045	412,528	1,593,211	568,765	3,176,578	473,369	1	3			
29	1,592,245	408,630	1,592,410	564,866	3,176,334	472,181	1	5	1	1	
30	1,592,921	407,763	1,593,086	564,000	3,176,540	471,917	1	5			2
		TOTALS					27	102	5	5	10

Notes:
(1) Physical testing to be performed by Madrid at their lab in Bartow.
(2) Approximately 5 of these buckets will be selected by PB for delivery by Madrid to UF lab in Gainesville.
(3) Buckets delivered by PB to Environmental Research & Design at their lab in Orlando for elutriate/alum testing.
(4) Sample jars delivered by PB to PC&B Environmental Laboratories in Oviedo for beneficial use testing.

APPENDIX D

Final Report on Sediment Dewatering Tests/
Performance of Polymer and/or Alum
Lake Jesup Aquatic Enhancement Project
Dr. Hassan El-Shall, University of Florida, July 2002

Final Report

On
Sediment Dewatering Tests/ Performance of Polymer and / or Alum
Lake Jesup Aquatic Enhancement Project

Submitted by

Dr. Hassan El-Shall

To

Parsons Brinckerhoff Quade & Douglas, Inc (PBQD)
100 East Pine Street, Suite 500
Orlando, FL 32801

July 1, 2002

Introduction

Nine 5-gallon buckets of lake-bottom sediment samples were obtained from different locations at Lake Jesup (Table 1). In addition, three buckets of Lake Jesup water were obtained to be used for dilution of the sediment samples. Three composite sediment samples (A, B, and C), representative of the eastern, central, and western portions of the lake, respectively, were created by mixing and thoroughly homogenizing the bucket samples, as shown in Table 1 below.

Table 1 : Composite samples created from received samples

Composite Sample	Bucket / Site No.	Sampling date
A (East)	3	4-23-02
	4	4-23-02
	5	4-23-02
B (Central)	14	4-24-02
	15	4-24-02
	17	4-24-02
C (West)	27	4-24-02
	28	4-24-02
	29	4-24-02

- According to the agreement with Parsons Brinckerhoff (PB), we were supposed to conduct one column settling test on each of the three composite-samples A, B, and C (after dilution) for a period of 3 weeks, and record the height of the "B" line and "Mud" line, if visible. Also, we were to test the effect of alum and/ or polymer on clarification of supernatants taken after 3 days of settling. In addition, several other measurements were to be made such as solids content, organic content, and total carbon content.

Following is the list of analyses carried out on the samples and the results obtained.

- Settling test with column heights 6, 5, and 4 feet for samples A, B, and C respectively. Extract 40 to 50 gram sample from test probes (located at 1-foot intervals along settling column) after 1, 5, and 15 days from the start of the test.
- Solids content determination.
- Testing alum dosage needed to reduce turbidity of supernatant collected after 3 days.
- Testing different polymers at different dosages needed to reduce turbidity of supernatant collected after 3 days.
- Solids, organic and total carbon content determination.
- Washing of settled fraction of each column on 200-mesh screen and determination of the percentage of mass finer than 200 mesh.

All the above tests are needed to provide a comprehensive picture about the behavior of received sludge samples.

Following is a description of the laboratory experiments conducted on the supplied sludge samples.

Results and Discussion

1) Mixing of Samples

The received samples were in three buckets each and were not homogeneous (see Table 1). Settling of the solids had taken place and hence in order to obtain a uniform sample for the experiments, the buckets were stirred using a Lightnin Mixer (Model L1U08F). The buckets were mixed before obtaining samples for each of the experiments described below. The buckets no. 3, 4, and 5 were mixed to get sample A; buckets no. 14, 15, and 17 were mixed to get sample B; and buckets no. 27, 28, 29 were mixed to get sample C.

2) Solids Content

Samples were obtained from each composite sample and placed in pre-weighed 250-ml glass beakers. The weight of the sludge in the beakers was determined, and then the beakers were covered with perforated aluminum foils and placed in a drying oven at 100 °C for 24 hours to remove water. After drying, the beakers with the dried solids were weighed and the weight of the dried solids was determined. The weights of the sludge and the dried solids were then used to calculate the percent solids for each composite sample, and the results obtained are shown in Table 2 below.

Table 2. Solids Content of the Samples

Composite	Pre-Dilution Solids Content* (%)	Diluted Solids Content** (%)
A	8.89	5.2
B	13.58	4.9
C	11.35	5.0

*From as-received samples, following mixing and removal of shell.
**Following dilution of composite samples using lake water.

3) Column Settling Test

Prior to the column settling test, each composite sample of A, B, and C was thoroughly mixed, sieved using #10 mesh to remove the shells, diluted by adding lake water until a solids content of approximately 5 percent was obtained (see Table 2), then transferred into 6, 5, and 4-foot-high columns (5.75 inch, I.D) respectively. The settling behavior was observed to study settling under the solids self-weight. The sediment height was noted periodically in order to quantify the settling rate of all the samples. The sediment height is plotted in Figures 1, 2, and 3 as a function of the settling time. All collected data (height in feet and time in hours) are given in Appendix I for reference.

From Figure 1 and the data in the appendix, it can be seen that settling of sample A occurs very fast. This can be depicted from the change in sediment height from 6 feet to 3 feet, half the column height, within 12-15 hours and the sediment level reaches a constant value approximately after one day. The final height, after three weeks, is about 2.1 feet, which is about one-third the column height.

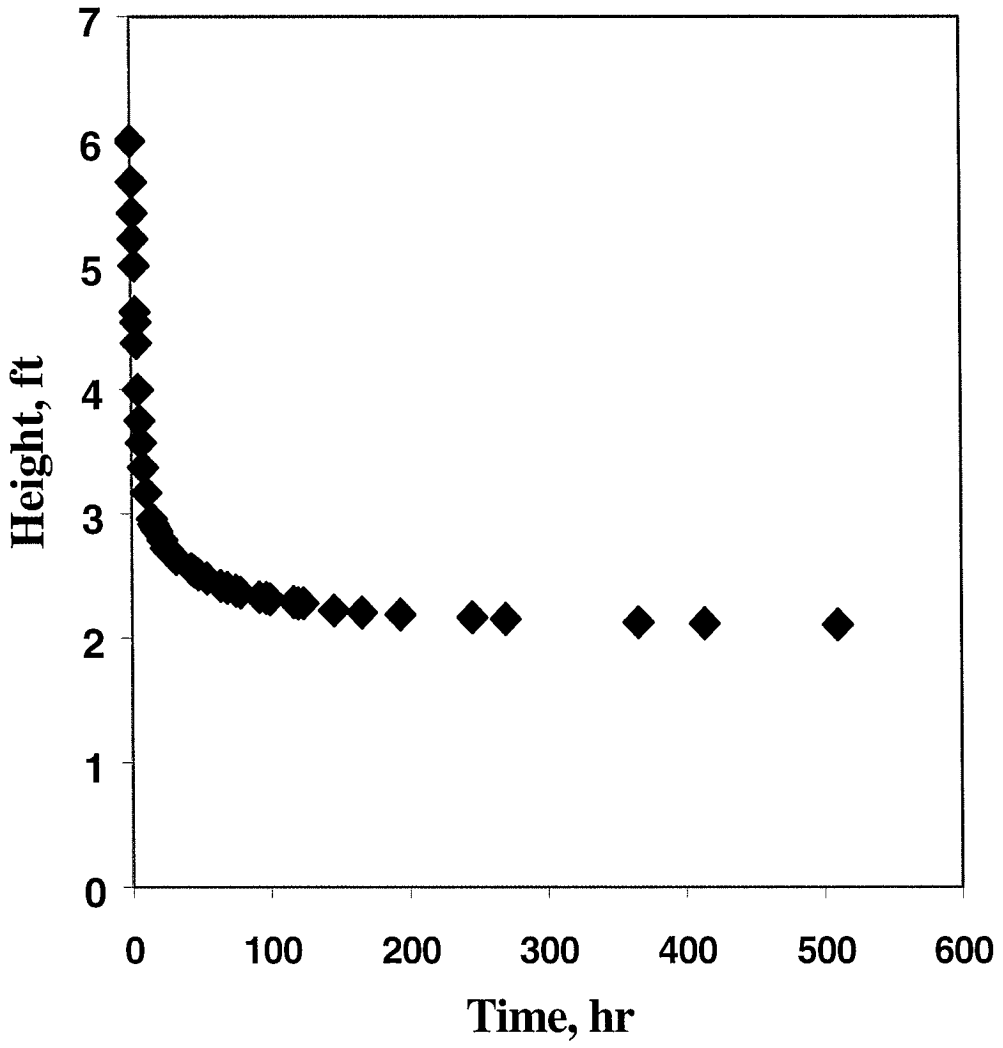

Figure 1. Settling rate of 5-wt% samples in 6 ft. high column, Sample A

From Figure 2, the settling rate of sample B is very fast within the first 5 hours then becomes slower until the sediment level reaches a constant value after a settling time of about 30 hours. The sediment height changes from 5 feet to 2.5 feet within 10 hours. The final height, after three weeks, is about 1.63 feet, which is 33% of the original settling height.

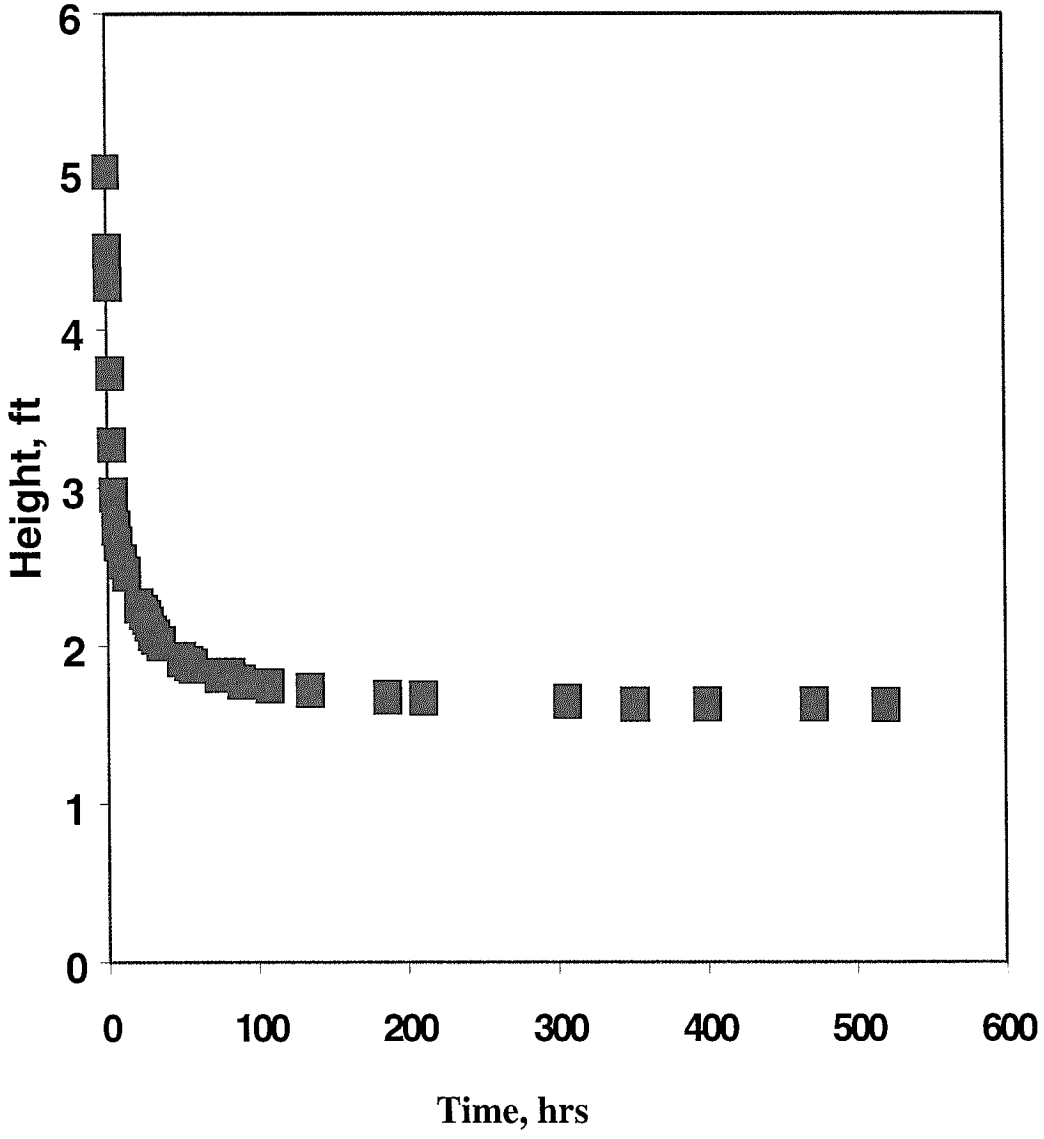

Figure 2. Settling rate of 5-wt% samples in 5 ft. high column, Sample B

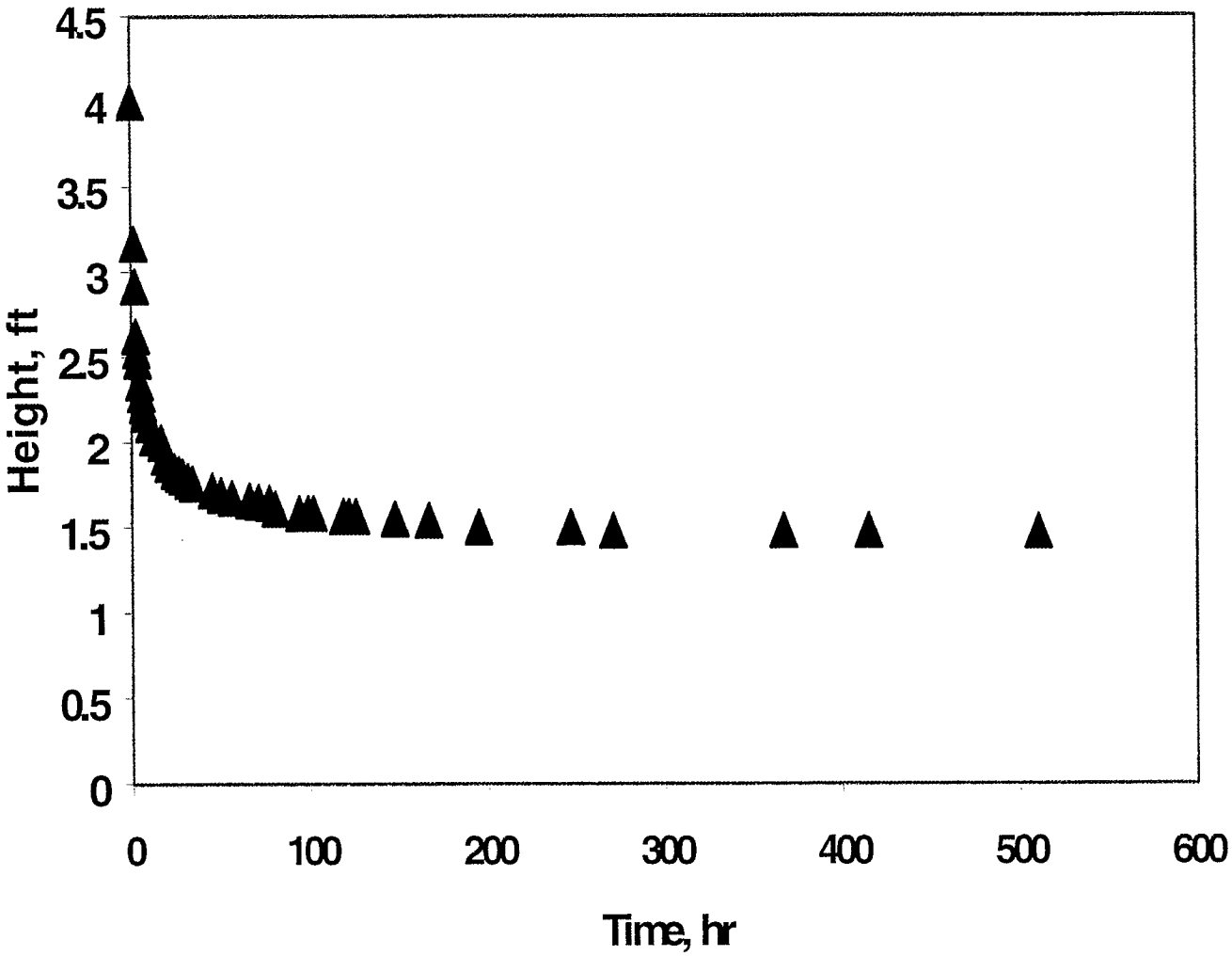

Figure 3. Settling rate of 5-wt% samples in 4 ft. high column, Sample C

From Figure 3, the settling rate of sample C, similar to A and B, occurs very fast and the sediment height is 1.5 feet lower within the first 5-6 hours. Also, the sediment height changes from 4 feet to 2 feet within 14 hours. The sediment level reaches an approximate constant value after 20 hours. The final height, after three weeks, is about 1.48 feet, which is 37% of the original settling height.

For comparison, the settling curves of the three samples are plotted in Figure 4, which illustrates that the settling rate of the three samples is approximately similar. Sample B lies mid-way between samples A and C in the first 15 hours then becomes closer to the settling curve of sample C than A. Also, we may conclude that all the samples reach a constant level after one day of settling.

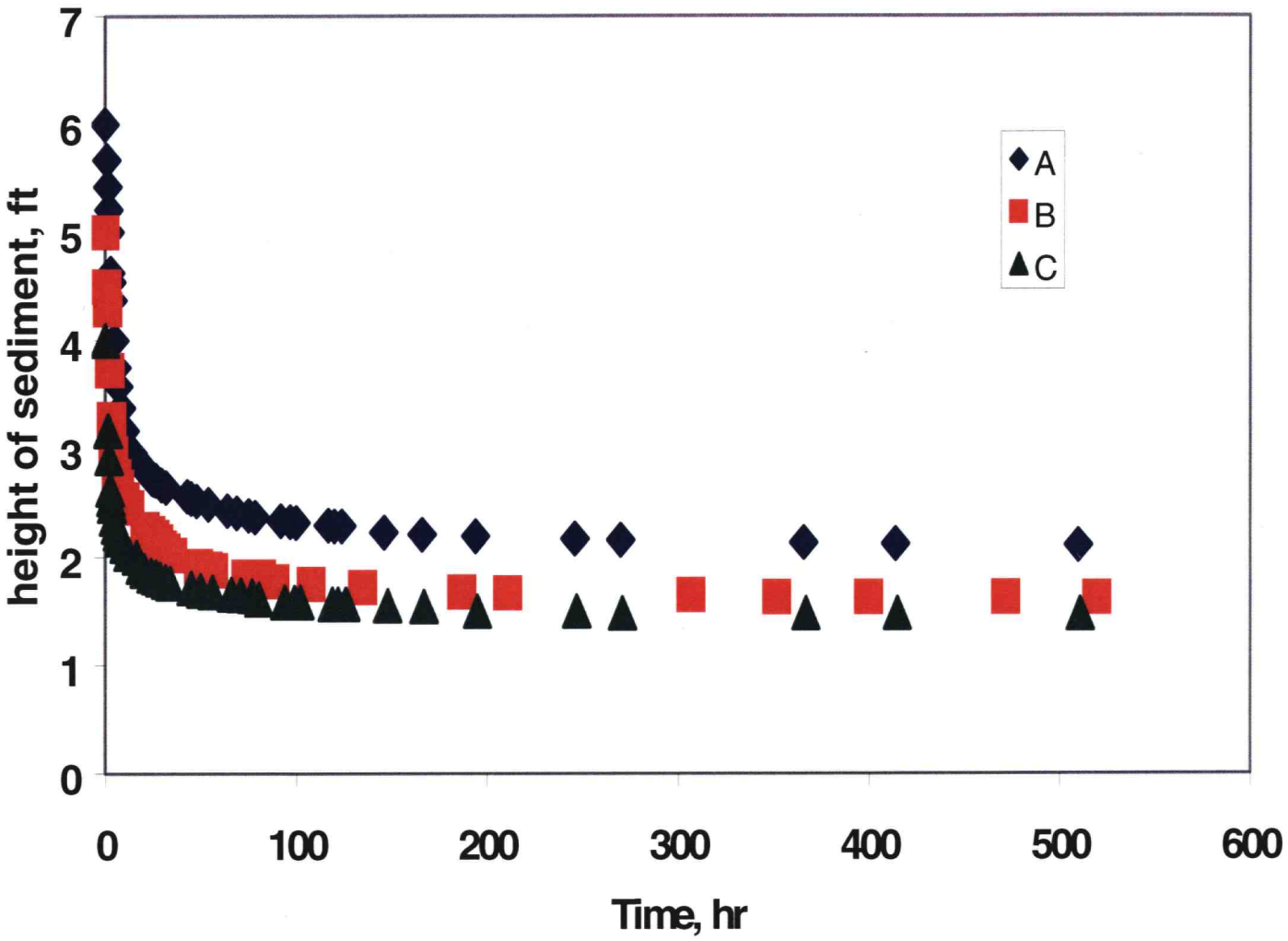

Figure 4. The settling rate of the three composite samples A, B, and C

The solids weight percentage at different heights in the column (at various settling times) was calculated from the collected samples and reported in Table 3.

Table 3. Solids content of Settled Mass at Different Heights after 1, 5, and 15 days of Settling in Various Columns

Sample	Height in the Column, Feet	Solid Content, % after 1 day	Solid Content, % after 5 days	Solid Content, % after 15 days
A	5.5	0.2	0.2	0.2
	4.5	1.2	0.3	0.25
	3.5	1.2	0.8	0.33
	2.5	5.9	2.8	0.35
	1.5	7.6	9.2	9.37
	0 (bottom)	8.1	12.0	16.94
B	4.5	0.1	0.05	0.05
	3.5	0.1	0.1	0.1
	2.5	0.2	0.1	0.1
	1.5	6.1	6.0	0.84
	0 (bottom)	14.2	11.4	16.60
C	3.5	0.3	0.2	0.15
	2.5	0.3	0.2	0.15
	1.5	4.0	8.6	2.1
	0.5	4.0	9.4	14.1
	0 (no probe)	----	-----	---

It is interesting to note that solids content in the column above 1.5 feet is very low in all columns. This indicates high settling rate of most of the solid content with the very fine particles left at a level of less than 1% solids. However, the highest solids content could be only found in the bottom few inches of the settling columns. Thus, it is expected that the average solids content in the bottom 1.0 to 1.5 feet will not be much higher than 10% as indicated by the determined final solids content as reported later.

4) Flocculation Tests on Supernatants

Left over samples after filling the settling columns were set aside in the buckets for a period of 72 hours. Supernatants were withdrawn after 3 days from the samples and the turbidity of these supernatants was measured using Hach Turbidimeter Model 2100AN. The turbidity values are listed in Table 4 below.

Table 4. Supernatant Turbidity (NTU) after 3 days for different samples

Sample	Turbidity (NTU)
A	122
B	172
C	214
Jesup lake water	2.11

Table 4 indicates that the supernatant turbidity increases in sequence of A, B, and C respectively. The high turbidity may be related to the higher organic and carbon content in B and C samples as shown in Tables 9 and 10. Such organic content may lead to the dark color (humate color) of the supernatant. We may consider that the higher the organic content of the sample, the higher the turbidity of the supernatant.

Flocculation tests were carried out on the supernatants in order to improve clarity. Predetermined amounts of Alum and two commercially available polymers Magnafloc-455, and DF 409 from CIBA and Ashland Chemicals respectively, were added to the supernatants while stirring. The beakers and its contents were allowed to stand for 24 hours and then the turbidity was measured and compared to the initial turbidity of the supernatant. The turbidities values are listed in Tables 5, 6, and 7.

Table 5. Supernatant Clarity (Turbidity in NTU) as a Function of Alum Dosage

Sample (Supernatant)	Alum Dosage (ppm)				
	0 (Initial)	20	50	100	150
A	122	110	47.1	9.9	4.9
B	172	144	61.0	18.8	10.1
C	214	176	49.2	5.97	1.80

Table 6. Supernatant Clarity (Turbidity in NTU) as a Function of Magnafloc-455 Dosage

Sample (Supernatant)	Magnafloc-455 Dosage (ppm)				
	0 (Initial)	1	3	5	10
A	122	110	48.9	23.1	13.0
B	172	133	97.0	45.9	26.5
C	214	170	104	49.4	44.3

Table 7. Supernatant Clarity (Turbidity in NTU) as a Function of DF409 Dosage

Sample (Supernatant)	DF409 Dosage (ppm)				
	0 (Initial)	1	3	5	10
A	122	107	80.6	17.5	2.0
B	172	172	132	51.0	13.5
C	214	212	119	42.3	4.49

The data in Tables 5, 6, and 7 indicate that all samples respond well to flocculation with any of the tested chemicals. However, as expected, amount of alum needed to achieve same level of clarity is much higher than that of any of the polymers. A small difference is noticed, however, in the response of the samples to the different polymers. This is attributed to the difference in organic content. In any case, it may be concluded that 150 ppm of alum or 10-15ppm of polymers may be used to achieve clarity of less than 10 % turbidity value.

5) Tests on the Settled Solids

After three weeks of settling, all supernatant water and another inch of the solids, was removed. The remaining solids were homogenized, and the following tests were run:

a) Solids Content: The solids content of the settled mass for samples A, B, and C was determined using the procedure mentioned above after completely removing the supernatant with the upper 1 inch of the solids. The solids contents of the samples are listed in Table 8.

Table 8: Solids Content of the Settled Mass

Sample	% Solids (Settled Mass)
A	10.8
B	8.7
C	8.1

b) Organic Content: Samples from the solids dried at 100 °C for 24 hours were used for determining the organic content of each of the samples. Pre-weighed dried samples were placed in porcelain crucibles and placed in a furnace at 300 °C for 8 hours to burn off the organic material contained in these solids. The samples were then weighed and the organic content is calculated as listed in Table 9.

Table 9. Organic Content of the settled mass

Sample	% Organic
A	20.0
B	25.1
C	24.8

c) Total Carbon Content: The solids dried at 100 °C for 24 hours were used for determining the total carbon content of each of the samples. Pre-weighed dried samples were placed in porcelain crucibles, and the organic and the carbonate content of the samples were burnt off by heating in a furnace at 950 °C for 8 hours. The weight loss upon ignition is due to carbon dioxide loss. The weight loss is used to calculate total carbon content using the molecular weight and atomic weight ratio of carbon dioxide and carbon. Loss on ignition (LOI) % and calculated carbon content are given in Table 10.

Table 10. Loss On Ignition (LOI) and Total Carbon Content in the settled mass

Sample	CO_2 (LOI)%*	Total Carbon, %**
A	31.25	8.5
B	35.5	9.7
C	37.4	10.2

* Includes organic content

** Does not include shells removed before conducting the settling test

d) Wash Test on (–200 mesh screen): The settled mass was sieved through a 200 mesh with repeated washing, and the percentage of mass finer that 200 mesh was determined and is listed in Table 11 below.

Table 11. Washing Test on –200 mesh screen

Sample	% -200, by dry weight
A	61.40
B	66.32
C	42.36

It is interesting to see that sample C has lower amount of –200 mesh. Thus, the high turbidity values is not related to the clay content (-200 mesh) as much as related to the organic content in these samples as shown in Table 9.

Conclusions/Recommendations

- Settling tests were conducted on 5% solids content slurry samples prepared from the received samples A, B, and C after separating shells on #10 mesh screen. The data indicate that settling occurs very fast and the sediment level nearly reaches a constant value after 24 hours. The sediment levels after three weeks for A, B, and C are about 33%, 33%, and 37% of the initial height, respectively.

- For sample A, the settling test was conducted in a 6-foot-high (5.75 inch, I.D) column, for three weeks. Final height after 21 days is about 33% of the original height. Solids content at the bottom of the settling column has increased to about 16.9%.

- For sample B, the settling test was conducted in a 5-foot-high (5.75 inch, I.D) column, for three weeks. Final height after 21 days is about 33% of the original height. Solids content at the bottom of the settling column has reached up to 16.6%.

- For sample C, the settling test was conducted in a 4-foot-high (5.75 inch, I.D) column, for three weeks. Final height after 21 days is about 37% of the original height. Solids content at about 6 inch from the bottom of the settling column has increased up to 14.1%.

- Solids content in samples taken above 1.5 feet from the bottom indicated that the slurry contained a small amount of suspended solids, generally less than 1%).

- In order to improve the clarity of the settling pond, Alum can be used as the coagulating agent. Alum dosage of 150 ppm. may be used to achieve a turbidity value less than 10% should be used.

- Cationic polymers can be used to flocculate the sediment from all samples. Specifically, DF 409 and Magnafloc-455 from Ashland Chemicals (Drew Division) and CIBA could be used for that purpose.

- Naturally, lower dosages of polymers (about 10 ppm) can be used to flocculate and clarify the supernatant.

Appendix I

Table: Settling data of columns A, B, and C for three weeks

Time, hr	Height in Settling Column, ft.		
	A	B	C
0	6.00	5.00	4.00
1	5.67	4.50	.....
1.5	5.42	4.29	3.17
2	5.21	.....	2.92
2.5	5.00	3.73	2.63
3	4.63	.....	2.54
3.5	4.54	3.28	2.48
4	4.38	.....	.....
4.5	.....	2.96	2.35
5	4.00	.....	.....
5.5	.....	.....	2.28
6	3.75	2.75	.....
6.5	.....	.....	2.22
7	3.58	.....	.....
7.5	.....	2.65	2.17
8.5	3.38	.....	.....
10	.....	.....	2.11
10.5	3.17	2.53	.....
12	.....	.....	2.03
13	.....	2.46	.....
14.5	2.96	.....	.....
15.5	2.92	.....	.....
16	.....	.....	.....
16.5	2.90	.....	2.00
17.5	2.88	.....	.....
18.5	2.86	.....	1.92
20.5	.....	.....	1.88

Time, hr	Height in Settling Column, ft.		
	A	B	C
21	.....	2.26	.....
22	2.79	.....	.....
24	.....	2.22	1.83
24.5	2.73	.....	.....
25.5	2.72	.....	.....
26	.....	2.18	.....
26.5	2.71	.....	1.82
28	.....	2.14	.....
28.5	.....	.....	1.80
29.5	2.67	.....	.....
30	.....	2.08	.....
31.5	.....	.....	1.78
32	2.64	2.06	.....
34	.....	.....	1.76
35.5	.....	2.02	.....
43	2.56	.....	.....
45	2.54	.....	1.72
48	2.52	.....	.....
49	.....	1.92	.....
50	.....	.....	1.69
54	2.48	1.89	.....
56	.....	.....	1.68
57	.....	1.88	.....
64	2.43	.....	.....
66	.....	.....	1.66
69	2.41	.....	.....
71	.....	.....	1.65
74	.....	1.82	.....

Time, hr	Height in Settling Column, ft.		
	A	B	C
75	2.38	.....	.....
77	.....	1.82	1.64
78.5	2.37	.....	.....
80.5	.....	.....	1.61
82	.....	1.82	.....
89	.....	1.78	.....
92	2.33	.....	.....
94	.....	.....	1.58
97	2.33	.....	.....
99	.....	.....	1.58
100	2.32	.....	.....
102	.....	.....	1.58
108	.....	1.75	.....
117	2.29	.....	.....
119	.....	.....	1.57
120	2.28	.....	.....
122	.....	.....	1.57
124	2.28	.....	.....
126	.....	.....	1.57
135	.....	1.72	.....
146	2.23	.....	.....
148	.....	.....	1.55
166	2.21	.....	.....
167	.....	.....	1.54
187	.....	1.68	.....
194	2.19	.....	.....
195	.....	.....	1.50
211		1.67	.....

Time, hr	Height in Settling Column, ft.		
	A	B	C
246	2.17	.....	.....
247	.....	.....	1.50
270	2.15	.....	.....
271	.....	.....	1.48
307	.....	1.65	.....
352	.....	1.63	.....
366	2.13	.....	.....
367	.....	.....	1.48
400	.....	1.63	.....
414	2.12	.....	.....
415	.....	.....	1.48
472	.....	1.63	.....
510	2.11	.....	.....
511	.....	.....	1.48
520	.....	1.63	.....

APPENDIX E

Elutriate and Chemical Testing of Lake Jesup Unconsolidated Sediment
Environmental Research & Design, Inc., July 2002

E R D

ENVIRONMENTAL RESEARCH & DESIGN, INC.

WATER QUALITY ENGINEERING
3419 TRENTWOOD BOULEVARD ■ SUITE 102 ■ ORLANDO, FLORIDA 32812
TELEPHONE: (407) 855-9465 FAX: (407) 826-0419

July 15, 2002

Mr. A. Dale Helms, P.E.
Parsons Brinckerhoff Quade & Douglas, Inc.
100 East Pine Street, Suite 500
Orlando, FL 32801

RE: Lake Jesup Aquatic Enhancement Project - Elutriate Testing

Dear Dale:

Environmental Research & Design, Inc. (ERD) is pleased to provide the results of the elutriate testing performed on Lake Jesup sediment and water samples in accordance with our Agreement dated April 24, 2002. On April 23rd, ERD received approximately 20 liters of lake bottom sediment and 20 liters of lake water from each of five locations selected by PBQD. On April 25th, composite lake sediment-water samples from all five sites were prepared in accordance with FDEP's "Deepwater Ports Maintenance, Dredging, and Disposal Manual" dated December 1984. The samples were vigorously mixed for 30 minutes and allowed to settle for one hour. Elutriate water was then carefully removed from the composite sediment-water sample and analyzed for the parameters listed in the project contract. As a comparison, lake surface water samples collected at all five locations were also analyzed for the same parameters. The laboratory results for lake water samples and elutriate samples are provided in Tables 1 and 2, respectively.

Elutriate samples had a slightly lower pH and significantly higher concentrations of ammonia, nitrate, total nitrogen, orthophosphorus, and total phosphorus. Elutriate samples also had slightly higher concentrations of BOD, COD, TOC, and monomeric aluminum. At Sites 4 and 22, the elutriate samples had slightly higher concentrations of zinc. Lake water and elutriate samples from all five locations were also analyzed using EPA's Method 8081 and 8141. All results from these methods were below detectable limits. A summary of these results are provided at the end of this letter.

On April 24th, ERD also prepared one composite lake sediment-water sample from all five sites in accordance with FDEP's "Deepwater Ports Maintenance, Dredging, and Disposal Manual" (December 1984). The sample was vigorously mixed for 30 minutes and allowed to settle for one hour. Elutriate water was then carefully removed from the composite sediment-water sample and allowed to settle for seven days. After seven days, the supernatant was carefully removed from the sample and treated with liquid aluminum sulfate at doses of 2.5, 5.0, 10, and 15 mg/l as aluminum. Each alum treated sample was then allowed to settle for 24 hours. The supernatant was carefully removed from the sample and analyzed for the parameters listed in the project contract. The laboratory results from this procedure are provided in Table 3. Alum addition resulted in significant concentration reductions for turbidity, total suspended solids, ammonia nitrogen, orthophosphorus, total phosphorus, BOD, COD, and total aluminum.

We appreciate the opportunity of working with PBQD on this important project. Please give me a call if you have any questions or comments regarding the enclosed information.

Sincerely,

Jeffrey L. Herr, P.E.
Vice President - Engineering

Job No. 02-008
Enclosures: Tables 1-3
Laboratory Result of Analysis Forms

JESUP\HELMS.715

TABLE 1

CHEMICAL CHARACTERISTICS OF LAKE JESUP FILTERED LAKE WATER SAMPLES USED FOR ELUTRIATE TESTING COLLECTED ON 4/23/02

PARAMETER	UNITS	SITE				
		4	11	22	24	29
pH (24 hours)	s.u.	7.72	8.04	8.05	8.07	7.99
Turbidity	NTU	0.7	0.5	1	0.5	0.4
TDS	mg/l	0.69	0.74	0.68	0.66	0.66
VDS	mg/l	0.13	0.15	0.11	0.09	0.15
NH_3	µg/l	25	54	54	54	54
NO_3	µg/l	671	747	717	911	853
Total N	µg/l	1573	1653	1745	1809	1792
Ortho-P	µg/l	14	14	14	14	14
Total P	µg/l	24	27	26	21	25
BOD	mg/l	8.3	7.7	8.3	7.4	7.9
COD	mg/l	12	12	14	12	15
TOC	mg/l	17.2	17.2	17.0	17.0	17.1
Monomeric Al	µg/l	36	36	36	22	133
Cu	µg/l	< 2	< 2	< 2	< 2	< 2
Cd	µg/l	< 1	< 1	< 1	< 1	< 1
Hg	µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Pb	µg/l	< 2	< 2	< 2	< 2	< 2
Zn	µg/l	4	2	4	< 2	7

NOTES:

1. Values with "<" indicate detection limit per FDEP approved QAPP

2. All results are below detectable limits for EPA Methods 8081 and 8141

TABLE 2

CHEMICAL CHARACTERISTICS OF LAKE JESUP FILTERED SEDIMENT ELUTRIATE SAMPLES COLLECTED ON 4/23/02

PARAMETER	UNITS	SITE				
		4	11	22	24	29
pH (24 hours)	s.u.	7.41	7.42	7.01	7.81	7.78
Turbidity	NTU	3.7	9.9	14.0	2.6	6.7
TDS	mg/l	0.84	0.81	0.89	0.66	0.61
VDS	mg/l	0.17	0.15	0.15	0.11	0.12
NH_3	µg/l	352	336	369	431	563
NO_3	µg/l	5168	5333	11,050	3390	2321
Total N	µg/l	5875	6118	13,186	4239	3452
Ortho-P	µg/l	202	350	1024	90	57
Total P	µg/l	273	392	1524	129	80
BOD	mg/l	12.4	12.3	12.5	11.5	24.0
COD	mg/l	20	20	25	17	13
TOC	mg/l	21.2	20.2	19.4	18.4	15.6
Monomeric Al	µg/l	112	278	293	51	97
Cu	µg/l	< 2	4	< 2	2	< 2
Cd	µg/l	< 1	< 1	< 1	< 1	< 1
Hg	µg/l	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Pb	µg/l	< 2	< 2	< 2	< 2	< 2
Zn	µg/l	12	4	10	< 2	7

NOTES:

1. Composite lake sediment/water samples prepared in accordance with FDEP's "Deepwater Ports Maintenance, Dredging, and Disposal Manual" (December 1984)

2. Values with "<" indicate detection limit per FDEP approved QAPP

3. All results are below detectable limits for EPA Methods 8081 and 8141

TABLE 3

RESULTS OF ALUM ADDITION TO COMPOSITE LAKE JESUP SEDIMENT ELUTRIATE SAMPLES

PARAMETER	UNITS	ALUM DOSE (as Al)				
		RAW	2.5 mg/l	5.0 mg/l	10 mg/l	15 mg/l
pH (initial)	s.u.	6.91	6.73	6.61	6.38	6.13
pH (24 hours)	s.u.	6.88	7.16	7.03	6.77	6.65
Turbidity	NTU	47.0	31.0	16.4	5.1	1.1
TSS	mg/l	69.0	61.5	23.8	8.4	1.2
TDS	mg/l	0.87	0.87	0.81	0.77	0.78
NH_3	µg/l	1218	58	54	54	54
NO_3	µg/l	6232	6065	6202	2247	681
Total N	µg/l	8462	8236	7756	7398	7192
Ortho-P	µg/l	440	55	10	14	14
Total P	µg/l	592	354	140	60	25
BOD	mg/l	46	34	14	< 2	< 2
COD	mg/l	48.3	50.2	21.9	4.8	< 3
Total Al	µg/l	1076	1566	536	429	127
Cu	µg/l	3	3	3	< 2	< 2
Cd	µg/l	< 1	< 1	< 1	< 1	< 1
Pb	µg/l	< 2	< 2	< 2	< 2	< 2
Zn	µg/l	4	4	< 2	2	21

NOTES:

1. Composite lake sediment/water sample prepared in accordance with FDEP's "Deepwater Ports Maintenance, Dredging, and Disposal Manual" (December 1984); allowed to settle for 7 days; treated with alum; allowed to settle for 24 hours; and supernatant analyzed

2. Values with "<" indicate detection limit per FDEP approved QAPP

3. All results are below detectable limits for EPA Methods 8081 and 8141

EPA METHODS 8081

AND 8141 RESULTS

Sample Summary

Environmental Research & Design

Lake Jessup

Job No: F13251

Sample Number	Collected Date	Time	By	Received	Matrix Code	Matrix Type	Client Sample ID
F13251-1	05/16/02	15:00	WF	05/17/02	AQ	Ground Water	LAKE JESSUP #4
F13251-2	05/16/02	14:00	WF	05/17/02	AQ	Ground Water	LAKE JESSUP #11
F13251-3	05/16/02	11:00	WF	05/17/02	AQ	Ground Water	LAKE JESSUP #22
F13251-4	05/16/02	13:00	WF	05/17/02	AQ	Ground Water	LAKE JESSUP #24
F13251-5	05/16/02	16:00	WF	05/17/02	AQ	Ground Water	LAKE JESSUP #29
F13251-6	05/16/02	10:00	WF	05/20/02	AQ	Ground Water	COMPOSITE

Report of Analysis

Client Sample ID:	LAKE JESSUP #4		
Lab Sample ID:	F13251-1	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846 8081A SW846 3510C	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	ST14902.D	1	05/23/02	SKW	05/22/02	OP5190	GST551
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	10.0 ml
Run #2		

Pesticide TCL List

CAS No.	Compound	Result	RL	Units	Q
309-00-2	Aldrin	ND	0.050	ug/l	
319-84-6	alpha-BHC	ND	0.050	ug/l	
319-85-7	beta-BHC	ND	0.050	ug/l	
319-86-8	delta-BHC	ND	0.050	ug/l	
58-89-9	gamma-BHC (Lindane)	ND	0.050	ug/l	
5103-71-9	alpha-Chlordane	ND	0.10	ug/l	
5103-74-2	gamma-Chlordane	ND	0.10	ug/l	
60-57-1	Dieldrin	ND	0.050	ug/l	
72-54-8	4,4'-DDD	ND	0.10	ug/l	
72-55-9	4,4'-DDE	ND	0.10	ug/l	
50-29-3	4,4'-DDT	ND	0.10	ug/l	
72-20-8	Endrin	ND	0.10	ug/l	
1031-07-8	Endosulfan sulfate	ND	0.10	ug/l	
7421-93-4	Endrin aldehyde	ND	0.10	ug/l	
53494-70-5	Endrin ketone	ND	0.10	ug/l	
959-98-8	Endosulfan-I	ND	0.050	ug/l	
33213-65-9	Endosulfan-II	ND	0.10	ug/l	
76-44-8	Heptachlor	ND	0.050	ug/l	
1024-57-3	Heptachlor epoxide	ND	0.050	ug/l	
72-43-5	Methoxychlor	ND	0.20	ug/l	
8001-35-2	Toxaphene	ND	2.5	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	78%		47-126%
2051-24-3	Decachlorobiphenyl	75%		13-144%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #4		
Lab Sample ID:	F13251-1	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1 [a]		1	06/04/02	SUB	n/a	n/a	R9707
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	Units	Q
21646-99-1	TEPP	ND	10	ug/l	
62-73-7	Dichlorvos	ND	1.0	ug/l	
7786-34-7	Mevinphos	ND	1.0	ug/l	
8065-48-3	Demeton-S	ND	1.0	ug/l	
13194-48-4	Ethoprop	ND	1.0	ug/l	
298-02-2	Phorate	ND	1.0	ug/l	
300-76-5	Naled	ND	10	ug/l	
3689-24-5	Sulfotep	ND	2.0	ug/l	
333-41-5	Diazinon	ND	1.0	ug/l	
298-04-4	Disulfoton	ND	1.0	ug/l	
60-51-5	Dimethoate	ND	2.0	ug/l	
299-84-3	Ronnel	ND	1.0	ug/l	
150-50-5	Merphos	ND	1.0	ug/l	
2921-88-2	Chlorpyrifos	ND	1.0	ug/l	
55-38-9	Fenthion	ND	2.0	ug/l	
327-98-0	Trichloronate	ND	1.0	ug/l	
298-00-0	Methyl parathion	ND	1.0	ug/l	
121-75-5	Malathion	ND	1.0	ug/l	
34643-46-4	Tokuthion	ND	1.0	ug/l	
56-38-2	Ethyl Parathion	ND	1.0	ug/l	
22248-79-9	Stirophos	ND	1.0	ug/l	
35400-43-2	Bolstar	ND	1.0	ug/l	
115-90-2	Fensulfothion	ND	1.0	ug/l	
2104-64-5	EPN	ND	1.0	ug/l	
86-50-0	Methyl Azinphos	ND	2.0	ug/l	
56-72-4	Coumaphos	ND	1.0	ug/l	
1912-24-9	Atrazine	ND	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
	Trithion	0%		-%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #4		
Lab Sample ID:	F13251-1	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

CAS No.	Compound	Result	RL	Units	Q

(a) Analyzed By Accutest Southeast Subcontract Lab.

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #4		
Lab Sample ID:	F13251-1	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed	By	Method	Prep Method
Mercury	1.0	1.0	ug/l	1	05/21/02	05/24/02	LIR	SW846 7470A	EPA 245.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #4		
Lab Sample ID:	F13251-1	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed By	Method
Total Organic Carbon	21.2	4.0	mg/l	4	06/03/02 ATX	EPA 415.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #11		
Lab Sample ID:	F13251-2	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846 8081A SW846 3510C	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1 [a]	ST14903.D	1	05/23/02	SKW	05/22/02	OP5190	GST551
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	10.0 ml
Run #2		

Pesticide TCL List

CAS No.	Compound	Result	RL	Units	Q
309-00-2	Aldrin	ND	0.050	ug/l	
319-84-6	alpha-BHC	ND	0.050	ug/l	
319-85-7	beta-BHC	ND	0.050	ug/l	
319-86-8	delta-BHC	ND	0.050	ug/l	
58-89-9	gamma-BHC (Lindane)	0.032	0.050	ug/l	J
5103-71-9	alpha-Chlordane	ND	0.10	ug/l	
5103-74-2	gamma-Chlordane	ND	0.10	ug/l	
60-57-1	Dieldrin	ND	0.050	ug/l	
72-54-8	4,4'-DDD	ND	0.10	ug/l	
72-55-9	4,4'-DDE	ND	0.10	ug/l	
50-29-3	4,4'-DDT	ND	0.10	ug/l	
72-20-8	Endrin	ND	0.10	ug/l	
1031-07-8	Endosulfan sulfate	ND	0.10	ug/l	
7421-93-4	Endrin aldehyde	ND	0.10	ug/l	
53494-70-5	Endrin ketone	ND	0.10	ug/l	
959-98-8	Endosulfan-I	ND	0.050	ug/l	
33213-65-9	Endosulfan-II	ND	0.10	ug/l	
76-44-8	Heptachlor	ND	0.050	ug/l	
1024-57-3	Heptachlor epoxide	ND	0.050	ug/l	
72-43-5	Methoxychlor	ND	0.20	ug/l	
8001-35-2	Toxaphene	ND	2.5	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	94%		47-126%
2051-24-3	Decachlorobiphenyl	74%		13-144%

(a) All hits confirmed by dual column analysis.

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #11		
Lab Sample ID:	F13251-2	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1 [a]		1	06/04/02	SUB	n/a	n/a	R9707
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	Units	Q
21646-99-1	TEPP	ND	10	ug/l	
62-73-7	Dichlorvos	ND	1.0	ug/l	
7786-34-7	Mevinphos	ND	1.0	ug/l	
8065-48-3	Demeton-S	ND	1.0	ug/l	
13194-48-4	Ethoprop	ND	1.0	ug/l	
298-02-2	Phorate	ND	1.0	ug/l	
300-76-5	Naled	ND	10	ug/l	
3689-24-5	Sulfotep	ND	2.0	ug/l	
333-41-5	Diazinon	ND	1.0	ug/l	
298-04-4	Disulfoton	ND	1.0	ug/l	
60-51-5	Dimethoate	ND	2.0	ug/l	
299-84-3	Ronnel	ND	1.0	ug/l	
150-50-5	Merphos	ND	1.0	ug/l	
2921-88-2	Chlorpyrifos	ND	1.0	ug/l	
55-38-9	Fenthion	ND	2.0	ug/l	
327-98-0	Trichloronate	ND	1.0	ug/l	
298-00-0	Methyl parathion	ND	1.0	ug/l	
121-75-5	Malathion	ND	1.0	ug/l	
34643-46-4	Tokuthion	ND	1.0	ug/l	
56-38-2	Ethyl Parathion	ND	1.0	ug/l	
22248-79-9	Stirophos	ND	1.0	ug/l	
35400-43-2	Bolstar	ND	1.0	ug/l	
115-90-2	Fensulfothion	ND	1.0	ug/l	
2104-64-5	EPN	ND	1.0	ug/l	
86-50-0	Methyl Azinphos	ND	2.0	ug/l	
56-72-4	Coumaphos	ND	1.0	ug/l	
1912-24-9	Atrazine	ND	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
	Trithion	0%		-%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #11		
Lab Sample ID:	F13251-2	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

CAS No.	Compound	Result	RL	Units	Q

(a) Analyzed By Accutest Southeast Subcontract Lab.

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #11		
Lab Sample ID:	F13251-2	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed	By	Method	Prep Method
Mercury	1.0	1.0	ug/l	1	05/21/02	05/24/02	LIR	SW846 7470A	EPA 245.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #11		
Lab Sample ID:	F13251-2	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed By	Method
Total Organic Carbon	20.2	2.0	mg/l	2	06/03/02 ATX	EPA 415.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #22		
Lab Sample ID:	F13251-3	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846 8081A SW846 3510C	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	ST14904.D	1	05/23/02	SKW	05/22/02	OP5190	GST551
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	10.0 ml
Run #2		

Pesticide TCL List

CAS No.	Compound	Result	RL	Units	Q
309-00-2	Aldrin	ND	0.050	ug/l	
319-84-6	alpha-BHC	ND	0.050	ug/l	
319-85-7	beta-BHC	ND	0.050	ug/l	
319-86-8	delta-BHC	ND	0.050	ug/l	
58-89-9	gamma-BHC (Lindane)	ND	0.050	ug/l	
5103-71-9	alpha-Chlordane	ND	0.10	ug/l	
5103-74-2	gamma-Chlordane	ND	0.10	ug/l	
60-57-1	Dieldrin	ND	0.050	ug/l	
72-54-8	4,4'-DDD	ND	0.10	ug/l	
72-55-9	4,4'-DDE	ND	0.10	ug/l	
50-29-3	4,4'-DDT	ND	0.10	ug/l	
72-20-8	Endrin	ND	0.10	ug/l	
1031-07-8	Endosulfan sulfate	ND	0.10	ug/l	
7421-93-4	Endrin aldehyde	ND	0.10	ug/l	
53494-70-5	Endrin ketone	ND	0.10	ug/l	
959-98-8	Endosulfan-I	ND	0.050	ug/l	
33213-65-9	Endosulfan-II	ND	0.10	ug/l	
76-44-8	Heptachlor	ND	0.050	ug/l	
1024-57-3	Heptachlor epoxide	ND	0.050	ug/l	
72-43-5	Methoxychlor	ND	0.20	ug/l	
8001-35-2	Toxaphene	ND	2.5	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	87%		47-126%
2051-24-3	Decachlorobiphenyl	69%		13-144%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #22		
Lab Sample ID:	F13251-3	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1 [a]		1	06/04/02	SUB	n/a	n/a	R9707
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	Units	Q
21646-99-1	TEPP	ND	10	ug/l	
62-73-7	Dichlorvos	ND	1.0	ug/l	
7786-34-7	Mevinphos	ND	1.0	ug/l	
8065-48-3	Demeton-S	ND	1.0	ug/l	
13194-48-4	Ethoprop	ND	1.0	ug/l	
298-02-2	Phorate	ND	1.0	ug/l	
300-76-5	Naled	ND	10	ug/l	
3689-24-5	Sulfotep	ND	2.0	ug/l	
333-41-5	Diazinon	ND	1.0	ug/l	
298-04-4	Disulfoton	ND	1.0	ug/l	
60-51-5	Dimethoate	ND	2.0	ug/l	
299-84-3	Ronnel	ND	1.0	ug/l	
150-50-5	Merphos	ND	1.0	ug/l	
2921-88-2	Chlorpyrifos	ND	1.0	ug/l	
55-38-9	Fenthion	ND	2.0	ug/l	
327-98-0	Trichloronate	ND	1.0	ug/l	
298-00-0	Methyl parathion	ND	1.0	ug/l	
121-75-5	Malathion	ND	1.0	ug/l	
34643-46-4	Tokuthion	ND	1.0	ug/l	
56-38-2	Ethyl Parathion	ND	1.0	ug/l	
22248-79-9	Stirophos	ND	1.0	ug/l	
35400-43-2	Bolstar	ND	1.0	ug/l	
115-90-2	Fensulfothion	ND	1.0	ug/l	
2104-64-5	EPN	ND	1.0	ug/l	
86-50-0	Methyl Azinphos	ND	2.0	ug/l	
56-72-4	Coumaphos	ND	1.0	ug/l	
1912-24-9	Atrazine	ND	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
	Trithion	0%		-%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #22		
Lab Sample ID:	F13251-3	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

CAS No.	Compound	Result	RL	Units	Q

(a) Analyzed By Accutest Southeast Subcontract Lab.

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #22		
Lab Sample ID:	F13251-3	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed	By	Method	Prep Method
Mercury	<1.0	1.0	ug/l	1	05/29/02	05/30/02	LIR	SW846 7470A	EPA 245.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #22		
Lab Sample ID:	F13251-3	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed By	Method
Total Organic Carbon	19.4	2.0	mg/l	2	06/03/02 ATX	EPA 415.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #24		
Lab Sample ID:	F13251-4	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846 8081A SW846 3510C	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1 [a]	ST14905.D	1	05/23/02	SKW	05/22/02	OP5190	GST551
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	10.0 ml
Run #2		

Pesticide TCL List

CAS No.	Compound	Result	RL	Units	Q
309-00-2	Aldrin	ND	0.050	ug/l	
319-84-6	alpha-BHC	ND	0.050	ug/l	
319-85-7	beta-BHC	ND	0.050	ug/l	
319-86-8	delta-BHC	ND	0.050	ug/l	
58-89-9	gamma-BHC (Lindane)	0.029	0.050	ug/l	J
5103-71-9	alpha-Chlordane	ND	0.10	ug/l	
5103-74-2	gamma-Chlordane	ND	0.10	ug/l	
60-57-1	Dieldrin	ND	0.050	ug/l	
72-54-8	4,4'-DDD	ND	0.10	ug/l	
72-55-9	4,4'-DDE	ND	0.10	ug/l	
50-29-3	4,4'-DDT	ND	0.10	ug/l	
72-20-8	Endrin	ND	0.10	ug/l	
1031-07-8	Endosulfan sulfate	ND	0.10	ug/l	
7421-93-4	Endrin aldehyde	ND	0.10	ug/l	
53494-70-5	Endrin ketone	ND	0.10	ug/l	
959-98-8	Endosulfan-I	ND	0.050	ug/l	
33213-65-9	Endosulfan-II	ND	0.10	ug/l	
76-44-8	Heptachlor	ND	0.050	ug/l	
1024-57-3	Heptachlor epoxide	ND	0.050	ug/l	
72-43-5	Methoxychlor	ND	0.20	ug/l	
8001-35-2	Toxaphene	ND	2.5	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	94%		47-126%
2051-24-3	Decachlorobiphenyl	78%		13-144%

(a) All hits confirmed by dual column analysis.

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #24		
Lab Sample ID:	F13251-4	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1 [a]		1	06/04/02	SUB	n/a	n/a	R9707
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	Units	Q
21646-99-1	TEPP	ND	10	ug/l	
62-73-7	Dichlorvos	ND	1.0	ug/l	
7786-34-7	Mevinphos	ND	1.0	ug/l	
8065-48-3	Demeton-S	ND	1.0	ug/l	
13194-48-4	Ethoprop	ND	1.0	ug/l	
298-02-2	Phorate	ND	1.0	ug/l	
300-76-5	Naled	ND	10	ug/l	
3689-24-5	Sulfotep	ND	2.0	ug/l	
333-41-5	Diazinon	ND	1.0	ug/l	
298-04-4	Disulfoton	ND	1.0	ug/l	
60-51-5	Dimethoate	ND	2.0	ug/l	
299-84-3	Ronnel	ND	1.0	ug/l	
150-50-5	Merphos	ND	1.0	ug/l	
2921-88-2	Chlorpyrifos	ND	1.0	ug/l	
55-38-9	Fenthion	ND	2.0	ug/l	
327-98-0	Trichloronate	ND	1.0	ug/l	
298-00-0	Methyl parathion	ND	1.0	ug/l	
121-75-5	Malathion	ND	1.0	ug/l	
34643-46-4	Tokuthion	ND	1.0	ug/l	
56-38-2	Ethyl Parathion	ND	1.0	ug/l	
22248-79-9	Stirophos	ND	1.0	ug/l	
35400-43-2	Bolstar	ND	1.0	ug/l	
115-90-2	Fensulfothion	ND	1.0	ug/l	
2104-64-5	EPN	ND	1.0	ug/l	
86-50-0	Methyl Azinphos	ND	2.0	ug/l	
56-72-4	Coumaphos	ND	1.0	ug/l	
1912-24-9	Atrazine	ND	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
	Trithion	0%		-%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #24		
Lab Sample ID:	F13251-4	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

CAS No.	Compound	Result	RL	Units	Q

(a) Analyzed By Accutest Southeast Subcontract Lab.

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #24		
Lab Sample ID:	F13251-4	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed	By	Method	Prep Method
Mercury	<1.0	1.0	ug/l	1	05/29/02	05/30/02	LIR	SW846 7470A	EPA 245.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #24		
Lab Sample ID:	F13251-4	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed By	Method
Total Organic Carbon	18.4	2.0	mg/l	2	06/03/02 ATX	EPA 415.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #29		
Lab Sample ID:	F13251-5	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846 8081A SW846 3510C	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	ST14906.D	1	05/23/02	SKW	05/22/02	OP5190	GST551
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	10.0 ml
Run #2		

Pesticide TCL List

CAS No.	Compound	Result	RL	Units	Q
309-00-2	Aldrin	ND	0.050	ug/l	
319-84-6	alpha-BHC	ND	0.050	ug/l	
319-85-7	beta-BHC	ND	0.050	ug/l	
319-86-8	delta-BHC	ND	0.050	ug/l	
58-89-9	gamma-BHC (Lindane)	ND	0.050	ug/l	
5103-71-9	alpha-Chlordane	ND	0.10	ug/l	
5103-74-2	gamma-Chlordane	ND	0.10	ug/l	
60-57-1	Dieldrin	ND	0.050	ug/l	
72-54-8	4,4'-DDD	ND	0.10	ug/l	
72-55-9	4,4'-DDE	ND	0.10	ug/l	
50-29-3	4,4'-DDT	ND	0.10	ug/l	
72-20-8	Endrin	ND	0.10	ug/l	
1031-07-8	Endosulfan sulfate	ND	0.10	ug/l	
7421-93-4	Endrin aldehyde	ND	0.10	ug/l	
53494-70-5	Endrin ketone	ND	0.10	ug/l	
959-98-8	Endosulfan-I	ND	0.050	ug/l	
33213-65-9	Endosulfan-II	ND	0.10	ug/l	
76-44-8	Heptachlor	ND	0.050	ug/l	
1024-57-3	Heptachlor epoxide	ND	0.050	ug/l	
72-43-5	Methoxychlor	ND	0.20	ug/l	
8001-35-2	Toxaphene	ND	2.5	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	95%		47-126%
2051-24-3	Decachlorobiphenyl	78%		13-144%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #29		
Lab Sample ID:	F13251-5	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1 [a]		1	06/04/02	SUB	n/a	n/a	R9707
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	Units	Q
21646-99-1	TEPP	ND	10	ug/l	
62-73-7	Dichlorvos	ND	1.0	ug/l	
7786-34-7	Mevinphos	ND	1.0	ug/l	
8065-48-3	Demeton-S	ND	1.0	ug/l	
13194-48-4	Ethoprop	ND	1.0	ug/l	
298-02-2	Phorate	ND	1.0	ug/l	
300-76-5	Naled	ND	10	ug/l	
3689-24-5	Sulfotep	ND	2.0	ug/l	
333-41-5	Diazinon	ND	1.0	ug/l	
298-04-4	Disulfoton	ND	1.0	ug/l	
60-51-5	Dimethoate	ND	2.0	ug/l	
299-84-3	Ronnel	ND	1.0	ug/l	
150-50-5	Merphos	ND	1.0	ug/l	
2921-88-2	Chlorpyrifos	ND	1.0	ug/l	
55-38-9	Fenthion	ND	2.0	ug/l	
327-98-0	Trichloronate	ND	1.0	ug/l	
298-00-0	Methyl parathion	ND	1.0	ug/l	
121-75-5	Malathion	ND	1.0	ug/l	
34643-46-4	Tokuthion	ND	1.0	ug/l	
56-38-2	Ethyl Parathion	ND	1.0	ug/l	
22248-79-9	Stirophos	ND	1.0	ug/l	
35400-43-2	Bolstar	ND	1.0	ug/l	
115-90-2	Fensulfothion	ND	1.0	ug/l	
2104-64-5	EPN	ND	1.0	ug/l	
86-50-0	Methyl Azinphos	ND	2.0	ug/l	
56-72-4	Coumaphos	ND	1.0	ug/l	
1912-24-9	Atrazine	ND	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
	Trithion	0%		-%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #29		
Lab Sample ID:	F13251-5	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

CAS No.	Compound	Result	RL	Units	Q

(a) Analyzed By Accutest Southeast Subcontract Lab.

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	LAKE JESSUP #29		
Lab Sample ID:	F13251-5	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed	By	Method	Prep Method
Mercury	<1.0	1.0	ug/l	1	05/29/02	05/30/02	LIR	SW846 7470A	EPA 245.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	LAKE JESSUP #29		
Lab Sample ID:	F13251-5	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/17/02
		Percent Solids:	n/a
Project:	Lake Jessup		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed By	Method
Total Organic Carbon	15.6	2.0	mg/l	2	06/03/02 ATX	EPA 415.1

RL = Reporting Limit

Report of Analysis

Client Sample ID:	COMPOSITE		
Lab Sample ID:	F13251-6	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/20/02
Method:	SW846 8081A SW846 3510C	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	ST14907.D	1	05/23/02	SKW	05/22/02	OP5190	GST551
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	10.0 ml
Run #2		

Pesticide TCL List

CAS No.	Compound	Result	RL	Units	Q
309-00-2	Aldrin	ND	0.050	ug/l	
319-84-6	alpha-BHC	ND	0.050	ug/l	
319-85-7	beta-BHC	ND	0.050	ug/l	
319-86-8	delta-BHC	ND	0.050	ug/l	
58-89-9	gamma-BHC (Lindane)	ND	0.050	ug/l	
5103-71-9	alpha-Chlordane	ND	0.10	ug/l	
5103-74-2	gamma-Chlordane	ND	0.10	ug/l	
60-57-1	Dieldrin	ND	0.050	ug/l	
72-54-8	4,4'-DDD	ND	0.10	ug/l	
72-55-9	4,4'-DDE	ND	0.10	ug/l	
50-29-3	4,4'-DDT	ND	0.10	ug/l	
72-20-8	Endrin	ND	0.10	ug/l	
1031-07-8	Endosulfan sulfate	ND	0.10	ug/l	
7421-93-4	Endrin aldehyde	ND	0.10	ug/l	
53494-70-5	Endrin ketone	ND	0.10	ug/l	
959-98-8	Endosulfan-I	ND	0.050	ug/l	
33213-65-9	Endosulfan-II	ND	0.10	ug/l	
76-44-8	Heptachlor	ND	0.050	ug/l	
1024-57-3	Heptachlor epoxide	ND	0.050	ug/l	
72-43-5	Methoxychlor	ND	0.20	ug/l	
8001-35-2	Toxaphene	ND	2.5	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	101%		47-126%
2051-24-3	Decachlorobiphenyl	88%		13-144%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	COMPOSITE		
Lab Sample ID:	F13251-6	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/20/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1 [a]		1	06/04/02	SUB	n/a	n/a	R9707
Run #2							

	Initial Volume	Final Volume
Run #1	1000 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	Units	Q
21646-99-1	TEPP	ND	10	ug/l	
62-73-7	Dichlorvos	ND	1.0	ug/l	
7786-34-7	Mevinphos	ND	1.0	ug/l	
8065-48-3	Demeton-S	ND	1.0	ug/l	
13194-48-4	Ethoprop	ND	1.0	ug/l	
298-02-2	Phorate	ND	1.0	ug/l	
300-76-5	Naled	ND	10	ug/l	
3689-24-5	Sulfotep	ND	2.0	ug/l	
333-41-5	Diazinon	ND	1.0	ug/l	
298-04-4	Disulfoton	ND	1.0	ug/l	
60-51-5	Dimethoate	ND	2.0	ug/l	
299-84-3	Ronnel	ND	1.0	ug/l	
150-50-5	Merphos	ND	1.0	ug/l	
2921-88-2	Chlorpyrifos	ND	1.0	ug/l	
55-38-9	Fenthion	ND	2.0	ug/l	
327-98-0	Trichloronate	ND	1.0	ug/l	
298-00-0	Methyl parathion	ND	1.0	ug/l	
121-75-5	Malathion	ND	1.0	ug/l	
34643-46-4	Tokuthion	ND	1.0	ug/l	
56-38-2	Ethyl Parathion	ND	1.0	ug/l	
22248-79-9	Stirophos	ND	1.0	ug/l	
35400-43-2	Bolstar	ND	1.0	ug/l	
115-90-2	Fensulfothion	ND	1.0	ug/l	
2104-64-5	EPN	ND	1.0	ug/l	
86-50-0	Methyl Azinphos	ND	2.0	ug/l	
56-72-4	Coumaphos	ND	1.0	ug/l	
1912-24-9	Atrazine	ND	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
	Trithion	0%		-%

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	COMPOSITE		
Lab Sample ID:	F13251-6	Date Sampled:	05/16/02
Matrix:	AQ - Ground Water	Date Received:	05/20/02
Method:	SW846-8141	Percent Solids:	n/a
Project:	Lake Jessup		

CAS No.	Compound	Result	RL	Units	Q

(a) Analyzed By Accutest Southeast Subcontract Lab.

ND = Not detected
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

APPENDIX F

Beneficial Use Testing of Lake Jesup Unconsolidated Sediment
PC&B Environmental Laboratories, Inc., May 2002

PC&B Environmental Laboratories, Inc.

210 Park Road, Oviedo, Florida 32765
Phone: 407-359-7194 Fax: 407-359-7197

05-15-2002

Dale Helms, PE
Parsons Brinkerhoff Companies
100 East Pine Street, Ste 500
Orlando, FL 32801-

Dear Dale Helms, PE:

Enclosed are the results of the analysis of your samples received 04/23/2002.

Our laboratory is NELAP certified by the Florida DOH (Lab #E83239) and operates under an NELAP approved Quality Assurance Plan. Unless otherwise noted, all results are reported as received. All data were determined in accordance with published procedures (EPA-600/4-79-020), Methods for Chemical Analysis of Water and Wastes, Revised March 1983, or later and/or Standard Methods for the examination of Water and Wastewater, 18th Edition 1989, or later and/or Test Methods for Evaluating Solid Waste (EPA-SW-846, Revised January 1995, or later), unless stated otherwise in our CompQapp under method modifications.

Test results meet all of the requirements of the NELAC Standards.

If you have any questions, please do not hesitate to give me a call.

Sincerely,

Nancy L. Moore
Technical Director

PC&B Environmental Laboratories, Inc.

210 Park Road, Oviedo, Florida 32765
Phone: 407-359-7194 Fax: 407-359-7197

Client : Parsons Brinkerhoff Companies
100 East Pine Street, Ste 500
Orlando, FL 32801-

Contact : Dale Helms, PE
Phone : (407) 587-7800

Laboratory Reference Number : 202040247

Project Name : Lake Jesup
Project Number : 25508A

Chain of Custody : 32421

Laboratory ID	Matrix	Client ID	Status	Date/Time Sampled
202040247-1	Soil	JESUP #1	RUN	04/23/2002 13:00
202040247-2	Soil	JESUP #11	RUN	04/23/2002 15:30
202040247-3	Soil	JESUP #16	RUN	04/23/2002 14:45
202040247-4	Soil	JESUP #25	RUN	04/23/2002 13:40
202040247-5	Soil	JESUP #30	RUN	04/23/2002 11:15

Number	Parameter	Description
5	EPA 8081A	Chlorinated Pesticides
5	EPA 8141	Organophosphorus Pesticides
5	EPA 8310	PAH's by HPLC
5	EPA 8082	PCB in Soil
5	EPA 8270	Semivolatile Organics by GCMS
5	EPA 8021	Volatile Organics
5	EPA 6010	Arsenic by ICAP
5	EPA 6010	Barium by ICAP
5	EPA 6010	Cadmium by ICAP
5	EPA 6010	Calcium by ICAP
5	EPA 6010	Chromium by ICAP
5	EPA 6010	Copper by ICAP
5	EPA 6010	Iron by ICAP
5	EPA 6010	Lead by ICAP
5	EPA 6010	Magnesium by ICAP
5	EPA 7471	Mercury (Total) by Cold Vapor
5	EPA 1664	Oil & Grease
5	EPA 160.3	Percent Solids
5	EPA 6010	Phosphorus by ICAP
5	EPA 6010	Potassium by ICAP
5	EPA 6010	Selenium by ICAP
5	EPA 6010	Silver by ICAP
5	EPA 9045	Soil pH
5	SM 2340B	Total Hardness as CaCO3
5	EPA 9200/351.2	Total Nitrogen
5	EPA 160.4	Total Organic Content
5	EPA 6010	Zinc by ICAP

PC&B Environmental Laboratories, Inc.

210 Park Road
Oviedo, FL 32765-8801
407-359-7194 - (FAX) 407-359-7197

Case Narrative

Dale Helms, PE
Parsons Brinkerhoff Companies
100 East Pine Street, Ste 500
Orlando, FL 32801-

CASE NARRATIVE for Work Order: 202040247
Project Number: 25508A
Project Name: Lake Jesup

This Case Narrative is a summary of events and/or problems encountered with this Work Order.

For samples requesting EPA 601/602/8021 analysis, the GCMS method EPA 624/8260 was substituted in order to generate the highest quality data possible at no additional cost.
For EPA 8310 PAH analysis, hits below 100 ppb (soil) cannot be confirmed.

Analysis for Total Organic Content and Total Organic Carbon were performed by Bottorf Associates, Inc. (E83283).

Analysis for %Solids and TKN were performed by ELab Inc., (E83079).
* Indicates an alternate surrogate is being reported due to matrix interference with the normal 8310 surrogate.

Definition of Flags

DL	=	No surrogate result due to dilution or matrix interference.
J	=	Estimated Value, value not accurate.
L	=	Off-scale high. Actual value is greater than value given.
Q	=	Sample analyzed beyond the accepted holding time.
T	=	Value reported is less than the laboratory method detection limit.
V	=	Analyte was both detected in the method blank and sample.

Report of Analysis

PC&B Environmental Laboratories, Inc.
210 Park Road
Oviedo, FL 32765-8801
PHONE: 407-359-7194
FAX: 407-359-7197

Volatile Organics

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002
ANALYTICAL PROTOCOL: EPA 8021

Lab Reference Number	202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID	JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled	04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Date/Time Extracted	04/24/2002	04/24/2002	04/24/2002	04/24/2002	04/24/2002
Date/Time Analyzed	04/24/2002 23:38	04/24/2002 00:16	04/24/2002 00:54	04/24/2002 01:32	04/24/2002 02:10
Sample Matrix (as Received)	Soil	Soil	Soil	Soil	Soil
Analysis Confirmed	GCMS	GCMS	GCMS	GCMS	GCMS
Dilution Factor	1	1	1	1	1
Result Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Benzene	5 U	5 U	5 U	5 U	5 U
Bromobenzene	5 U	5 U	5 U	5 U	5 U
Bromochloromethane	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U
Bromoform	5 U	5 U	5 U	5 U	5 U
Bromomethane	5 U	5 U	5 U	5 U	5 U
n-Butylbenzene	5 U	5 U	5 U	5 U	5 U
sec-Butylbenzene	5 U	5 U	5 U	5 U	5 U
tert-Butylbenzene	5 U	5 U	5 U	5 U	5 U
Carbon tetrachloride	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5 U	5 U	5 U	5 U	5 U
Chloroethane	5 U	5 U	5 U	5 U	5 U
Chloroform	5 U	5 U	5 U	5 U	5 U
Chloromethane	5 U	5 U	5 U	5 U	5 U
2-Chlorotoluene	5 U	5 U	5 U	5 U	5 U
4-Chlorotoluene	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5 U	5 U	5 U	5 U	5 U
1,2-Dibromoethane	5 U	5 U	5 U	5 U	5 U
Dibromomethane	5 U	5 U	5 U	5 U	5 U
1,2-Dichlorobenzene	5 U	5 U	5 U	5 U	5 U
1,3-Dichlorobenzene	5 U	5 U	5 U	5 U	5 U
1,4-Dichlorobenzene	5 U	5 U	5 U	5 U	5 U
Dichlorodifluoromethane	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethane	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	5 U	5 U	5 U	5 U
cis-1,2-Dichloroethene	5 U	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5 U	5 U	5 U	5 U	5 U
1,3-Dichloropropane	5 U	5 U	5 U	5 U	5 U
2,2-Dichloropropane	5 U	5 U	5 U	5 U	5 U
1,1-Dichloropropene	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U	5 U
Hexachlorobutadiene	5 U	5 U	5 U	5 U	5 U
Isopropylbenzene	5 U	5 U	5 U	5 U	5 U
p-Isopropyltoluene	5 U	5 U	5 U	5 U	5 U
Methylene chloride	5 U	5 U	5 U	5 U	5 U
Naphthalene	5 U	5 U	5 U	5 U	5 U
n-Propylbenzene	5 U	5 U	5 U	5 U	5 U
Styrene	5 U	5 U	5 U	5 U	5 U
1,1,1,2-Tetrachloroethane	5 U	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5 U	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U	5 U
1,2,3-Trichlorobenzene	5 U	5 U	5 U	5 U	5 U
1,2,4-Trichlorobenzene	5 U	5 U	5 U	5 U	5 U
1,1,1-Trichloroethane	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5 U	5 U	5 U	5 U	5 U
1,2,3-Trichloropropane	5 U	5 U	5 U	5 U	5 U
1,2,4-Trimethylbenzene	5 U	5 U	5 U	5 U	5 U
1,3,5-Trimethylbenzene	5 U	5 U	5 U	5 U	5 U
Vinyl chloride	5 U	5 U	5 U	5 U	5 U

Report of Analysis

PC&B Environmental Laboratories, Inc.
210 Park Road
Oviedo, FL 32765-8801
PHONE: 407-359-7194
FAX: 407-359-7197

Volatile Organics

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002
ANALYTICAL PROTOCOL: EPA 8021

Lab Reference Number	202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID	JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled	04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Date/Time Extracted	04/24/2002	04/24/2002	04/24/2002	04/24/2002	04/24/2002
Date/Time Analyzed	04/24/2002 23:38	04/24/2002 00:16	04/24/2002 00:54	04/24/2002 01:32	04/24/2002 02:10
Sample Matrix (as Received)	Soil	Soil	Soil	Soil	Soil
Analysis Confirmed	GCMS	GCMS	GCMS	GCMS	GCMS
Dilution Factor	1	1	1	1	1
Result Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
m&p-Xylenes	5 U	5 U	5 U	5 U	5 U
o-Xylene	5 U	5 U	5 U	5 U	5 U
MTBE	5 U	5 U	5 U	5 U	5 U
(Surr) 1,2-Dichloroethane-d4 (%)	110	108	109	119	121
(Surr) Toluene-d8 (%)	97	92	97	94	102
(Surr) 4-Bromofluorobenzene (%)	91	88	83	84	83

U = Undetected. The value preceeding the 'U' is the RL for the analyte, based on dilution. Results reported on a Wet Weight basis.

Reviewed by : lem

Quality Control Report for Spike/Spike Duplicate Analysis

Volatile Organics

Matrix: Soil
Lab Sample ID: 202040216-2
QC Batch ID: 200204MS3076
Spike Units: ug/kg

Analysis Date: 04/24/2002
Preparation Date: 04/24/2002
Method: EPA 8021
Analyst: KN

Analyte	Spike Amount	Sample Result	Spike Result	Spike Percent Recovery	MSD Result	MSD Percent Recovery	RPD
Benzene	50	0	50	100	48	96	4
Carbon tetrachloride	50	0	56	112	54	108	4
Chlorobenzene	50	0	48	96	48	96	0
1,4-Dichlorobenzene	50	0	44	88	47	94	7
1,1-Dichloroethene	50	0	53	106	53	106	0
Ethylbenzene	50	0	50	100	48	96	4
Toluene	50	0	52	104	49	98	6
Trichloroethene	50	0	52	104	50	100	4
m&p-Xylenes	100	0	97	97	93	93	4
o-Xylene	50	0	54	108	50	100	8

Quality Control Limits

Analyte	Lower Limit	Upper Limit	RPD
Benzene	71	132	10
Carbon tetrachloride	65	136	12
Chlorobenzene	76	125	9
1,4-Dichlorobenzene	76	125	8
1,1-Dichloroethene	62	142	13
Ethylbenzene	75	125	8
Toluene	67	132	11
Trichloroethene	74	127	9
m&p-Xylenes	70	127	10
o-Xylene	73	125	9

Report of Analysis

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Semivolatile Organics by GCMS

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002
ANALYTICAL PROTOCOL: EPA 8270

Lab Reference Number	202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID	JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled	04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Date/Time Extracted	04/26/2002	04/26/2002	04/26/2002	04/26/2002	04/26/2002
Date/Time Analyzed	05/02/2002	05/02/2002	05/02/2002	05/02/2002	05/02/2002
Sample Matrix (as Received)	Soil	Soil	Soil	Soil	Soil
Analysis Confirmed	GCMS	GCMS	GCMS	GCMS	GCMS
Dilution Factor	1	1	1	1	1
Result Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Acenaphthene	160 U	160 U	160 U	160 U	160 U
Acenaphthylene	160 U	160 U	160 U	160 U	160 U
Anthracene	160 U	160 U	160 U	160 U	160 U
Benzidine	160 U	160 U	160 U	160 U	160 U
Benzoic Acid	1600 U	1600 U	1600 U	1600 U	1600 U
Benzo(a)anthracene	160 U	160 U	160 U	160 U	160 U
Benzo(b)fluoranthene	160 U	160 U	160 U	160 U	160 U
Benzo(k)fluoranthene	160 U	160 U	160 U	160 U	160 U
Benzo(ghi)perylene	160 U	160 U	160 U	160 U	160 U
Benzo(a)pyrene	160 U	160 U	160 U	160 U	160 U
Benzyl alcohol	600 U	600 U	600 U	600 U	600 U
Bis(2-chloroethyl)ether	160 U	160 U	160 U	160 U	160 U
Bis(2-chloroethoxy)methane	160 U	160 U	160 U	160 U	160 U
Bis(2-chloroisopropyl)ether	160 U	160 U	160 U	160 U	160 U
Bis(2-ethylhexyl)phthalate	160 U	160 U	160 U	160 U	160 U
4-Bromophenyl phenyl ether	160 U	160 U	160 U	160 U	160 U
Butyl benzyl phthalate	160 U	160 U	160 U	160 U	160 U
4-Chloroaniline	600 U	600 U	600 U	600 U	600 U
1-Chloronaphthalene	160 U	160 U	160 U	160 U	160 U
2-Chloronaphthalene	160 U	160 U	160 U	160 U	160 U
4-Chloro-3-methylphenol	160 U	160 U	160 U	160 U	160 U
2-Chlorophenol	160 U	160 U	160 U	160 U	160 U
4-Chlorophenyl phenyl ether	160 U	160 U	160 U	160 U	160 U
Chrysene	160 U	160 U	160 U	160 U	160 U
Dibenz(a,h)anthracene	160 U	160 U	160 U	160 U	160 U
Dibenzofuran	160 U	160 U	160 U	160 U	160 U
Di-n-butyl phthalate	160 U	160 U	160 U	160 U	160 U
1,3-Dichlorobenzene	160 U	160 U	160 U	160 U	160 U
1,4-Dichlorobenzene	160 U	160 U	160 U	160 U	160 U
1,2-Dichlorobenzene	160 U	160 U	160 U	160 U	160 U
3,3'-Dichlorobenzidine	600 U	600 U	600 U	600 U	600 U
2,4-Dichlorophenol	160 U	160 U	160 U	160 U	160 U
2,6-Dichlorophenol	160 U	160 U	160 U	160 U	160 U
Diethylphthalate	160 U	160 U	160 U	160 U	160 U
2,4-Dimethylphenol	160 U	160 U	160 U	160 U	160 U
Dimethylphthalate	160 U	160 U	160 U	160 U	160 U
4,6-Dinitro-2-methylphenol	160 U	160 U	160 U	160 U	160 U
2,4-Dinitrophenol	1600 U	1600 U	1600 U	1600 U	1600 U
2,4-Dinitrotoluene	160 U	160 U	160 U	160 U	160 U
2,6-Dinitrotoluene	160 U	160 U	160 U	160 U	160 U
Diphenylamine	160 U	160 U	160 U	160 U	160 U
1,2-Diphenylhydrazine	160 U	160 U	160 U	160 U	160 U
Di-n-Octylphthalate	160 U	160 U	160 U	160 U	160 U
Fluoranthene	160 U	160 U	160 U	160 U	160 U
Fluorene	160 U	160 U	160 U	160 U	160 U
Hexachlorobenzene	160 U	160 U	160 U	160 U	160 U
Hexachlorobutadiene	160 U	160 U	160 U	160 U	160 U
Hexachlorocyclopentadiene	160 U	160 U	160 U	160 U	160 U
Hexachloroethane	160 U	160 U	160 U	160 U	160 U
Indeno(123-cd)pyrene	160 U	160 U	160 U	160 U	160 U
Isophorone	160 U	160 U	160 U	160 U	160 U
1-Methylnaphthalene	160 U	160 U	160 U	160 U	160 U
2-Methylnaphthalene	160 U	160 U	160 U	160 U	160 U
2-Methylphenol	160 U	160 U	160 U	160 U	160 U

Report of Analysis

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Semivolatile Organics by GCMS

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002
ANALYTICAL PROTOCOL: EPA 8270

Lab Reference Number	202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID	JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled	04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Date/Time Extracted	04/26/2002	04/26/2002	04/26/2002	04/26/2002	04/26/2002
Date/Time Analyzed	05/02/2002	05/02/2002	05/02/2002	05/02/2002	05/02/2002
Sample Matrix (as Received)	Soil	Soil	Soil	Soil	Soil
Analysis Confirmed	GCMS	GCMS	GCMS	GCMS	GCMS
Dilution Factor	1	1	1	1	1
Result Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
4-Methylphenol	160 U	160 U	160 U	160 U	160 U
Naphthalene	160 U	160 U	160 U	160 U	160 U
2-Nitroaniline	1600 U	1600 U	1600 U	1600 U	1600 U
3-Nitroaniline	1600 U	1600 U	1600 U	1600 U	1600 U
4-Nitroaniline	1600 U	1600 U	1600 U	1600 U	1600 U
Nitrobenzene	160 U	160 U	160 U	160 U	160 U
2-Nitrophenol	160 U	160 U	160 U	160 U	160 U
4-Nitrophenol	160 U	160 U	160 U	160 U	160 U
N-Nitrosodiphenylamine	160 U	160 U	160 U	160 U	160 U
N-Nitroso-di-n-propylamine	160 U	160 U	160 U	160 U	160 U
Pentachlorophenol	1600 U	1600 U	1600 U	1600 U	1600 U
Phenanthrene	160 U	160 U	160 U	160 U	160 U
Phenol	160 U	160 U	160 U	160 U	160 U
Pyrene	160 U	160 U	160 U	160 U	160 U
1,2,4-Trichlorobenzene	160 U	160 U	160 U	160 U	160 U
2,4,5-Trichlorophenol	160 U	160 U	160 U	160 U	160 U
2,4,6-Trichlorophenol	160 U	160 U	160 U	160 U	160 U
Pyridine	250 U	250 U	250 U	250 U	250 U
Aniline	250 U	250 U	250 U	250 U	250 U
(Surr) 2-Fluorophenol (%)	71	77	78	82	72
(Surr) Phenol-d5 (%)	68	78	62	97	72
(Surr) Nitrobenzene-d5 (%)	60	83	72	93	68
(Surr) 2-Fluorobiphenyl (%)	37	65	42	67	49
(Surr) 2,4,6-Tribromophenol (%)	76	84	57	86	78
(Surr) Terphenyl-d14 (%)	97	81	119	88	89

U = Undetected. The value preceeding the 'U' is the RL for the analyte, based on dilution. Results reported on a Wet Weight basis.

Reviewed by : KLM

Quality Control Report for LCS Analysis

Semivolatile Organics by GCMS

Matrix: Soil
Lab Sample ID: LCS
QC Batch ID: 200204BNA039A
LCS Units: ug/kg

Analysis Date: 05/02/2002
Preparation Date: 04/26/2002
Method: EPA 8270
Analyst: KN

Analyte	LCS Conc	LCS Result	Percent Recovery	Lower Control Limit	Upper Control Limit
(Surr) 2-Fluorophenol	100	83	83	24	120
(Surr) Phenol-d5	100	79	79	25	121
(Surr) Nitrobenzene-d5	100	77	77	23	120
(Surr) 2-Fluorobiphenyl	100	48	48	30	120
(Surr) 2,4,6-Tribromophenol	100	49	49	19	130
(Surr) Terphenyl-d14	100	95	95	18	137
Acenaphthene	50	35	70	42	96
4-Chloro-3-methylphenol	100	119	119	49	120
2-Chlorophenol	100	83	83	51	101
1,3-Dichlorobenzene	50	38	76	57	104
2,4-Dinitrotoluene	50	31	62	45	108
4-Nitrophenol	100	74	74	41	115
N-Nitroso-di-n-propylamine	50	35	70	47	98
Pentachlorophenol	100	78	78	54	120
Phenol	100	68	68	50	115
Pyrene	50	23	46	40	118
1,2,4-Trichlorobenzene	50	36	72	47	112

Report of Analysis

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PAH's by HPLC

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002
ANALYTICAL PROTOCOL: EPA 8310

Lab Reference Number	202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID	JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled	04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Date/Time Extracted	04/26/2002	04/26/2002	04/26/2002	04/26/2002	04/26/2002
Date/Time Analyzed	04/27/2002 03:57	04/27/2002 04:40	04/30/2002 13:38	04/27/2002 06:06	04/30/2002 14:13
Sample Matrix (as Received)	Soil	Soil	Soil	Soil	Soil
Analysis Confirmed	GCMS	GCMS	No	GCMS	No
Dilution Factor	1	1	1	1	1
Result Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Acenaphthene	25 U	25 U	25 U	25 U	25 U
Acenaphthylene	50 U	50 U	50 U	50 U	50 U
Anthracene	1 U	1 U	1 U	1 U	1 U
Benzo(a)anthracene	3 U	3 U	3 U	3 U	3 U
Benzo(a)pyrene	6 U	6 U	6 U	6 U	6 U
Benzo(b)fluoranthene	10 U	10 U	10 U	10 U	10 U
Benzo(ghi)perylene	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	6 U	6 U	6 U	6 U	6 U
Chrysene	3 U	3 U	3 U	3 U	3 U
Dibenzo(ah)anthracene	20 U	20 U	20 U	20 U	20 U
Fluoranthene	5 U	5 U	5 U	5 U	5 U
Fluorene	5 U	5 U	5 U	5 U	5 U
Indeno(123cd)pyrene	3 U	3 U	3 U	3 U	3 U
Naphthalene	60 U	60 U	60 U	60 U	60 U
1-Methyl naphthalene	100 U	100 U	100 U	100 U	100 U
2-Methyl naphthalene	100 U	100 U	100 U	100 U	100 U
Phenanthrene	3 U	3 U	3 U	3 U	3 U
Pyrene	25 U	25 U	25 U	25 U	25 U
(Surr) Decafluorobipheynl (%)	25 *	35 *	78	36 *	69

U = Undetected. The value preceeding the 'U' is the RL for the analyte, based on dilution. Results reported on a Wet Weight basis.

Reviewed by : KUM

Quality Control Report for LCS Analysis

PAH's by HPLC

Matrix: Soil
Lab Sample ID: LCS
QC Batch ID: 200204PAH034A
LCS Units: ug/kg

Analysis Date: 04/26/2002
Preparation Date: 04/26/2002
Method: EPA 8310
Analyst: RM

Analyte	LCS Conc	LCS Result	Percent Recovery	Lower Control Limit	Upper Control Limit
Acenaphthene	50.0	34.2	68	60	120
Acenaphthylene	25.0	19.5	78	60	120
Anthracene	1.0	0.9	89	60	120
Benzo(a)anthracene	2.5	2.0	82	60	120
Benzo(a)pyrene	2.5	2.2	88	60	120
Benzo(b)fluoranthene	1.0	0.9	91	60	120
Benzo(ghi)perylene	4.0	3.3	83	60	120
Benzo(k)fluoranthene	1.0	0.8	83	60	120
Chrysene	2.5	2.0	82	60	120
Dibenzo(ah)anthracene	10.0	9.6	96	60	120
Fluoranthene	2.5	2.5	98	60	120
Fluorene	5.0	3.4	67	60	120
Indeno(123cd)pyrene	2.5	2.1	86	60	120
Naphthalene	25.0	18.1	72	60	120
Phenanthrene	2.5	2.0	78	60	120
Pyrene	5.0	4.9	99	60	120

Report of Analysis

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Chlorinated Pesticides

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002
ANALYTICAL PROTOCOL: EPA 8081A

Lab Reference Number	202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID	JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled	04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Date/Time Extracted	04/25/2002	04/25/2002	04/25/2002	04/25/2002	04/25/2002
Date/Time Analyzed	04/26/2002 21:56	04/26/2002 22:31	04/26/2002 23:07	04/26/2002 23:42	04/27/2002 00:17
Sample Matrix (as Received)	Soil	Soil	Soil	Soil	Soil
Analysis Confirmed	No	No	No	No	No
Dilution Factor	1	1	1	1	1
Result Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Aldrin	8 U	8 U	8 U	8 U	8 U
Alpha-BHC	8 U	8 U	8 U	8 U	8 U
Beta-BHC	8 U	8 U	8 U	8 U	8 U
Delta-BHC	8 U	8 U	8 U	8 U	8 U
Gamma_BHC (Lindane)	8 U	8 U	8 U	8 U	8 U
Chlordane	8 U	8 U	8 U	8 U	8 U
4,4'-DDD	16 U	16 U	16 U	16 U	16 U
4,4'-DDE	16 U	16 U	16 U	16 U	16 U
4,4'-DDT	16 U	16 U	16 U	16 U	16 U
Dieldrin	16 U	16 U	16 U	16 U	16 U
Endosulfan I	8 U	8 U	8 U	8 U	8 U
Endosulfan II	16 U	16 U	16 U	16 U	16 U
Endosulfan Sulfate	16 U	16 U	16 U	16 U	16 U
Endrin	16 U	16 U	16 U	16 U	16 U
Endrin Aldehyde	16 U	16 U	16 U	16 U	16 U
Heptachlor	8 U	8 U	8 U	8 U	8 U
Heptachlor Epoxide	8 U	8 U	8 U	8 U	8 U
Methoxychlor	16 U	16 U	16 U	16 U	16 U
Toxaphene	160 U	160 U	160 U	160 U	160 U
(Surr) Decachlorobiphenyl (%)	51	62	80	61	82

U = Undetected. The value preceeding the 'U' is the RL for the analyte, based on dilution. Results reported on a Wet Weight basis.

Reviewed by : _____

Quality Control Report for Spike/Spike Duplicate Analysis

Chlorinated Pesticides

Matrix: Soil
Lab Sample ID: 202040012-11
QC Batch ID: 200204PEST043
Spike Units: ug/kg

Analysis Date: 04/26/2002
Preparation Date: 04/25/2002
Method: EPA 8081A
Analyst: RM

Analyte	Spike Amount	Sample Result	Spike Result	Spike Percent Recovery	MSD Result	MSD Percent Recovery	RPD
(Surr) Decachlorobiphenyl	100	0	87	87	87	87	0
Aldrin	33	0	23	70	24	73	4
Alpha-BHC	33	0	23	70	23	70	0
Beta-BHC	33	0	25	76	25	76	0
Delta-BHC	33	0	26	79	27	82	4
Gamma_BHC (Lindane)	33	0	23	70	24	73	4
4,4'-DDD	33	0	23	70	23	70	0
4,4'-DDE	33	0	28	85	28	85	0
4,4'-DDT	33	0	23	70	23	70	0
Dieldrin	33	0	27	82	28	85	4
Endosulfan I	33	0	27	82	27	82	0
Endosulfan II	33	0	24	73	25	76	4
Endosulfan Sulfate	33	0	23	70	23	70	0
Endrin	33	0	23	70	23	70	0
Endrin Aldehyde	33	0	34	103	34	103	0
Heptachlor	33	0	23	70	23	70	0
Heptachlor Epoxide	33	0	27	82	27	82	0
Methoxychlor	33	0	24	73	23	70	4

Quality Control Limits

Analyte	Lower Limit	Upper Limit	RPD
SS_Decachlorobiphenyl	24	154	20
Aldrin	23	120	20
Alpha-BHC	23	120	20
Beta-BHC	23	120	20
Delta-BHC	23	120	20
Gamma_BHC (Lindane)	23	120	20
4,4'-DDD	23	120	20
4,4'-DDE	23	120	20
4,4'-DDT	23	120	20
Dieldrin	23	120	20
Endosulfan I	23	120	20
Endosulfan II	23	120	20
Endosulfan Sulfate	23	120	20
Endrin	23	120	20
Endrin Aldehyde	23	120	20
Heptachlor	23	120	20
Heptachlor Epoxide	23	120	20
Methoxychlor	23	120	20

Report of Analysis

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Organophosphorus Pesticides

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002
ANALYTICAL PROTOCOL: EPA 8141

Lab Reference Number	202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID	JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled	04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Date/Time Extracted	04/26/2002	04/26/2002	04/26/2002	04/26/2002	04/26/2002
Date/Time Analyzed	04/29/2002 17:11	04/29/2002 18:14	04/29/2002 19:16	04/29/2002 20:19	04/29/2002 21:22
Sample Matrix (as Received)	Soil	Soil	Soil	Soil	Soil
Analysis Confirmed	No	No	No	No	No
Dilution Factor	1	1	1	1	1
Result Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Azinphos methyl	100 U	100 U	100 U	100 U	100 U
Bolstar	20 U	20 U	20 U	20 U	20 U
Chlorpyrifos	20 U	20 U	20 U	20 U	20 U
Coumaphos	100 U	100 U	100 U	100 U	100 U
Demeton, O&S	20 U	20 U	20 U	20 U	20 U
Diazinon	20 U	20 U	20 U	20 U	20 U
Dichlorvos	40 U	40 U	40 U	40 U	40 U
Dimethoate	20 U	20 U	20 U	20 U	20 U
Disulfoton	20 U	20 U	20 U	20 U	20 U
EPN	20 U	20 U	20 U	20 U	20 U
Ethoprop	20 U	20 U	20 U	20 U	20 U
Fensulfothion	100 U	100 U	100 U	100 U	100 U
Fenthion	20 U	20 U	20 U	20 U	20 U
Malathion	20 U	20 U	20 U	20 U	20 U
Merphos	20 U	20 U	20 U	20 U	20 U
Mevinphos	20 U	20 U	20 U	20 U	20 U
Monocrotophos	20 U	20 U	20 U	20 U	20 U
Naled	20 U	20 U	20 U	20 U	20 U
Parathion ethyl	20 U	20 U	20 U	20 U	20 U
Parathion methyl	20 U	20 U	20 U	20 U	20 U
Phorate	20 U	20 U	20 U	20 U	20 U
Ronnel	20 U	20 U	20 U	20 U	20 U
Sulfotepp	20 U	20 U	20 U	20 U	20 U
TEPP	20 U	20 U	20 U	20 U	20 U
Stirophos	200 U	200 U	200 U	200 U	200 U
Tokuthion	80 U	80 U	80 U	80 U	80 U
Trichloronate	20 U	20 U	20 U	20 U	20 U
Ethion	20 U	20 U	20 U	20 U	20 U
(Surr) 4Chloro-3Nitrobenzotrifl (%)	58	50	40	42	40

U = Undetected. The value preceeding the 'U' is the RL for the analyte, based on dilution. Results reported on a Wet Weight basis.

Reviewed by :

Quality Control Report for Spike/Spike Duplicate Analysis

Organophosphorus Pesticides

Matrix: Soil
Lab Sample ID: 202020140-2
QC Batch ID: 200204OP047
Spike Units: ug/kg

Analysis Date: 04/29/2002
Preparation Date: 04/26/2002
Method: EPA 8141
Analyst: RM

Analyte	Spike Amount	Sample Result	Spike Result	Spike Percent Recovery	MSD Result	MSD Percent Recovery	RPD
Diazinon	2	0	2	75	2	80	6
Parathion methyl	2	0	2	91	2	93	2
Phorate	2	0	2	75	2	83	10

Quality Control Limits

Analyte	Lower Limit	Upper Limit	RPD
Diazinon	40	140	25
Parathion methyl	40	140	25
Phorate	40	140	25

Report of Analysis

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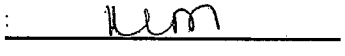
PHONE: 407-359-7194
FAX: 407-359-7197

PCB in Soil

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002
ANALYTICAL PROTOCOL: EPA 8082

Lab Reference Number	202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID	JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled	04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Date/Time Extracted	04/26/2002	04/26/2002	04/26/2002	04/26/2002	04/26/2002
Date/Time Analyzed	04/27/2002 04:25	04/27/2002 05:00	04/27/2002 05:36	04/27/2002 06:11	04/27/2002 06:47
Sample Matrix (as Received)	Soil	Soil	Soil	Soil	Soil
Analysis Confirmed	No	No	No	No	No
Dilution Factor	1	1	1	1	1
Result Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Arochlor 1016 (PCB)	80 U	80 U	80 U	80 U	80 U
Arochlor 1221 (PCB)	80 U	80 U	80 U	80 U	80 U
Arochlor 1232 (PCB)	80 U	80 U	80 U	80 U	80 U
Arochlor 1242 (PCB)	80 U	80 U	80 U	80 U	80 U
Arochlor 1248 (PCB)	80 U	80 U	80 U	80 U	80 U
Arochlor 1254 (PCB)	80 U	80 U	80 U	80 U	80 U
Arochlor 1260 (PCB)	80 U	80 U	80 U	80 U	80 U
(Surr) Decachlorobiphenyl (%)	81	81	106	80	90

U = Undetected. The value preceeding the 'U' is the RL for the analyte, based on dilution. Results reported on a Wet Weight basis.

Reviewed by : 

Quality Control Report for LCS Analysis

PCBs in Soil

Matrix: Soil
Lab Sample ID: LCS
QC Batch ID: 200204PCB021A
LCS Units: ug/kg

Analysis Date: 04/26/2002
Preparation Date: 04/26/2002
Method: EPA 8082
Analyst: RM

Analyte	LCS Conc	LCS Result	Percent Recovery	Lower Control Limit	Upper Control Limit
(Surr) Decachlorobiphenyl	100	104	104	**24**	**154**
Arochlor 1254 (PCB)	825	850	103	**80**	**120**

PC&B Environmental Laboratories, Inc.
210 Park Road
Oviedo, FL 32765-8801
PHONE: 407-359-7194

Report of Analysis

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002

Lab Reference Number			202040247-1		202040247-2		202040247-3		202040247-4		202040247-5	
Client Sample ID			JESUP #1		JESUP #11		JESUP #16		JESUP #25		JESUP #30	
Date/Time Sampled			04/23/2002 13:00		04/23/2002 15:30		04/23/2002 14:45		04/23/2002 13:40		04/23/2002 11:15	
Sample Matrix (as Received)			Soil		Soil		Soil		Soil		Soil	
EPA 160.3	Percent Solids	%	45.50		14.40		31.40		17.60		10.20	
EPA 160.4	Total Organic Content	%	46.75		85.25		63.21		75.33		87.42	
EPA 9045	pH	Units	8.47		6.29		7.58		6.25		7.29	
EPA 6010	Arsenic, Total	mg/kg	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
EPA 6010	Barium, Total	mg/kg	4		2		8		6		3	
EPA 6010	Cadmium, Total	mg/kg	0.2		0.1	U	0.4		0.2		0.2	
EPA 6010	Calcium, Total	mg/kg	1040		1370		1860		1800		1680	
EPA 6010	Chromium, Total	mg/kg	1.7		0.5		1.1		1.5		0.1	U
EPA 6010	Copper, Total	mg/kg	2.6		2.6		1.7		5.8		1.0	
EPA 6010	Iron, Total	mg/kg	1140		605		2280		1080		1480	
EPA 6010	Lead, Total	mg/kg	2.2		1.1		2.2		3.7		0.9	
EPA 6010	Magnesium, Total	mg/kg	230		170		280		135		145	
EPA 7471	Mercury, Total	mg/kg	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
EPA 1664	Oil & Grease	mg/kg	10	U	10	U	10	U	10	U	10	U
EPA 6010	Phosphorus, Total	mg/kg	93.0		80.0		100		140		52.0	
EPA 6010	Potassium, Total	mg/kg	58.0		48.0		50.0		46.0		21.0	
EPA 6010	Selenium, Total	mg/kg	0.5	U	0.5	U	0.5	U	0.5	U	1.0	
EPA 6010	Silver, Total	mg/kg	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
SM 2340B	Total Hardness as CaCO3	mg/kg	35		41		58		51		48	
EPA 9200/351.2	Total Nitrogen	mg/kg	1370		1870		1950		1590		2140	
EPA 6010	Zinc, Total	mg/kg	5.0		7.0		7.7		12.0		4.5	

U = Undetected. The value preceeding the 'U' is the RL for the analyte. Results reported on a Wet Weight basis.

FDEP CompQAPP # 900134G - FDOH Certification # E83239

Reviewed by : lum

Quality Control Report for Spike Analysis

INORGANICS

Analyte		Spike Amount	Sample Result	Spike Result	Percent Recovery	Lower Control Limit	Upper Control Limit
Method: EPA 9073	QC Batch: 200204OAG012	Sample ID: 202040191-18	Date Prep: 04/26/2002	Date Anal: 04/29/2002		Analyst: GIG	
Oil & Grease		50 mg/kg	0	52	104	75	120
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Arsenic, Total		20.0 mg/kg	0.0	17.3	87	68	114
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Barium, Total		50.0 mg/kg	0.0	52.0	104	71	123
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Cadmium, Total		10.0 mg/kg	0.0	9.7	97	70	113
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Calcium, Total		500.0 mg/kg	529.0	962.0	87	62	125
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Chromium, Total		10.0 mg/kg	0.0	10.6	106	69	126
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Copper, Total		10.0 mg/kg	5.8	15.6	98	73	120
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Iron, Total		200.0 mg/kg	23.0	240.0	109	70	130
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Lead, Total		10.0 mg/kg	0.0	9.4	94	66	123
Method: EPA 6010	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Magnesium, Total		500.0 mg/kg	103.0	555.0	90	70	120
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Phosphorus, Total		200.0 mg/kg	310.0	530.0	110	70	120
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Potassium, Total		500.0 mg/kg	87.0	540.0	91	50	164
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Selenium, Total		10.0 mg/kg	0.0	9.3	93	59	110
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Silver, Total		10.0 mg/kg	0.0	9.5	95	65	114
Method: EPA 6010A	QC Batch: 200204RC177	Sample ID: 202040180-1	Date Prep: 04/24/2002	Date Anal: 04/24/2002		Analyst: GG	
Zinc, Total		20.0 mg/kg	12.0	30.0	90	66	119
Method: EPA 7471	QC Batch: 200204HG159	Sample ID: 202040180-1	Date Prep: 04/23/2002	Date Anal: 04/23/2002		Analyst: LS	
Mercury, Total		0.1700 mg/kg	0.0000	0.1800	106	70	140

PC&B Environmental Laboratories, Inc.
210 Park Road
Oviedo, FL 32765-8801
PHONE: 407-359-7194

Report of Analysis

CLIENT NAME: Parsons Brinkerhoff Companies
PROJECT NAME: Lake Jesup
PROJECT NUMBER: 25508A
DATE RECEIVED: 04/23/2002

Lab Reference Number			202040247-1	202040247-2	202040247-3	202040247-4	202040247-5
Client Sample ID			JESUP #1	JESUP #11	JESUP #16	JESUP #25	JESUP #30
Date/Time Sampled			04/23/2002 13:00	04/23/2002 15:30	04/23/2002 14:45	04/23/2002 13:40	04/23/2002 11:15
Sample Matrix (as Received)			Soil	Soil	Soil	Soil	Soil
EPA 9060	Total Organic Carbon	mg/kg	175	340	270	650	995

NR = Analysis not Requested.

U = Undetected. The value preceeding the 'U' is the RL for the analyte. Results reported on a Wet Weight basis.

FDEP CompQAPP # 900134G - FDOH Certification # E83239

Reviewed by : NLM

32421

PC&B Environmental

210 Park Road, Oviedo, FL 32765
407-359-7194 (FAX) 407-359-7197

Chain of Custody

Work Order: 20204024 7

Date: 4/23/02 Page 1 of 1

COMPANY: PARSONS BRINCKERHOFF
ADDRESS: 100 E PINE ST SUITE 500
ORLANDO FL 32801
SAMPLED BY: DALE HELMS SIGN:
PHONE: 407-587-7800 FAX: 407-587-7960

#	SAMPLE ID	DATE/TIME	MATRIX: AIR	WATER	SLUDGE	SOIL/SOLID	ORG. LIQUID	8081/82	8021	8141	8270	8310	Metals	TOC/TKN	7471	pH	% solids	1664 (oil & grease)					Number of Containers
								PRESERVATION															
1	Jesup #1	4/23/02 13:00				X		X	X	X	X	X	X	X	X	X	X	X					2
2	Jesup #11	4/23/02 15:30				X		X	X	X	X	X	X	X	X	X	X	X					2
3	Jesup #16	4/23/02 14:45				X		X	X	X	X	X	X	X	X	X	X	X					2
4	Jesup #25	4/23/02 13:40				X		X	X	X	X	X	X	X	X	X	X	X					2
5	Jesup #30	4/23/02 11:15 AM				X		X	X	X	X	X	X	X	X	X	X	X					2
6																							
7																							
8																							
9																							
10																							
11																							
12																							
13																							

ANALYSIS REQUESTED

RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME
1: D. Dale Helms	4/23/02 17:48	1: Daufat	4-23-02 1748
2:		2:	
3:		3:	

SPECIAL INSTRUCTIONS/COMMENTS:

QUOTE/CONTRACT #: Q1748

PROJECT INFORMATION

PROJECT NAME: LAKE JESUP
PROJECT #: 25508A
SITE ADDRESS: SEMINOLE COUNTY, FL
PROJECT MANAGER: DALE HELMS, P.E.

SAMPLE RECEIPT

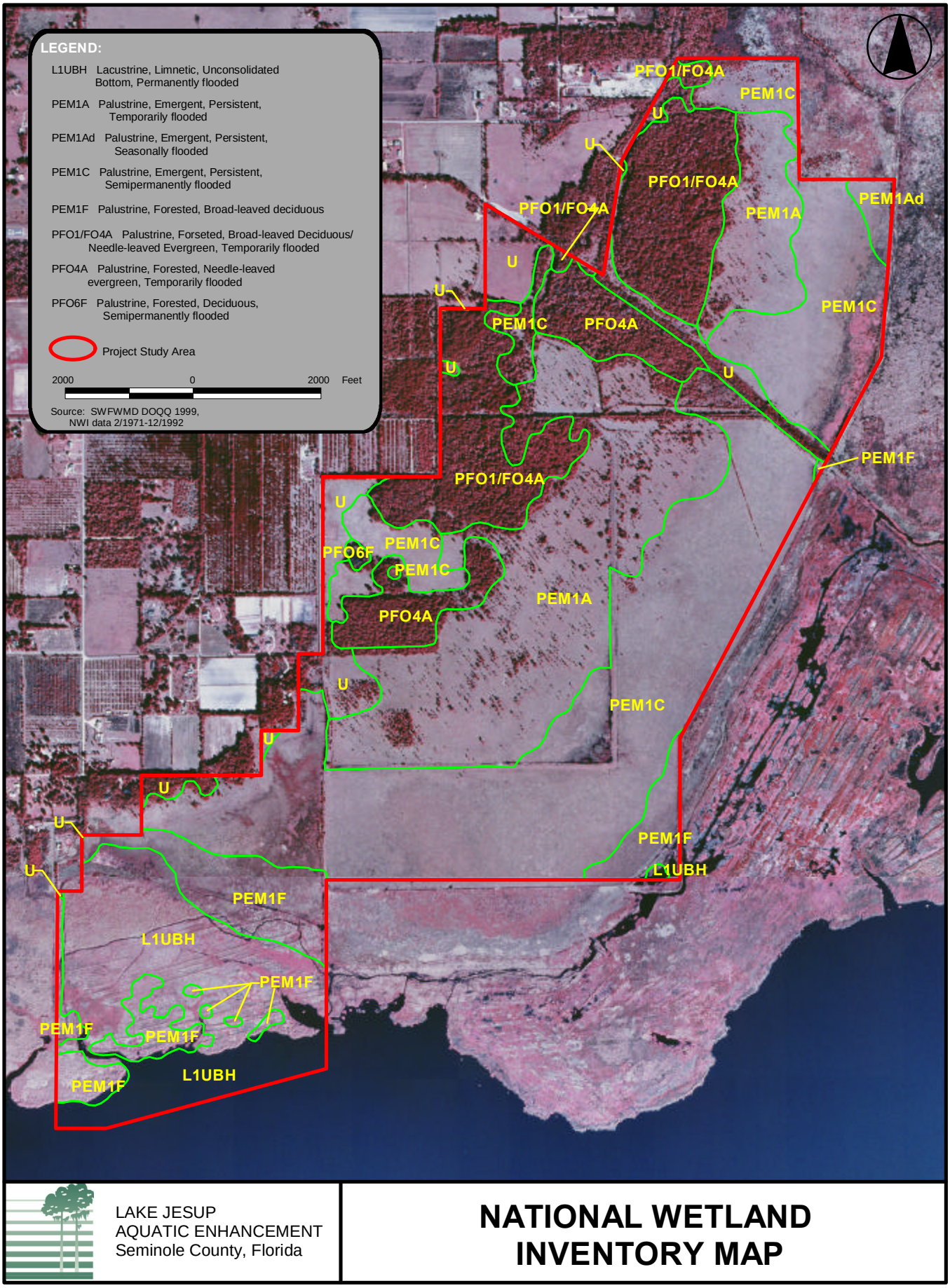
Total # of Containers:
Chain of Custody Seals:
Recv'd in Good Condition:
PO #:

INVOICE TO:
(IF DIFFERENT FROM ABOVE)

WHITE: Project File YELLOW: Laboratory PINK: Sampler

APPENDIX G

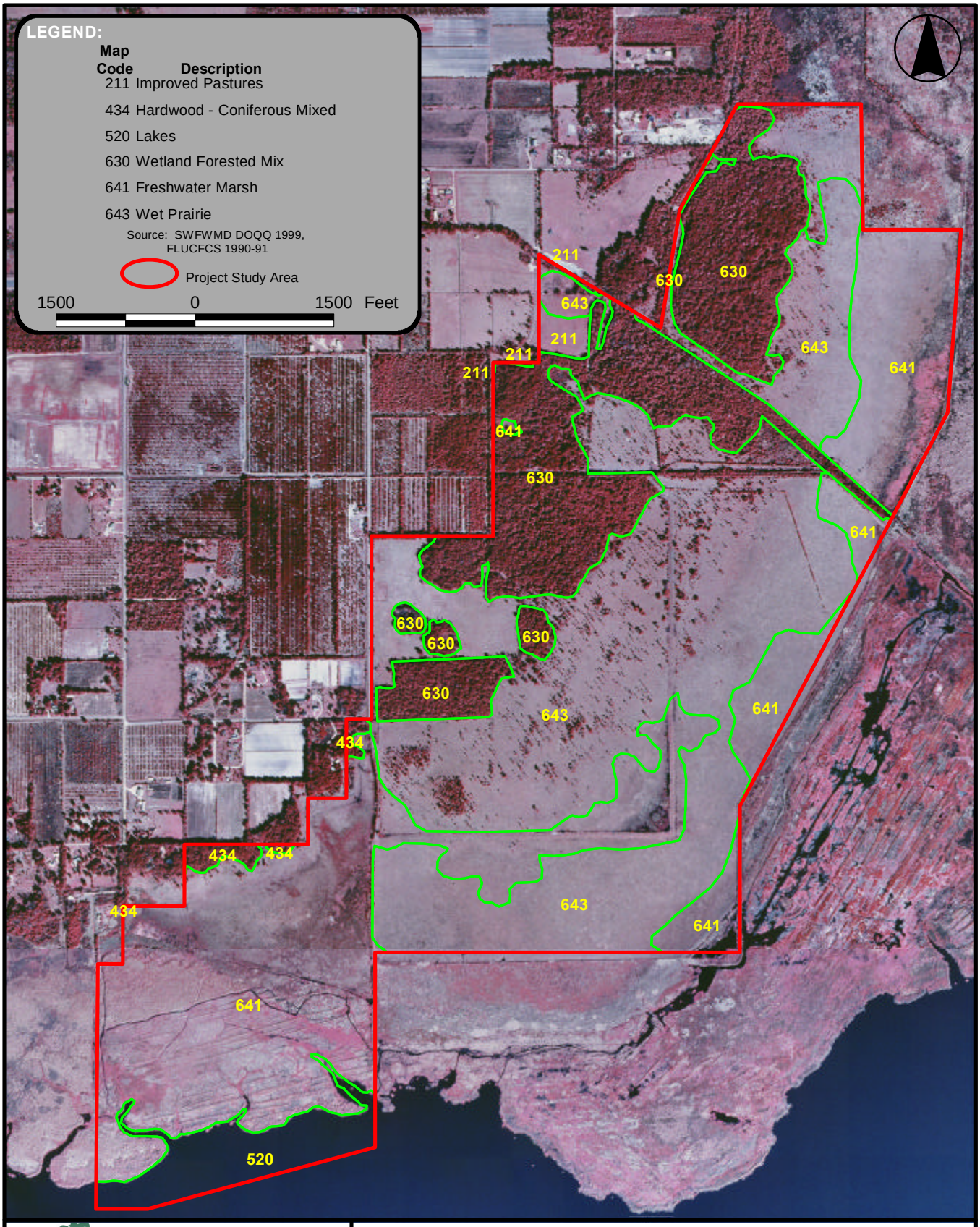
GIS-Based Environmental Assessment of Cameron/Little Ranch Site
Scheda Ecological Associates, Inc., August 2002



LAKE JESUP
AQUATIC ENHANCEMENT
Seminole County, Florida

NATIONAL WETLAND INVENTORY MAP

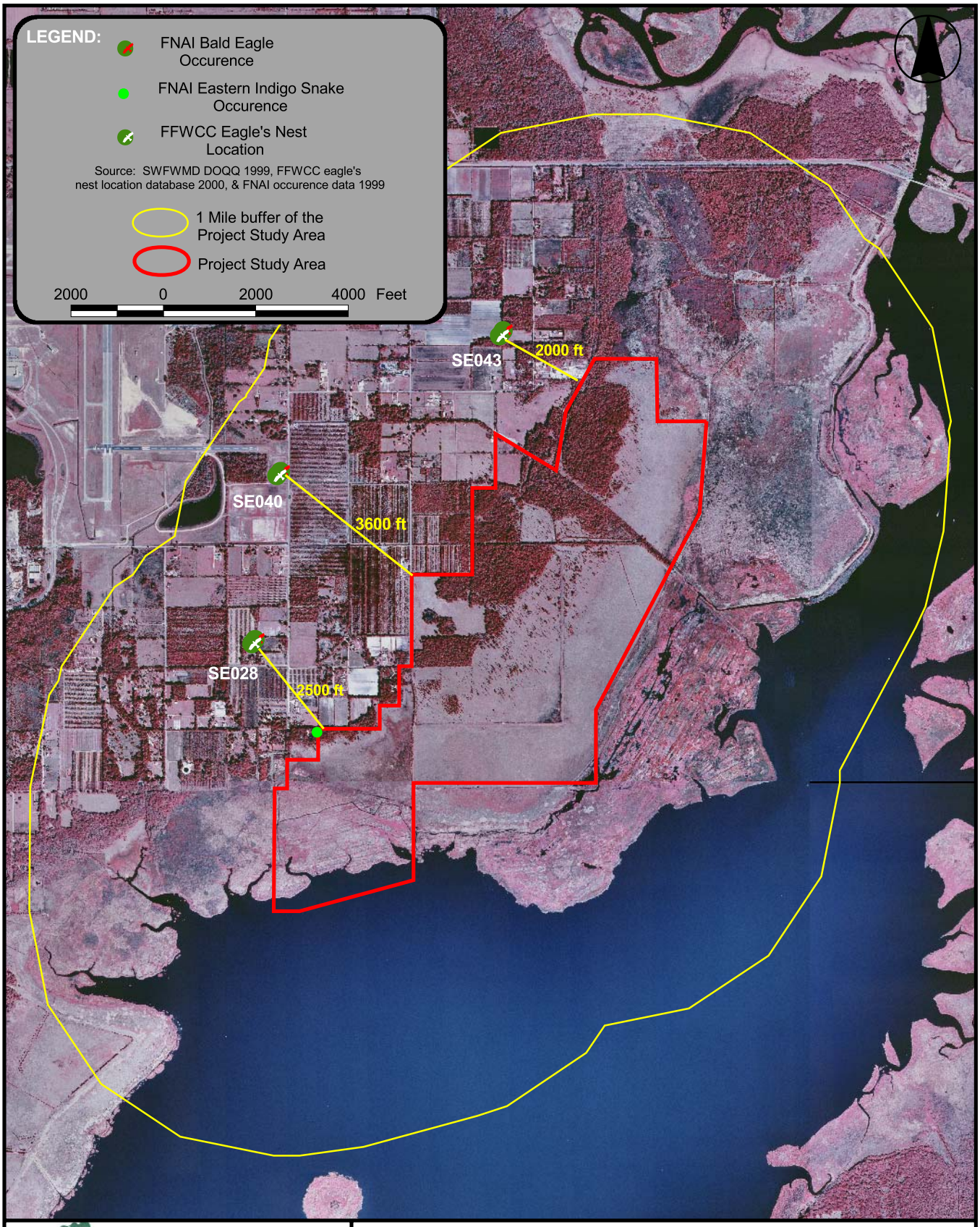
G\x\PROJECTS\503\503Prop.



LAKE JESUP
AQUATIC ENHANCEMENT
Seminole County, Florida

1995 FLUCFCS MAP

G\x\PROJECTS\503\503Prop.



LAKE JESUP
AQUATIC ENHANCEMENT
Seminole County, Florida

FNAI ELEMENT OCCURRENCE & BALD EAGLE NEST MAP

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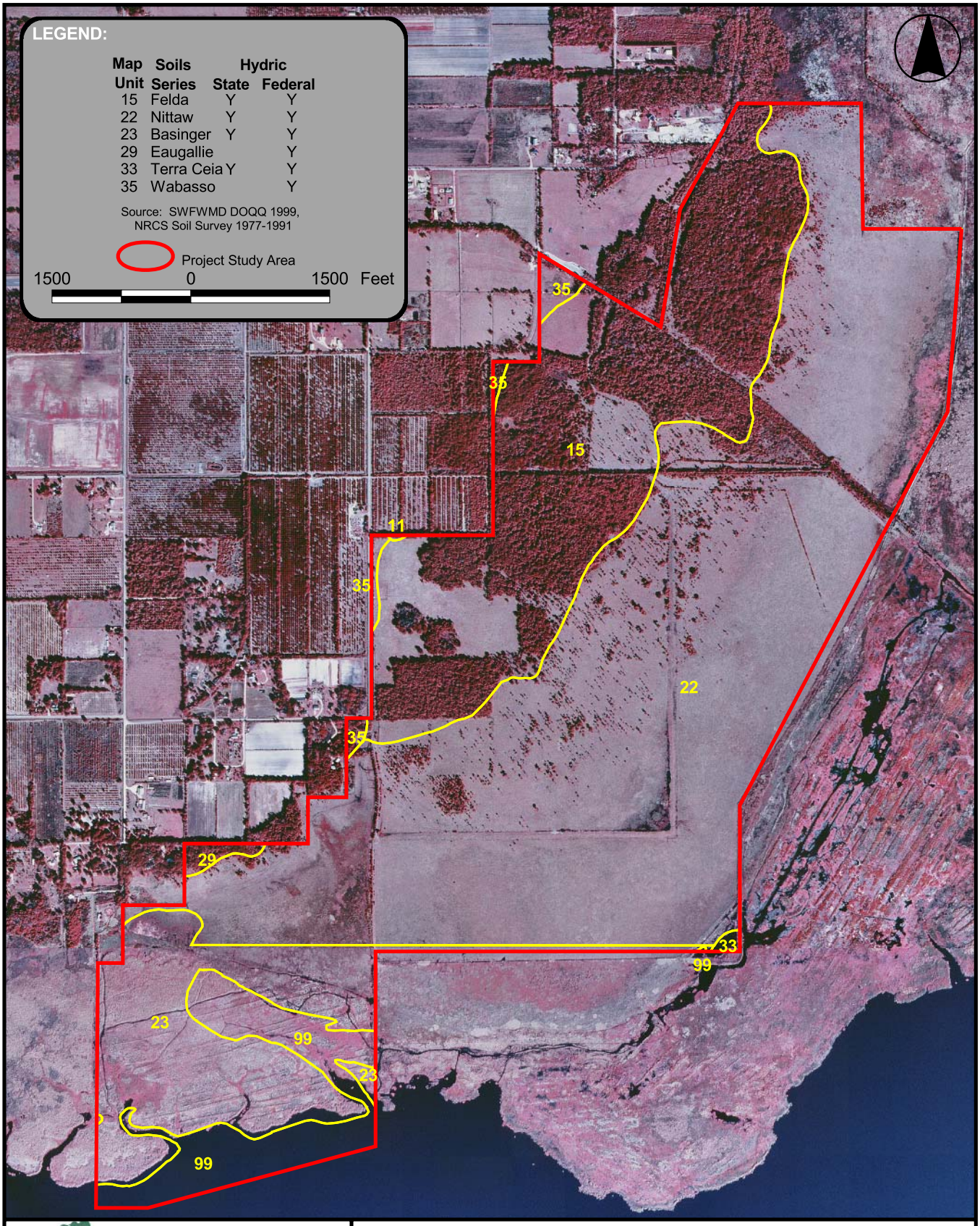

LAKE JESUP
AQUATIC ENHANCEMENT
Seminole County, Florida

SOILS MAP

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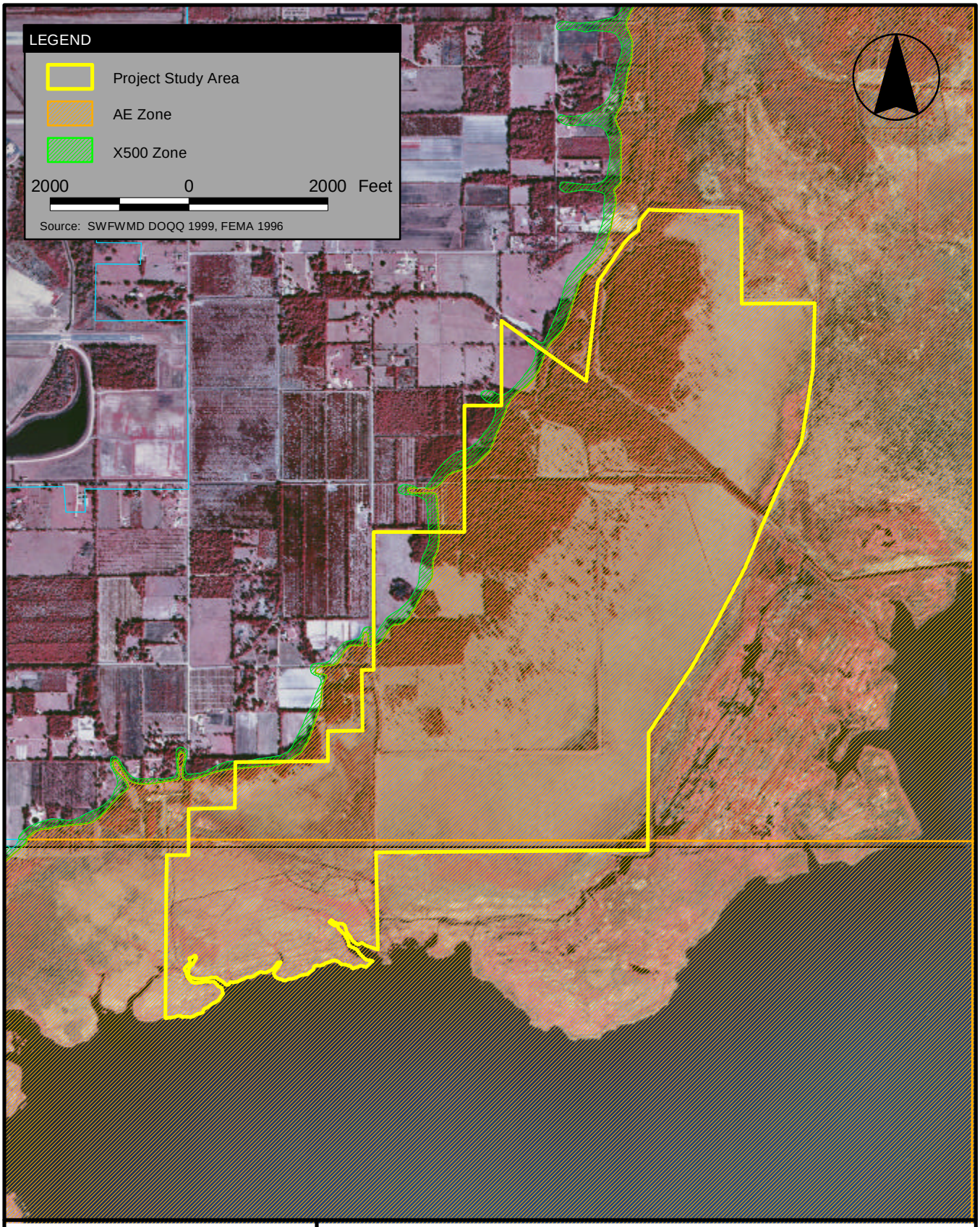

LAKE JESUP
AQUATIC ENHANCEMENT
Seminole County, Florida

1996 FEMA MAP

G\x\PROJECTS\503\503Prop.

APPENDIX H

Lake Jesup Ordinary High Water Line Designation by the State
Letter from the Florida Department of Environmental Protection, April 9, 2002

Department of Environmental Protection

Jeb Bush
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000
Please Respond to:
Division of State Lands
Bureau of Survey and Mapping
Title and Land Records Office
Mail Station 108
(850)488-8128

David B. Struhs
Secretary

April 9, 2002

Ed Hayes
Florida Fish and Wildlife Conservation Commission
Eustis Fisheries Research Lab
601 West Woodward Avenue
Eustis, Florida 32726

Dear Mr. Hayes:

Re: State Interest in Lake Jessup, Seminole County

Thank you for your recent inquiry requesting a determination of the Board of Trustees of the Internal Improvement Trust Fund's interest in the submerged lands of Lake Jessup, and adjacent uplands which in Sections 3, 10, 11, 14 and 15, Township 20 South, Range 31 East, Seminole County.

The Board of Trustees, on behalf of the people of the State of Florida, holds title to all natural waterbodies that are navigable in their ordinary condition. No records of any conveyances of sovereignty lands involving Lake Jessup were found at this site. No state interest was found in the adjacent uplands. Therefore, the state will claim ownership of the submerged lands lying below the ordinary high water line (OHWL) of Lake Jessup by virtue of sovereignty. Pursuant to Section 253.77 (1), F.S. any activity occurring waterward of the ordinary high water line will require authorization to use state owned lands. Although the OHWL has not been determined at this location, the elevation of 3.0 NGVD29 is considered to be at, or above the OHWL of Lake Jessup. Activities lying above a contour line along the natural shoreline at this elevation is, therefore, landward of the OHWL.

Thank you again for your inquiry. If this office can be of any further assistance regarding this determination, please address your questions to Melanie Knapp, Planner II, mail station No. 108 at the above letterhead address, or by telephone at (850) 488-8123.

Sincerely,

for Terry E. Wilkinson, Chief
Bureau of Survey and Mapping
Division of State Lands

TEW/mjk
F:\TITLE\MELANIE\2002-2\LakeJessup.doc

APPENDIX I

Cultural Resources Survey and Assessment,
Lake Jesup Aquatic Enhancement Project, Seminole County, Florida
SouthArc, Inc., June 2002

CULTURAL RESOURCES SURVEY AND ASSESSMENT, LAKE JESUP AQUATIC HABITAT ENHANCEMENT PROJECT, SEMINOLE COUNTY, FLORIDA

Prepared for:

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
Eustis Fisheries Research Laboratory
601 W. Woodward Avenue
Eustis, FL 32726-4560

Prepared by:

Martin F. Dickinson, RPA
Lucy B. Wayne, Ph.D., RPA
SOUTHARC, INC.
3700 NW 91st Street, Suite D300
Gainesville, FL 32606
(352)372-2633

June 28, 2002
258-02-01

SouthArc, Inc.

Specializing in Archaeological/Historical Services

Members Register of Professional Archaeologists (RPA)

American Cultural Resources Association (ACRA)

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INTRODUCTION
PROJECT PURPOSE AND EXECUTIVE SUMMARY

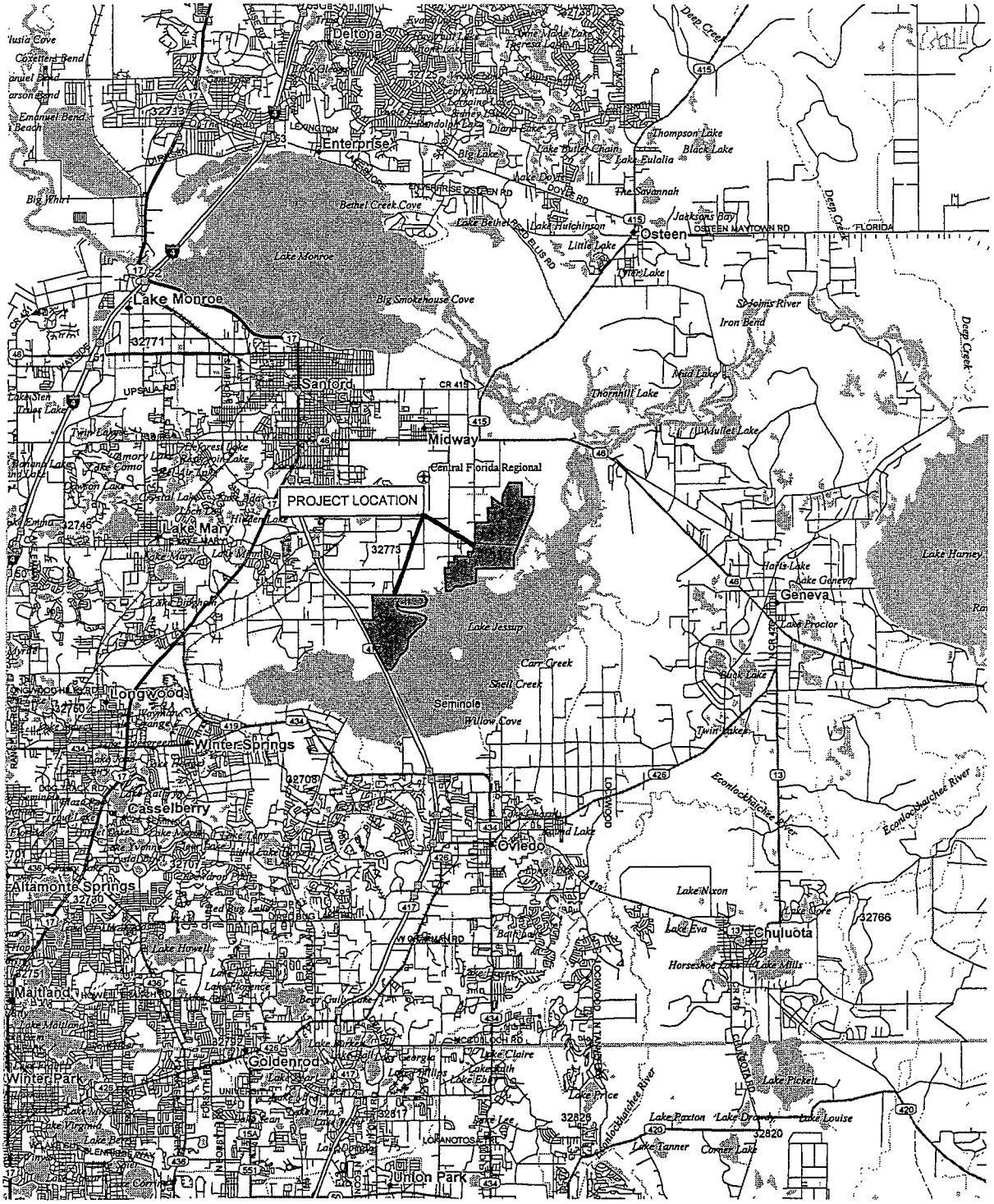
The Florida Fish and Wildlife Conservation Commission (FFWCC) proposes a series of lake enhancement projects for Lake Jesup in Seminole County. These efforts include demucking at one location and upland dredge disposal at two locations along the lake (Figure 1). The Florida Division of Historical Resources (FDHR) reviewed the proposed activities as part of its responsibilities under Section 267.061, Florida Statutes. As a result of this review, they requested that a cultural resources survey be conducted within the proposed upland disposal areas. FDHR further requested that a training session and periodic archaeological monitoring be conducted during the demucking process, due to the possibility of cultural remains such as canoes in the wetland areas. Since the property in question is state-owned, the cultural resources survey would be conducted under a Chapter 1A-32 Archaeological Research Permit (Appendix A).

FFWCC contracted with SouthArc, Inc. of Gainesville, Florida to provide the required cultural resources services. The fieldwork was conducted in May and June, 2002 by Martin F. Dickinson, RPA, President of SouthArc. Project documentation was prepared by Lucy B. Wayne, Ph.D., RPA, Vice President.

The project consisted of three basic areas: (1) the lake enhancement area at the interface of the Marl Bed Flats and the lake, a littoral habitat, (2) an upland disposal area within the Marl Bed Flats, and (3) an upland disposal/muck retention area at Cameron Ranch, a low muck area. The littoral enhancement area was surface inspected where accessible and also inspected using an airboat provided by FFWCC. Shallow water areas were carefully examined for possible evidence of canoes. The Marl Bed Flats upland disposal area was surface inspected using a metal detector. Attempts were also made to excavate test units in this area, but the marl was impenetrable with a sharpened shovel. The Cameron Ranch disposal area was also surface inspected with the metal detector. Attempts were made to shovel test low rises within this area, but again the marl was impenetrable. A transect of test units was attempted at the interface with the uplands, again hitting impenetrable marl.

The only cultural materials recovered were the result of modern land use activities. No archaeological sites were identified. In our opinion, the marl found throughout the project area limits cultural activity due to its frequently flooded nature, impenetrable subsurface and lack of wildlife cover. The somewhat higher hammocks around the lake would have been much more attractive habitation locations, as has been documented in previous studies of the Lake Jesup area (Wayne and Dickinson 1993).

In our opinion, the proposed demucking and disposal in the project areas will not impact any significant cultural resources. We recommend that no further research other than periodic monitoring be required.


PROJECT LOCATION
Deltona
Enterprise
Osteen
Lake Monroe
Sanford
Midway
Central Florida Regional
Lake Mary
Longwood
Winter Springs
Casselberry
Oviedo
Altamonte Springs
Maitland
Winter Park
Goldenrod
Union Park
Geneva
Chuluota
Lake Jesup
Seminole
Willow Cove
Shell Creek
Carr Creek
Econlockhatchee River
Lake Nixon
Lake Eva
Lake Pickett
Lake Price
Lake Tanner
Lake Louise
Lake Proctor
Lake Harney
Thornhill Lake
Mud Lake
Iron Bend
St Johns River
Deep Creek
Big Whirl
Big Smokehouse Cove
Bethel Creek Cove
Lake Bethel
Lake Hutchinson
Little Lake
Thompson Lake
Black Lake
Lake Eulalia
Lake Butler Chain
Lake Dovle
The Savannah
Jackson's Bay
Lake Monroe
Lake Sienn
Tibet Lake
Twin Lakes
Lake Como
Lake Emma
Lake Minnie
Lake Fairview
Lake Howell
Lake Florence
Lake Claire
Lake Keith
Lake Ethel
Lake Pickett
Lake Paxton
Lake Druid
Lake Concord
Lake Tibet
Lake Virginia
Lake Berry
Lake Sue
Lake Irma
Lake Jean
Lake Mills
Horseshoe Lake
Twin Lakes
Hatts Lake
Lake Geneva
Lake Jessup
Carr Creek
Shell Creek
Seminole
Willow Cove
Econlockhatchee River
Lake Nixon
Lake Eva
Lake Pickett
Lake Price
Lake Paxton
Lake Druid
Lake Louise
Lake Tanner
Corner Lake
Lake Proctor
Lake Harney
Mud Lake
Thornhill Lake
Iron Bend
St Johns River
Deep Creek
Big Whirl
Big Smokehouse Cove
Bethel Creek Cove
Lake Bethel
Lake Hutchinson
Little Lake
Thompson Lake
Black Lake
Lake Eulalia
Lake Butler Chain
Lake Doy

PROJECT SETTING

The project consists of three areas within two large tracts of land on the northwest side of Lake Jesup (Figure 2). The Marl Bed Flats tract consists of 500 acres in two areas: the enhancement area along the shoreline of the lake in Sections 20 and 29, and an uplands disposal area in Sections 19 and 20 of Township 20 South, Range 31 East. The 700-acre Cameron Ranch tract consists of the interface of the uplands and wetlands prairie in Sections 2, 3, 10, 11 and 15 of Township 20 South, Range 31 East.

Lake Jesup lies within the St. Johns Offset of the Central Lake District physiographic region (Brooks 1981). The Central Lake District "is a sandhill karst with solution basins" which serves as "the principle recharge area of the Floridan aquifer" (Brooks 1981:6). The St. Johns Offset is an ancient part of the St. Johns River valley which was formerly an estuary. Limestone is near the surface in this region and there are a number of large springs which discharge water from the aquifer (Brooks 1981). Elevations within the project tracts are below five feet, mean sea level (USGS 1980a, b and c).

The lake itself is an interesting body of water. It is the largest lake in Seminole County, draining an area of approximately 139 square miles. It is actually part of the St. Johns River, to which it is connected on the northeast. This linkage limits the drainage of the lake, since the river effectively acts as a "tailwater" (USDA 1991:4-5). The lake is fed by several creeks and springs, including Soldier, Howell, Sweetwater, Six Mile and Gee Creeks and Clifton Springs on the south shore (FEMA 1987:6-7). There are also artesian upwells in the lake bottom which increase its salinity (Frazee 1992). The rather shallow lake is 10,000 acres in size but only about seven feet deep (USDA 1991).

All three project tracts fall within the Nittaw-Felda-Floridana soil association. These are described as "Nearly level, very poorly drained and poorly drained mineral soils" found in floodplains and depressions (USDA 1988). The shoreline at the Marl Bed Flats contains Manatee, Floridana and Holopaw soils, described as frequently flooded, very poorly to poorly drained soils which support forested wetlands (Figure 3). The balance of the Marl Bed Flats tracts and the Cameron Ranch tract contain Nitaw muck, an occasionally flooded, very poorly drained soil which also supports forested wetlands (Figures 3 and 4; USDA 1990).

The varied habitats in and around Lake Jesup would have provided a variety of subsistence resources to prehistoric Native Americans, including fish, freshwater shellfish, reptiles, amphibians and migratory waterfowl from the lake, small mammals, reptiles, amphibians, birds, deer, and possibly bears in the uplands (USDA 1991, 1990; Bartram 1942). In addition, the hammocks would have yielded cabbage palm, hickory and acorn nuts, wild grapes, smilax, berries and tubers, as well as the raw materials for tools, structures, baskets and canoes. The soils within the project areas,

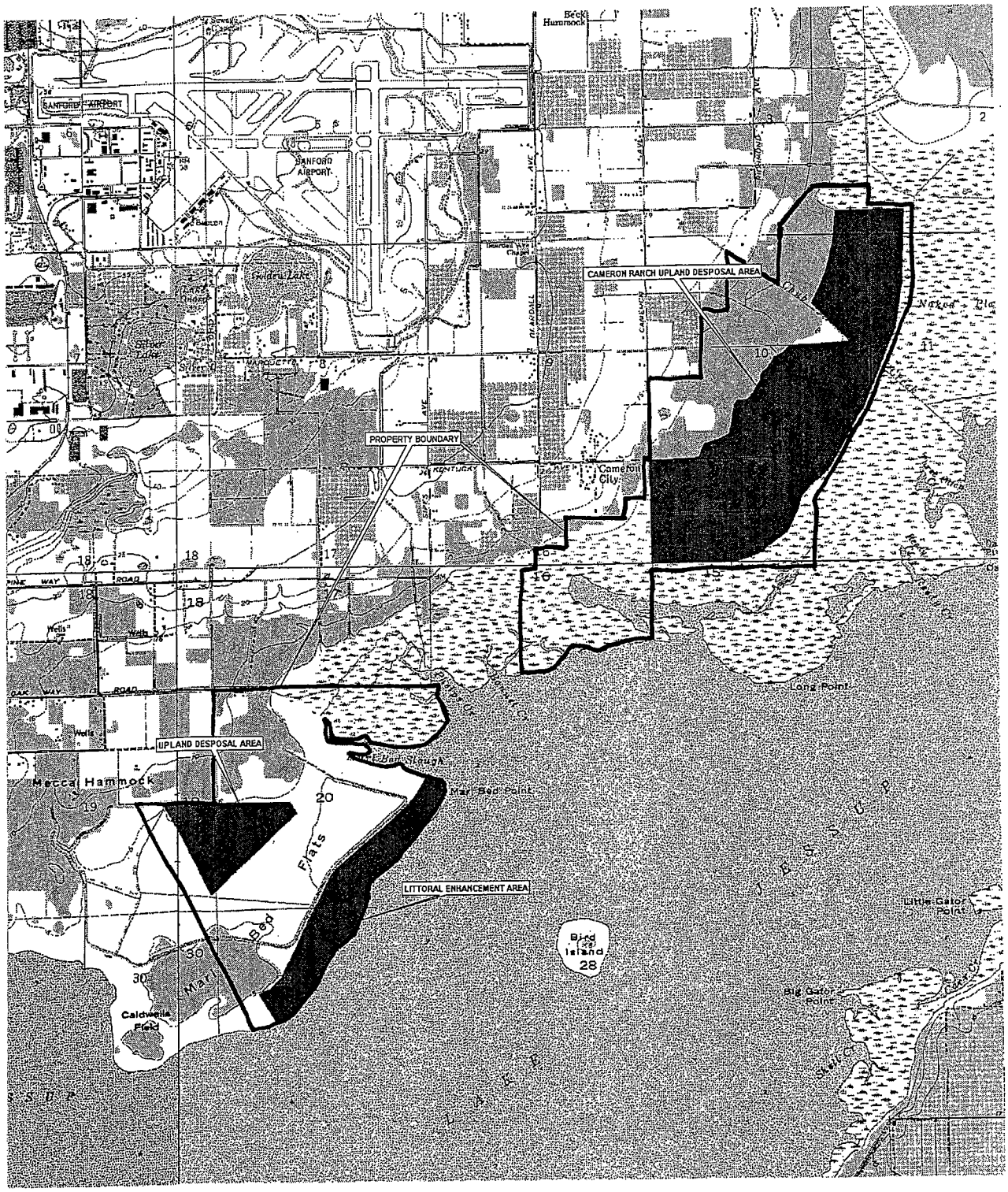


FIGURE 2. TOPOGRAPHIC MAP, LAKE JESUP AQUATIC ENHANCEMENT, SEMINOLE COUNTY, FLORIDA

SOURCE: DELORME 2000

SouthArc, Inc.

Archaeological and Historical Services

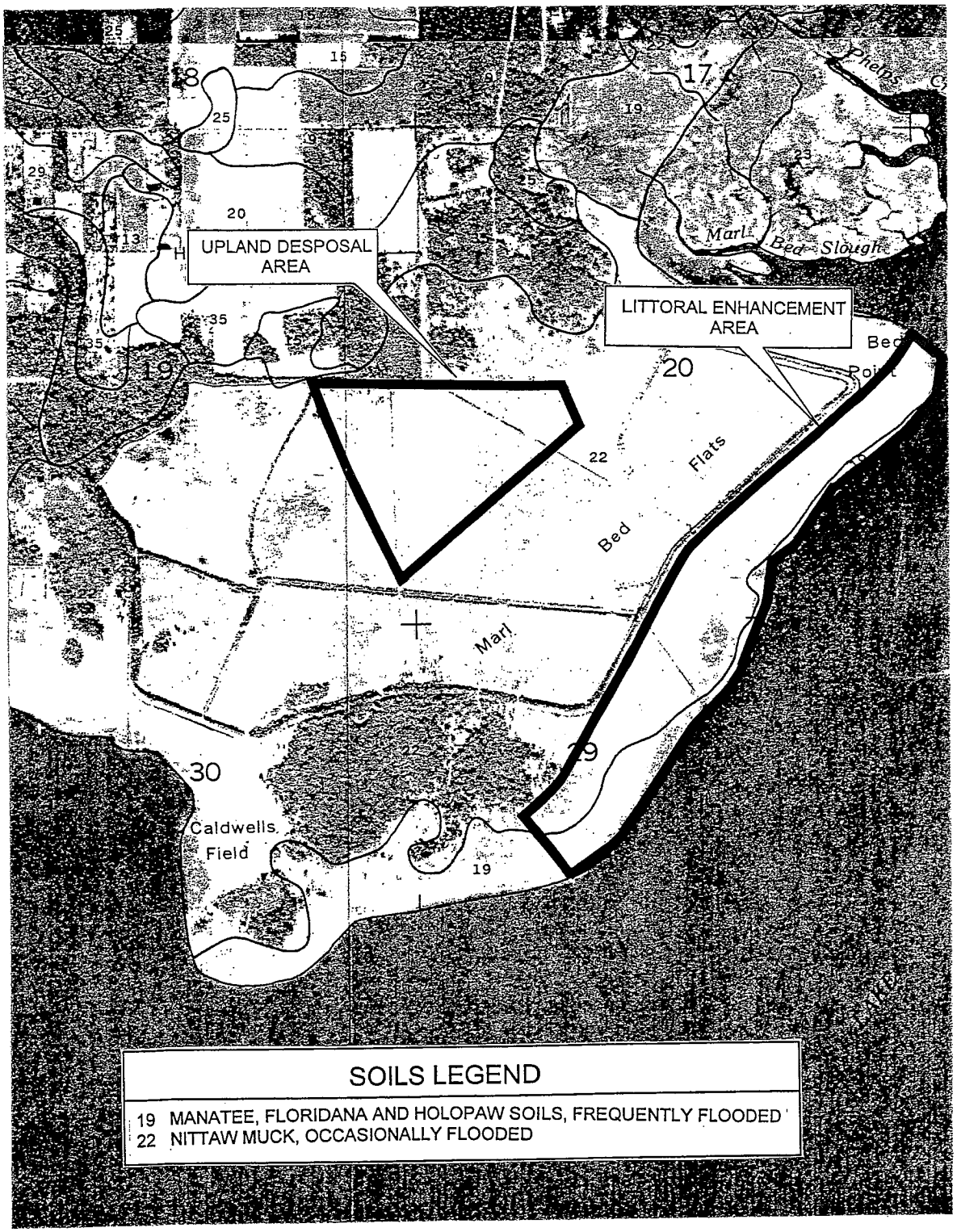


FIGURE 3. SOILS MAP, MARL BED FLATS, LAKE JESUP AQUATIC ENHANCEMENT, SEMINOLE COUNTY, FLORIDA

SOURCE: USDA 1990

SouthArc, Inc.

Archaeological and Historical Services

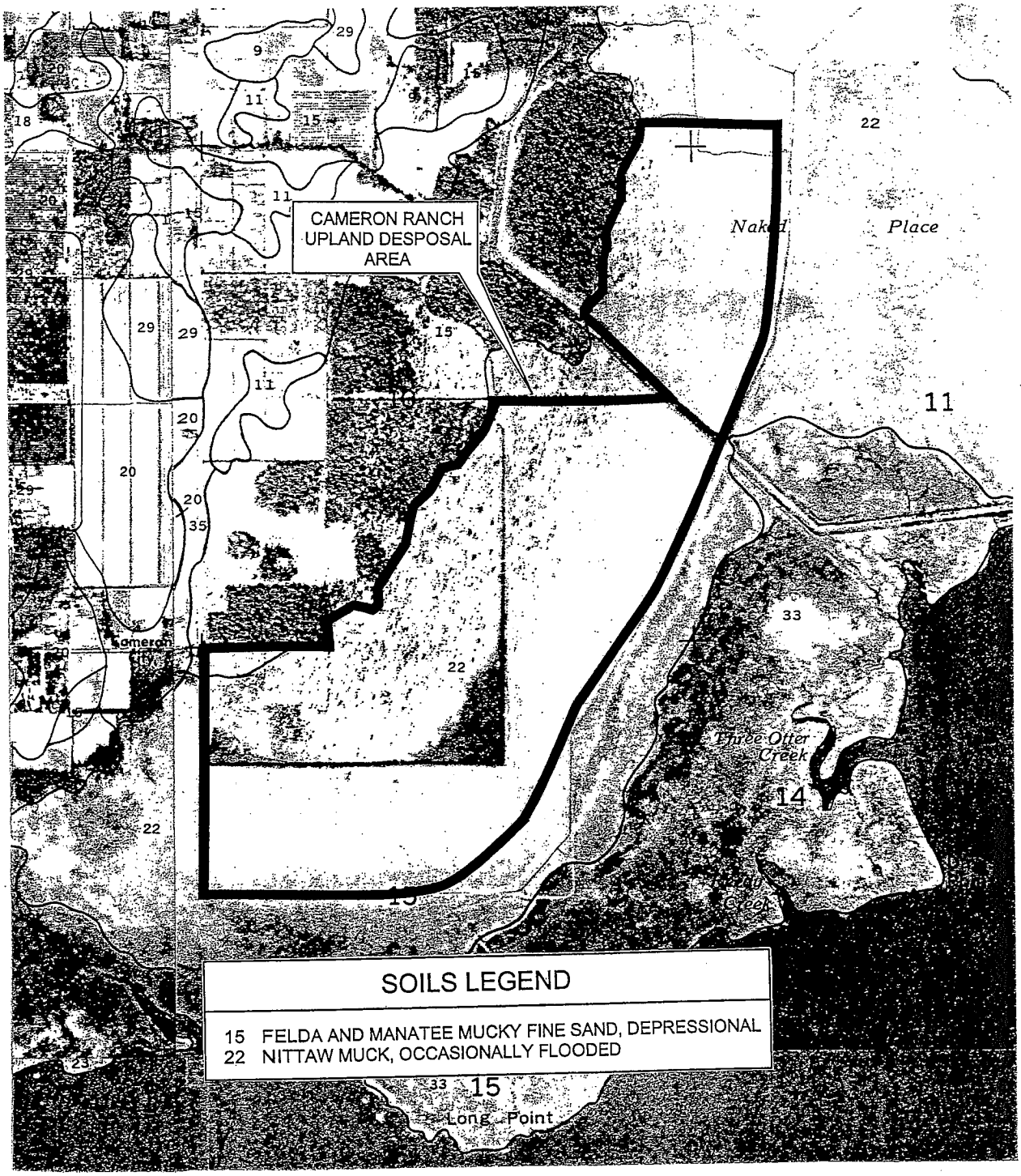


FIGURE 4. SOILS MAP, CAMERON RANCH, LAKE JESUP AQUATIC ENHANCEMENT, SEMINOLE COUNTY, FLORIDA

SOURCE: USDA 1990

SouthArc, Inc.

Archaeological and Historical Services

however, would have limited both prehistoric and historic occupation due to their poor drainage and frequent flooding. They would also have been unsuitable for agriculture.

Older aerial photographs show both tracts within the periodic flood zone of the lake (USDA 1940). There is a crisscross pattern of what appears to be either jeep or airboat trails and cattle trails within the tracts on these photographs. These trails probably functioned to drain the tracts as the water rose and fell. At the time of the photographs (April), they appear to be flooded. The present water control ditches did not exist in the 1940s. The Chub Creek canal at Cameron Ranch was much more limited at that time, and possibly incomplete in some areas. The hammock tree line was also further inland than at present. A number of cleared areas for pasture were visible in the cabbage palm stands at the time.

Presently the Marl Bed Flats shoreline is dominated by marsh vegetation up to an elevation of between two and three feet, mean sea level. The area above the marsh line is an exposed grass prairie which is frequently flooded. Based on water marks on palm trees further inland, the lake levels have extended beyond the five foot elevation point. Airboat trails are present within the marsh, with vegetation along the trails over six feet in height. The grass prairie area is maintained as a native pasture. An existing ditch and berm separate this area from the remainder of the Flats (Figure 2).

The Marl Bed Flats upland disposal area is at an elevation of four to six feet mean sea level with the northern boundary at the present tree line, which is maintained by current land use practices. This area has been recently bushhogged, leaving it open with scattered exposed surfaces (Figure 5).

Cameron Ranch is a native grass pasture with scattered cabbage palms. Small rises support stands of live oaks with occasional cabbage palms (Figure 5). The ecotone with the uplands is marked by the treeline. A canal has been dredged to drain Chub Creek through the prairie into the lake at the north end of this tract. A second north-south canal intersects the Chub Creek canal in the wetlands immediately east of the project tract (Figure 2).

UPLAND DISPOSAL AREA, MARL BED FLATS

CAMERON RANCH, TA-3, LOOKING SOUTHEAST

FIGURE 5. REPRESENTATIVE PHOTOGRAPHS, LAKE JESUP AQUATIC ENHANCEMENT, SEMINOLE COUNTY, FLORIDA

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REGIONAL CULTURAL HISTORY

Florida has been divided into a number of prehistoric cultural regions based on differences in the nature of the sites and the artifacts within each region. Lake Jesup lies within the East and Central Lakes Region as defined by Milanich and Fairbanks (1980). Although their discussion of this region emphasizes the eastern area within the St. Johns River Basin and the coastal zone, the basic cultural sequence for the Central Lakes area is believed to be similar to that to the east, based on the few excavations and sites identified within the area (Milanich and Fairbanks 1980). In addition, the two areas share similar environmental characteristics and their proximity and ready access to each other via the many streams and lakes would facilitate diffusion of both cultural traits and people.

It should be noted that Stewart (1992) identifies the Central Florida Lakes District as a separate cultural region bounded by Lake Tohopekaliga on the south, the upper Withlacoochee River on the west, the vicinity of Lake Harris on the north, and the St. Johns River floodplain on the east. She also separates the eastern portion of Milanich and Fairbanks' East and Central Lakes Region into two sections, the Northern St. Johns and the Indian River cultural areas; this division is basically at the point of the St. Johns Offset just north of Lake Jesup. Like Milanich and Fairbanks, Stewart believes that the location of the Central Florida Lake District facilitates a variety of influences from all of the surrounding cultural regions.

The following sections present a brief summary of the current understanding of the cultural traditions represented in the Central Lakes District, based on the archaeological studies to date. Dates given are based on those of Milanich and Fairbanks (1980):

Paleoindian	10,000-6,500 B.C.
Early Archaic	6,500-5,000 B.C.
Middle Archaic	5,000-4,000 B.C.
Mt. Taylor	4,000-2,000 B.C.
Orange	2,000-1,000 B.C.
Transitional	1,200-500 B.C.
St. Johns I	500 B.C.-A.D. 100
St. Johns Ia	A.D. 100-500
St. Johns Ib	A.D. 500-800
St. Johns IIa	A.D. 800-1300
St. Johns IIb	A.D. 1300-1513
St. Johns IIc	A.D. 1513-1565
Seminole	A.D. 1715-1842

The periods beginning with European contact are also considered to be the historic periods. This corresponds to St. Johns IIc and the Seminole periods of Native American occupation.

Paleoindian Period, 10,000-6,500 B.C.

In the traditional view of Paleoindians they are generally described as migratory hunters of the now extinct megafauna such as the mammoth and giant ground sloth. During this period, Florida was much cooler and drier, with the shorelines extending many miles further out from the present coast as a result of lower sea levels. It is believed that these Indians lived in small bands or family groups which followed the migrations of the megafauna on which they depended (Milanich and Fairbanks 1980). The majority of the known sites have been interpreted as "kill sites" located at springs or river crossings where the animals congregated (Milanich and Fairbanks 1980). Dunbar and Waller (1983) have also tied Paleoindian site distribution to access to karst outcroppings or deposits.

Recent research has indicated a broader subsistence pattern for Paleoindians, particularly in the Southeastern United States with its milder climate and abundant resources, even under the conditions of the Paleo environment. These studies postulate a more generalized hunter-gatherer pattern for the period (Goodyear *et al.* 1979). As Daniel and Wisenbaker (1987:134) state "...the idea of Paleoindian subsistence being almost totally dependent on big-game no longer seems tenable".

Paleoindian sites are identified by the presence of the distinctive fluted, lanceolate projectile points such as the Suwannee, Simpson and Clovis (Milanich and Fairbanks 1980). Late Paleoindian, or perhaps Early Archaic sites are marked by the presence of Santa Fe, Tallahassee, Dalton, Greenbriar, Bolen and Hardaway points as well as microlith assemblages (Bullen 1975; Milanich and Fairbanks 1980).

The nearest Paleoindian sites to the project area are located in Brevard, Marion, and Polk Counties. No sites from this period are known in the immediate vicinity of the project area. If sites do exist, it is probable that they would be located at stream crossings or in proximity to springs. Although there are springs at Lake Jesup, including Clifton Springs on the south side, it should be noted that recent research by Miller (1992) indicates that the St. Johns basin springs may not have been present during the Paleoindian period due to the lower sea level and lower water table at that time.

Archaic Tradition, 6,500-1,000 B.C.

The long Archaic Tradition is usually subdivided into three periods, Early, Middle, and Late Archaic, based on changes in the artifact assemblage and site patterns. These changes may have been closely related to the changing environmental conditions of the time. The environment during the Archaic gradually became more like that of today, with warmer, wetter conditions and a rise in sea level to near present heights. The megafauna of the Paleoindian period were either extinct or shifted their range to the north, leaving fauna typical of present-day Florida. This change began gradually during the Early Archaic and stabilized by the Late Archaic. As a result, the Middle to

Late Archaic is "marked by major differences in settlement pattern, subsistence strategies, and population size" (Miller 1992:100).

The Archaic Indians have traditionally been described as hunter-gatherers who, of necessity due to the environmental changes, exploited a wider range of resources than their predecessors. They were believed to migrate seasonally, although they were thought to have been somewhat more sedentary than Paleoindians (Torp 1991). Milanich and Fairbanks (1980) indicated a pattern of occupation of lowland villages near water sources from fall to spring, with dispersal for upland hunting in the summer. Archaic sites are characterized by a wide range of tools made from stone, shell, bone, and wood. The lithics from this tradition appear to be more crudely made than the finely crafted Paleoindian points; however, they display a greater variety of forms. The distinctive projectile points for the Archaic are large, stemmed types (Milanich and Fairbanks 1980).

Early Archaic (6,500 to 5,000 B.C.)

Both Stewart (1992) and Miller (1992) indicate that there is little evidence of Early Archaic occupation in the East and Central Lakes District, with the exception of the Windover Site near Titusville. Miller states that the rapidly rising sea level of this time would have inhibited coastal occupation because "the interface between land and sea was an extremely dynamic environment" which could not yet support significant subsistence resources (Miller 1992:101).

The diagnostic artifacts for the Early Archaic are stemmed points such as Arredondos, Hamiltons and Kirk Serrated (Bullen 1975). Other artifacts believed to be used during this period include bipointed bone points, barbed bone points, fish hooks, atlatl weights, and socketed antler handles (Milanich and Fairbanks 1980). The discovery of a cemetery at the Windover site indicates the beginning of burial ceremonialism, although midden burial with little regard for burial patterns is also known (Goggin 1952).

Middle Archaic (5,000 to 4,000 B.C.)

By the Middle Archaic the environment had generally stabilized at present conditions, although it was probably somewhat drier than today (Stewart 1992). According to Miller (1992), the rise in sea level by this period, coupled with climatic changes, would have resulted in the appearance of the artesian springs along the St. Johns River, as well as the beginnings of the coastal estuarine habitats. The increased water levels from the sea level rise and the new springs led to a dramatic change in the St. Johns River, which essentially became a drowned basin. The northern St. Johns is marked by tidal affects up to 150 miles from the mouth so that it is more like an estuary than a river, while the southern portion is "a system of connected lakes within a broad channel and an even broader flood plain" (Miller 1992:101). This environmental change provided an increased variety of subsistence resources ideal for the hunting-gathering patterns of the Archaic.

Although relatively few Middle Archaic sites are known in the Central Lakes portion of the East and Central Lakes District in comparison to those of later periods, this period is considered to mark the beginnings of well documented occupation of this region of Florida. Subsistence continued to be based on migratory hunting and gathering, although an increasingly wider variety of resources were exploited. Sites of this period are marked by the presence of large stemmed Newnan projectile points, drilled stone beads, and atlatl weights, as well as a variety of other lithic tools and debitage. Both shell and non-shell sites are known, while burial sites such as the Gauthier site indicate increasing ceremonialism. Both flexed and primary burials were recovered (Ste. Claire 1990).

Pre-Ceramic Late Archaic--Mt. Taylor (4,000 to 2,000 B.C.)

As a result of the increased water levels of the Archaic period, the southern portion of the St. Johns River provided the ideal environment to support freshwater shellfish, particularly *Viviparus georgianus*, which grows in colonies in the quiet waters of sloughs, creeks, lakes, ponds, and springs (Miller 1992; Cumbaa 1976). Stabilization of the ocean shoreline also led to establishment of coastal estuaries with their extensive oyster and coquina beds. As Miller says,

> For the first time in northeast Florida an environment existed which was sufficiently productive in terms of food resources, and sufficiently free from major change, to support a permanently settled way of life (Miller 1992:102).

The Pre-Ceramic Late Archaic or Mt. Taylor period is well-documented within the St. Johns River Basin. This period is marked by intensive exploitation of freshwater shellfish, as indicated by the extensive shell middens associated with riverine Mt. Taylor sites. This period marks a major change in settlement patterns and strategies of environmental exploitation, as well as a probable population increase (Miller 1992).

The Mt. Taylor type freshwater shell midden sites of the Late Archaic are characterized by the presence of freshwater snails, apple snails, and bivalve molluscs (Bullen and Bryant 1965). In addition to shell, Mt. Taylor middens contain bone from a variety of mammals, reptiles, birds, and fish. Hearths are indicated by areas of fused crushed shell with evidence of burning. Artifacts include Archaic stemmed points, steatite bannerstones (atlatl weights), other lithic tools and debitage, and bone and shell tools, particularly whelk gouges, bone awls or pins, bone points, and utilized antler. Midden burial continues to be utilized (Goggin 1952), but mass interments are also known at Tick Island and a site excavated by C. B. Moore (Milanich and Fairbanks 1980).

Ceramic Late Archaic--Orange Period (2,000 to 1,000 B.C.)

The Late Archaic Orange Period marks the first appearance of ceramics in the southeast. These early ceramics were primarily slab construction, tempered with plant fibers. Decoration included incising and punctation. Decorative treatments divide this period into four subperiods: (1) Orange 1 is characterized by predominantly plain ceramics; (2) Orange 2 is dominated by plain and

incised wares characterized by concentric vertical diamonds and the spiral patterns of Tick Island; (3) Orange 3 is characterized by use of incised straight lines both parallel and slanting, with some punctation; this subperiod includes the presence of steatite bowls as trade goods; (4) Orange 4 marks a return to simple incised forms (Milanich and Fairbanks 1980). Other than the ceramics, the artifact assemblages for this period are quite similar to the preceding Pre-ceramic Late Archaic or Mt. Taylor Period and include Archaic stemmed points, drilled and incised turtle carapaces, and lithic tools, particularly knives and scrapers. Evidence of the use of basketry and mats has been identified from impressions on pottery (Milanich and Fairbanks 1980).

Previous research on this period postulated a subsistence pattern of central-based occupation of the St. Johns River Basin with cold weather migration in small groups to the coast to exploit coquina, or to the interior uplands for hunting (Milanich and Fairbanks 1980). Recent research by Hale (1984) and Russo (Russo and Ste. Claire 1992) indicate that this may not be an accurate interpretation. Their studies indicate that both the river basin and the coast may have been occupied year-round by separate semi-nomadic groups which focused on intensive exploitation of their immediate environments, rather than moving between the two areas (Russo and Ste. Claire 1992).

Coastal sites focused on exploitation of coquina, as well as clams, fish, and turtles. Inland sites focused on freshwater shellfish as well as hunting and gathering of birds, reptiles, mammals, and plant foods. Miller (1992) believes that the large increase in the number of sites which can be attributed to the Orange period is a result of both the successful adaptation of this culture to the rich environment, and a rapid population growth which could be supported by the increased resource base.

Transitional Period, 1,200-500 B.C.

The comparatively brief Transitional time period may be the most poorly documented in the East and Central Lakes District. This period is generally identified as a component of other sites; few sites are identified as strictly Transitional, although Bullen (1972) identifies the Zabski site on the Banana River as solely Transitional. Stewart (1992) classifies the non-ceramic Hunter's Creek site as Transitional based on seriation of lithic points as well as radiocarbon dates which slightly post-date the usual Transitional time period dates.

The Transitional period has been identified on the basis of ceramic changes rather than shifts in subsistence patterns or settlement patterns. The Transitional appears to mark the beginning of increased cultural diversity and distinct regional groups in Florida. It is identified with the stage of cultural development known as the Formative, which is characterized by the establishment of more formal, sedentary communities and increasingly complex political and religious organization (Milanich and Fairbanks 1980). It is also marked by the appearance of trade goods from other regions, including, during the early Transitional, the Late Archaic Poverty Point culture of the Lower Mississippi Valley (Milanich and Fairbanks 1980). It has been postulated that this period

corresponds with the end of reliance solely on hunting-gathering for subsistence, and the beginning of horticulture (Milanich and Fairbanks 1980).

The settlement pattern for the Transitional period appears to have remained the same as that of the Orange period, with both inland sites along the St. Johns River and its chain of lakes, and coastal occupation to exploit the rich estuarine resources. Although it has been postulated that there was an increase in coastal occupation during the Late Archaic and Transitional period as a possible result of over-exploitation of *Viviparus*, this does not appear to be supported by the recent research of Russo and Hale (Russo and Ste. Claire 1992; Hale 1984).

The artifact assemblage of the Transitional is characterized by the change from slab construction, fiber tempered ceramics to coil construction and sand or untempered wares. The most common ceramic for this period in the East and Central Lakes District is the chalky untempered or semi-fiber tempered St. Johns Incised ware. Other ceramics include St. Johns wares with sherd inclusions, St. Johns Pinched and Punctated wares, and limestone tempered Pasco wares (Bullen 1972; Jahn and Bullen 1978). Side lugs are not unusual on vessels and drilled circular or oval sherd pendants have also been identified with this period (Milanich and Fairbanks 1980; Jahn and Bullen 1978). As Goggin pointed out, this time period is marked by "gradual ceramic change with much experimentation" (Goggin 1952:45). Other common artifacts include bone pins or awls, a few steatite vessel fragments, whelk gouges and celts, and evidence of basketry or woven mats as imprints on ceramics (Bullen 1972). Lithic points which date to this period include the Lafayette, Hernando, and Citrus types (Stewart 1992; Bullen 1975). These points are characterized by drooping barbs and basal notching (Bullen 1975).

St. Johns, 500 B.C.-A.D. 1565

Goggin neatly summarizes the St. Johns Tradition as "a pottery using, mound building, semi-sedentary complex probably with agriculture" (Goggin 1952:68). It is divided into two archaeological periods and several subperiods based on ceramic and cultural changes, and is noted for its chalky ware ceramics. The presence of mound burial indicates an increasingly complex society, probably based on chiefdoms. It also implies a rather sedentary existence with larger populations to provide the necessary labor for such construction. Goggin (1952:68) describes the Tradition as one of "constant trade and interchange with neighboring northern and western cultures" in which traits were briefly adapted but the society's basic conservatism prevented their long-term integration into the cultural pattern of the Tradition.

St. Johns I (500 B.C. to A.D. 800)

The St. Johns I Period is marked by the beginning of mound burial in the form of low sand mounds which may be truncated cones or merely low rises from 4 to 12 feet in height. Mounds may be single or in groups of intersecting mounds; some mounds display evidence of basal excavation prior to construction. Secondary bundle burials are the most common form, but primary burials and

cremations are also present. Most mounds contain less than 25 burials, although as many as 100 have been found. The few burial goods consist primarily of "killed" vessels with a hole in the base; the hole may be present before or after firing of the vessel (Goggin 1952).

Goggin believed that there was a shift in occupation during this period from the upper to the lower St. Johns, and that there was a decrease in occupation of the coast. He noted, however, that this apparent decrease may have been a function of site documentation rather than an actual shift in settlement. Sites consist of both village middens and burial mounds, often in close association (Goggin 1952). Milanich and Fairbanks (1980) postulate that the increased occupation of the lower St. Johns during this period was a result of population increase.

The St. Johns I period has been subdivided into St. Johns I, Ia, and Ib. The St. Johns I subperiod (500 B.C.-A.D. 100) is characterized by the dominance of St. Johns Plain ceramics in the village areas and the appearance of Dunns Creek Red slipped ceramics, particularly in burials. The Plain wares frequently have tetrapods, tripods, or bipods. Burial mounds may also contain Deptford pottery characteristic of cultural groups to the north and west. This implies an exchange of goods and perhaps ideas between the two groups. The Deptford wares represented in mounds include Deptford Linear Check Stamped, Deptford Bold Check Stamped, Deptford Simple Stamped, and Deptford Cord Marked. Other artifacts for this period include a variety of stone, bone, and shell tools such as celts, gouges, chisels, socketed bone points, chert points, bone pins, awls, and needles, and shell dippers, beads, disks, and pendants. Less common artifacts, which reflect the influence of the Hopewellian-Yent complex of the Gulf Coast and northwestern Florida are usually found in ceremonial contexts; this includes quartz plummets, clay elbow pipes, mica and galena fragments, and a few copper ornaments (Goggin 1952).

During the St. Johns Ia subperiod (A.D. 100-500) increasing evidence of the Green Point complex characteristic of the Swift Creek societies of the northwest coast began to appear in burial mounds. This complex is characterized by more elaborate burial ceremonialism marked by an increase in artifacts such as elbow pipes, cut mica, galena, shell gorgets, clay and copper ornaments, and stone pendants and beads which were found only occasionally in St. Johns I sites. Village pottery continued to be dominated by St. Johns Plain wares, often with tetrapods, but mounds contain Dunns Creek Red, occasional Deptford, Swift Creek, and, during the latter part of the subperiod, Weeden Island types from northwest Florida. Other artifacts include shell celts, stone hones, worked fossil bone, hammerstones, mica, and a possible shell bannerstone (Goggin 1952).

St. Johns Ib (A.D. 500-800) is marked by an increase in Weeden Island influences from the northwest, although the village pottery remained St. Johns Plain. Fewer copper ornaments are known for this subperiod, but clay elbow pipes and mica continue to be present (Goggin 1952).

St. Johns II (A.D. 800-1565)

During the St. Johns II period coastal occupation for exploitation of oysters became vital to the culture's subsistence pattern. Milanich and Fairbanks (1980) postulate winter occupation of the coast and spring to summer inland occupation for agriculture. They site the massive shell middens of this period as evidence of the importance of this resource. Stewart (1992) claims that there is little evidence of inland occupation in the Central Lakes District during this period. She states that this is particularly true in the area south of Lake Jesup, possibly due to its poor suitability for Indian horticulture (Stewart 1979).

St. Johns II sites consist of shell mounds as well as more widespread shell "fields". Sand burial mounds are often quite large domed, conical, or truncated cones, sometimes with associated earthworks. Both primary and secondary burials are present, but there are few burial goods. Late mounds contain evidence of European contact in the form of artifacts and primary burials in the Christian pattern of east-facing, extended burial with crossed arms (Goggin 1952).

The distinguishing artifact of the St. Johns II Period is check stamped pottery. Like the previous period, St. Johns II has been divided into three subperiods based on changes in the artifact assemblage.

St. Johns IIa (A.D. 800-1300) is marked by an increased use of burial mounds and the presence of the distinctive St. Johns Check Stamped pottery. Weeden Island pottery continues to appear in mounds and some mounds contain caches of ceramics. Milanich and Fairbanks (1980) believed that the increased use of horticulture at this time supported a population increase as reflected in the increase in the number and size of the sites which can be dated to this period.

St. Johns IIb (A.D. 1300-1513) sites begin to display Mississippian influences with the presence of ceremonial mound centers with Southeastern Ceremonial Cult motifs and copper items in the mounds. Although St. Johns Check Stamped pottery dominates the sites, there are some Fort Walton and Safety Harbor ceramics represented, indicating contact with the west coast of Florida. Other artifacts include simple stamped or scored wares, occasional St. Johns Cob Marked wares, sherd tempered wares, stone celts and small triangular points, clay effigies, and the usual assortment of stone, bone, and shell tools and ornaments (Goggin 1952). Mounds became larger and more complex during this period, indicating an increasingly sedentary and stratified society. Based on ethnographic accounts at the time of European contact, the Indians of this period were organized in hereditary chiefdoms and priesthoods (Milanich and Fairbanks 1980).

St. Johns IIc (A.D. 1513-1565) is the final prehistoric stage in Florida during which full European contact occurred. Although St. Johns Check Stamped ceramics and burial mounds were still present, European artifacts began to appear in the sites and mound burial decreased (Goggin 1952). The population of this period suffered severe reductions as a result of the introduction of European diseases.

In general, the St. Johns II period represents a continuance of the subsistence patterns of previous periods, with a heavy dependence on marine and estuarine resources, particularly coquina, oyster and clam. Some shell middens along the coast were over 25 feet high, indicating the presence of large populations.

At the time of European contact, the Indians of the study area were described as the Freshwater (or Agua Dulce) and Acuera groups of the Timucuan people. These are probably the least known of the Timucuan groups due to limited contact with the early Spanish settlers. They were described as agriculturists who grew corn, beans, and tobacco, but also relied heavily on hunting, fishing, and gathering wild plant foods. Social organization was based on ranked clans headed by chiefs, and polygamy was common. The people were described as tall and often tattooed. Extensive rituals were practiced in association with warfare and burials (Milanich and Fairbanks 1980).

St. Augustine Period, A.D. 1565-1716

European contact would result in the virtual destruction of the native Indian population of Florida within a hundred year period, primarily through the introduction of European diseases. Native ways of life were altered through the introduction of European goods and agricultural practices. The native religious practices were largely supplanted by the introduction of Catholicism through the Spanish mission system. Ceramics of the contact period also reflect European influences, particularly in their shapes. These ceramics are known as San Marcos types in eastern Florida (Milanich and Fairbanks 1980).

The English raids of the early 18th century led to the demise of the Timucua and their culture. After 1715, the Spaniards encouraged Creek Indians from Georgia and Alabama to migrate to Florida, where they became known as the Seminole.

Historic Period, A.D. 1716-present

After the decimation of the native Indians, the Creek Indians moved into northern Florida during the period described by Fairbanks (1978) as Colonization, 1716-1763. Once in Florida, they became known as the Seminoles. The Creeks (Seminoles) in Florida appear to have abandoned the Creek town pattern with its central square in favor of a more dispersed pattern of separate farmsteads. This may reflect their increasing dependence on exploitation of the cattle herds introduced by the Spaniards. Seminole sites in North Florida are marked by the presence of Chattahoochee Brushed ceramics as well as European trade goods. Although the Seminole traded with the Spaniards, there was little additional contact and apparently no attempt to reintroduce the mission system.

Fairbanks (1978) characterizes the period from 1763 to 1790 as Separation. The British acquisition of Florida in 1763 led to a well-defined Indian policy which centered on increasing

attempts to control the Indians. The Indians, in turn, extended their isolation from their homeland to an attempt at isolation from the British. This isolation was accompanied by increasing hostility towards the British. At the same time, the Seminole were harboring runaway slaves from Georgia and the Carolinas, which promoted their distrust of white settlers as well as hostility on the part of those settlers. The British did establish a number of trading posts among the Seminole, thus increasing the presence of European goods on Indian sites. The first description of Lake Jesup dates to this period, when John and William Bartram visited the lake and described the south shore as the "Indian side" (Bartram 1942:43).

The third Seminole period is characterized as Resistance and Removal, 1790-1840 (Fairbanks 1978). This was the period of the First and Second Seminole Wars. After the Spaniards regained Florida, they allowed the British and Americans to continue to trade with the Seminoles. Perhaps as a result of increasing frontier tensions, Seminole sites became even more dispersed. After the Creek Indian War, large numbers of Indians migrated to Florida, increasing the Seminole population. At the same time, American settlers continued to move into the same areas, resulting in greater friction between the two groups. This led to the First Seminole War of 1818. Although this war was rather limited and brief, it did influence the cession of Florida to the United States in 1819. The 1823 Treaty of Moultrie Creek attempted to confine the Seminole to the area south of Ocala. This led to the Seminole presence in the Central Lakes area of Florida, but also to further friction between the two groups.

Much of the information on Seminole Indian sites in this region is based on references to "old Indian fields" and abandoned towns on later Second Seminole War period records and land survey maps of the 1840s. For example, in 1837, Lt. John Pickell observed the "remains of several Indian lodges" and a trail on the north side of Lake Jesup between Sections 17 and 25 of Township 20 South, Range 30 East (Francke 1977). Although it is not clear where in this three mile distance the lodges and trail may have been, the point known as Caldwell's Field west of the Marl Bed Flats might be a likely spot based on its relatively high elevation, hammock vegetation and proximity to the lake. The trail may have either followed the sandy lake shoreline or been located north of the lake in Mecca Hammock; no trace of such a trail is presently visible. The Davidson (1835-37) map of the Second Seminole War does show a trail leading from a point opposite Bird Island northwest through Sections 19 and 20; this trail is also no longer identifiable.

The new Seminole reservation area did not offer the same resource base as the area previously occupied. At the same time, the increased friction between Indians and American settlers had resulted in reduced access to trade goods. In 1830, this friction erupted into the Second Seminole War. During this war, a number of military outposts and highways were established in Central Florida, including Fort Christmas, Fort Mellon, Fort Lane, Fort McNeil, Fort Gatlin, and Fort Taylor in the region of the St. Johns Basin (Davidson 1835-37). No outposts are shown in the vicinity of Lake Jesup on the military maps of the period; however, local informants believe that an outpost of some kind existed in the hammock on the north side of the lake (Elliott 1990). It is possible that this outpost would have been at the site of the abandoned Indian camp noted by Pickell.

Again, Caldwell's Field seems a likely location. Another possibility may be the landing shown on Davidson's (1835-37) map opposite Bird Island. The trails described in accounts of the war (Francke 1977) are no longer in evidence and would leave few archaeological traces in this area which has been subjected to extensive agricultural activity as well as road and railroad construction, although none of this construction was in the project area. Examination of older aerial photographs shows no evidence of well defined trails within the Marl Bed Flats. Based on field observations, a likely location would be the Marl Bed Slough just north of the project tract. In that area a well elevated, well drained oak hammock is located adjacent to the open slough providing good access to the lake (USDA 1940).

Lake Jesup was also identified at this time by 1st Lt. Richard C. Peyton when he brought an artillery detachment up the St. Johns River from Fort Mellon. Apparently the lake was initially named after Peyton and later renamed to honor General Jesup (Francke 1977).

The end of the Second Seminole War brought the fourth stage of the Seminole Period, Withdrawal, 1840-1880 (Fairbanks 1978). At this time, the Seminoles who remained in Florida withdrew into the reaches of the Everglades of South Florida, leaving North and Central Florida open to American settlement. The Armed Occupation Act of 1842, offering homestead rights to settlers, led to an increased movement of settlers into the state.

One of these early settlers may have been a man named "Tatum" who received a grant in Section 19 on the north side of the lake (DNR 1846). No information is available on him or his possible settlement. The lack of information may indicate he never settled his grant.

With the growth of Orlando in the late 19th century, homesteading increased and large tracts of land were acquired for potential development. The largest landowner was Hamilton Disston, who owned thousands of acres after 1881. At this time, the communities of Maitland, Oviedo and Sanford were established (Wells 1977). Much of the region has remained lightly settled until recently, with the land utilized for forestry and agriculture, particularly truck crops and cattle. Small settlements such as Clifton Springs on the south side of the lake were established tied to the citrus, cattle and logging industries. An 1890 map shows a scatter of homesteads and wharves on the south side of the lake (Wells 1977).

The recent growth and development of Orlando and Central Florida has led to increased pressure on the area. With transportation expansions such as the recently constructed Eastern Beltway Corridor of the Seminole County Expressway, which crosses Lake Jesup, it is almost certain that development will continue to spread to the east of Orlando and south from Sanford, impacting the Lake Jesup area.

PROJECT APPROACH

The original request for an archaeological survey for this project asked for an archaeological evaluation of the disposal areas within Cameron Ranch and the Marl Bed Flats, as well as the area to be excavated within the Flats shoreline. The FDHR also requested training of heavy equipment operators in identifying cultural remains during excavations, along with periodic monitoring of the project activities. At the request of FFWCC, the operator training and monitoring activities will be conducted under a separate contract, and are not addressed in this report.

SouthArc was familiar with the Marl Bed Flats from our previous work on the Seminole County Expressway Authority Eastern Beltway corridor, which transects the Flats (Wayne and Dickinson 1990). We have also completed a number of projects on the south side of the lake (Wayne and Dickinson 1993; Dickinson and Wayne 1996a, b, 2000). Based on this experience and an evaluation of the environmental characteristics of the Marl Bed Flats and Cameron Ranch tracts, we felt that both areas had a relatively low potential for archaeological or historic sites.

The Marl Bed Flats is a low, poorly drained area flooded during periods of high water. A dike already exists within this area; the proposed recontouring will occur between the dike and the lake edge. The upland disposal area also falls within the Flats. The soils within this area are described as muck; they also contain dense marl deposits. As a result, they are unattractive for habitation and virtually useless for horticulture or agriculture, other than pasture. The Florida Master Site File does not show any archaeological or historical sites within the Flats. Historic records suggest the possibility of trails through the Flats at the time of the Second Seminole War, but such trails are not identifiable and have not been verified to date. The previous Expressway survey did not find any evidence of Seminole period activity in the Flats.

The Cameron Ranch impact area is located between the interface of the uplands and wetlands. The elevation is very low, and a wide band of wetlands separates the uplands from the open water of the lake. The soil survey identified this area as frequently flooded muck soils. The recorded sites in the vicinity of Cameron Ranch are all closer to the St. Johns River and on higher elevations than that of the project tract.

Based on this evaluation, both tracts were classified as low potential for either archaeological or historical sites, although it is recognized that submerged resources, particularly canoes, could be present within the flooded lake edge and marshes.

The project consisted of three primary tasks: (1) background research; (2) fieldwork at both tracts; and (3) analysis and documentation. All project activities were conducted under a Chapter 1A-32 Archaeological Research Permit (Appendix A).

Background Research

The goals of the background research were: (1) to identify any previously recorded or potential sites within the tracts; (2) to evaluate the site potential within the tracts; and (3) to obtain the information for the project setting and cultural history sections of this report. Background research included the review of information from the Florida Master Site File, examination of information in SouthArc's files on Lake Jesup, a review of topographic and soils maps, a review of both present and older aerial photography, and a review of historic information on the lake.

Fieldwork

After discussing the project with Susan Harp of FDHR, it was determined that the survey approach would focus on anomalies such as areas of higher elevations within the two tracts, and on the interface of the uplands and wetlands. Anomalies would be identified by a combination of careful evaluation of topographic maps, soil surveys and aerial photographs, and surface inspection throughout the two tracts. If such anomalies were identified, they would be subjected to subsurface testing on transects or grids at an interval to be determined by the archaeologists. In addition, a transect of test units at 100 meter intervals would be placed along the upland/wetland interface in the Cameron Ranch tract.

As implemented, the project approach relied heavily on surface inspection, airboat inspection, and metal detection. Shovel testing was severely restricted by the dense marl deposits in all survey areas. There were basically three study areas: (1) the shoreline enhancement area littoral environment at the interface of the Marl Bed Flats and lake, (2) the Marl Bed Flats upland disposal area, and (3) the Cameron Ranch disposal/muck retention area.

Marl Bed Flats Enhancement Area

During the initial site visit, the water levels were estimated at less than one foot in this area, exposing a portion of an airboat trail along the shoreline within the marsh. The northern third of the study area was surface inspected along this trail. The area between the tall marsh line and the existing ditch/berm was inspected for anomalies in elevation and surface remains.

When the subsequent site visit occurred, the FFWCC furnished an airboat to inspect the shallow water areas, including the submerged portion of the airboat trail and the marsh/lake edge. The airboat was driven slowly through these areas while we looked for submerged logs (i.e. possible canoes) in the relatively clear water.

Marl Bed Flats Upland Disposal Area

This area and an access road were surface inspected during all field visits, with visual inspection supplemented by use of a metal detector. Other potential connection routes between the disposal area and the excavation area were also inspected. Recent bushhogging of the area provided surface exposure in some sections of the tract. Attempts to place shovel tests within this area were unsuccessful due to the dense, impenetrable marl.

Cameron Ranch

The initial task was a surface inspection to look for evidence of cultural activity and elevation anomalies. Surface inspection was again supplemented by use of the metal detector. Elevated anomalies were cruciformed and encircled by metal detector transects. No shovel tests were completed due to the dense marl.

The interface of the prairie and the adjacent uplands was also surface inspected with the metal detector. Since the area also contained dense marl which could not be effectively excavated, at 100 meter intervals a five-meter radius area was swept by the metal detector and a shovel divot was placed to document the presence of marl (Figure 6). The transect line between each location was also swept by the metal detector.

Analysis and Documentation

Analysis consisted of correlation of the background information with field observations. No cultural material was collected, so no artifact analysis was required. Documentation consists of this report and the Florida Master Site File Survey Record Log (Appendix B). Copies of all project records will be sent to the Bureau of Archaeological Research as required by the Chapter 1A-32 Archaeological Research Permit.

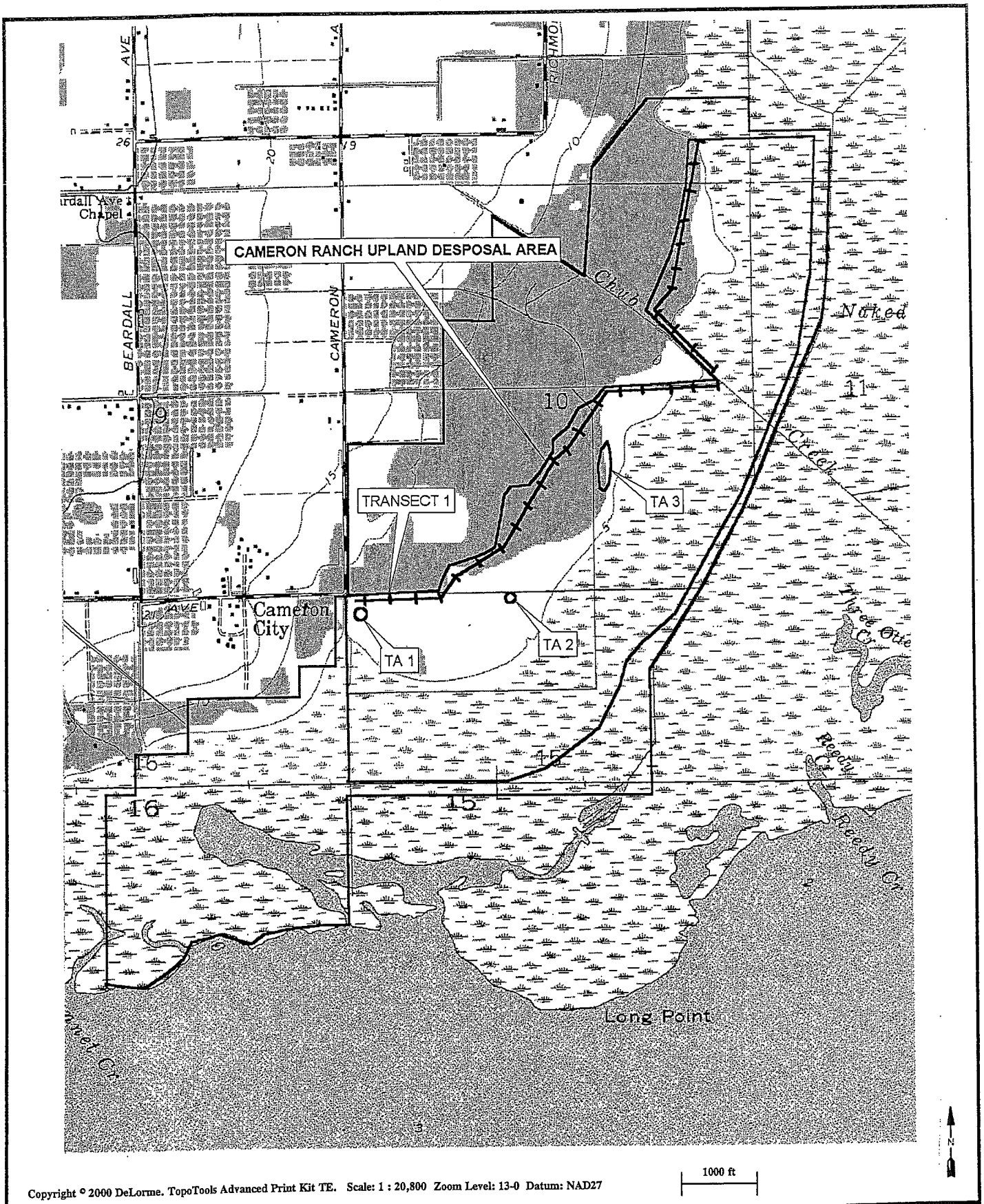

FIGURE 6. LOCATION OF TESTS, CAMERON RANCH, LAKE JESUP AQUATIC ENHANCEMENT, SEMINOLE COUNTY, FLORIDA

BASE MAP: DELORME 2000

SouthArc, Inc.

Archaeological and Historical Services

RESULTS AND RECOMMENDATIONS

As previously indicated, there were no archaeological or historical sites recorded within the two tracts. The discussion of results will be divided into the three distinct survey areas: Marl Bed Flats shoreline enhancement area, Marl Bed Flats upland disposal area and Cameron Ranch disposal area.

Marl Bed Flats Shoreline Enhancement Area

The shoreline enhancement area is the area between the existing ditch/berm and the open water of the lake. The area is dominated by marsh vegetation, two thirds of which was flooded at the time of the survey. Surface inspection and airboat inspection of this area did not locate any elevation anomalies or evidence of cultural activity, other than an airboat trail along the shoreline. No submerged logs/canoes were observed in the shallow water.

The well defined shoreline noted to the west during the earlier Expressway survey (Wayne and Dickinson 1990) was not present in the proposed excavation area. Rather, the land gradually slopes into the water. Overall, the frequently flooded nature and low elevation of this area argues against any significant utilization by either prehistoric or historic people.

Marl Bed Flats Upland Disposal Area

The upland disposal area abuts the treeline to the north at an elevation of four to six feet mean sea level. The hammock within the tree line may once have extended out into the disposal area, but the entire area has been bushhogged and cleared, leaving fair surface exposure (Figure 5). Attempts at shovel testing revealed a mix of organics, clay and lime/shell which is the virtually impenetrable marl substrate characteristic of the Flats. Surface inspection and metal detection did not reveal any evidence of cultural activity other than recent land usages.

Although the upland disposal area may once have contained hammocks, the low elevation, potential for flooding and marl soils limit its utility for either prehistoric or historic occupation, particularly given the close proximity of better environments.

Cameron Ranch

Surface inspection revealed three slightly elevated areas, designated TA1, TA2 and TA3 (Figure 6). All contained small stands of live oaks and scattered cabbage palms (Figure 5). TA2 also had a water hickory. Inspection of these rises with the metal detector and surface inspection located only recent trash at TA1 and TA3, including beer and soft drink cans and a copper-jacketed .38 caliber bullet casing; all were discarded in the field.

The upland ecotone transect divots (Figure 6) revealed a continuation of the marl deposits like those at Marl Bed Flats. The metal detector and surface inspection recovered only recent discards, including a cow ear clip, galvanized pipe elbow and rusted iron plate fragments; all were discarded in the field as modern.

Like the Marl Bed Flats, the Cameron Ranch tract is very low and frequently flooded, with an impenetrable marl substrate. It is also separated from the open water of the lake by a wide strip of marsh. These factors argue against any significant cultural activity in the area.

Conclusions and Recommendations

Evidence of cultural activity in the project tracts is limited to recent land usages, particularly cattle ranching. The potential for flooding within the project tracts as well as the impenetrable marl soils severely restricts the usage of these areas for habitation or any form of horticulture or agriculture other than pasture. In addition, the open environment would have provided little or no cover for wildlife.

It is probable that both prehistoric and historic Native Americans would have preferred the somewhat higher elevations and hammock environments located adjacent to the study tracts. Historic occupants would also have selected these areas as well as areas with soils suitable for agriculture. The wide swath of marsh separating the uplands from the open water of the lake would also reduce the attractiveness of these areas as potential canoe landings.

In the opinion of the project archaeologists, the proposed muck removal and disposal will not impact any significant cultural resources. The equipment operator training and periodic monitoring requested by FDHR should be sufficient to deal with unanticipated discoveries in the course of the project. No further research is recommended.

UNANTICIPATED DISCOVERIES

In the event that possible human remains are encountered during site development, the stipulations of Florida Statutes Chapter 872 (*Offenses Concerning Dead Bodies and Graves*) should be followed. The contractor should cease all ground disturbing work in the vicinity of the possible human remains and immediately contact **SouthArc, Inc. at (352)372-2633.** SouthArc will respond to such calls immediately and initiate the necessary steps to comply with Chapter 872.

The first priority is to insure that all ground disturbing activity in the vicinity has ceased and that the location is protected, including covering the find with plastic or tarps. The County Medical Examiner shall be immediately notified. Under Chapter 872, the Medical Examiner must determine: (1) that the remains are indeed human; and (2) whether the remains were deposited over 75 years ago. If the remains are human and less than 75 years old, the Medical Examiner and local law enforcement will assume jurisdiction. If they are human and deposited over 75 years ago, they are classified as archaeological and the State Archaeologist will be contacted to determine management procedures which will comply with Chapter 872 and, if applicable, Native American concerns.

Should the remains be classified as archaeological, SouthArc will negotiate a scope of work or management plan with the State Archaeologist. This plan may include disinterment or preservation in place. Should disinterment be selected, SouthArc will work with a physical anthropologist to carefully remove the remains for forensic examination. A management report will be provided as soon as this task is completed so that a decision can be made as to whether site development activities can proceed in the vicinity of the find. After all analyses are completed, SouthArc will prepare a draft report to the client for review and approval. Florida Master Site File forms will be completed or updated as needed. The report will also include all relevant correspondence with the Medical Examiner, State Archaeologist and other involved agencies. The final report will be submitted to the State Archaeologist in order to comply with Chapter 872.

SouthArc will also work with the property owner and contractors to alleviate construction delays or alterations resulting from such finds. Typically this can include shifting construction to areas away from the find while the assessment is conducted, but it may also mean redesign and/or provisions for reburial of remains upon completion of the study.

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APPENDIX A

CHAPTER 1A-32 ARCHAEOLOGICAL RESEARCH PERMIT

DIVISIONS OF FLORIDA DEPARTMENT OF STATE
Office of the Secretary
Office of International Relations
Division of Elections
Division of Corporations
Division of Cultural Affairs
Division of Historical Resources
Division of Library and Information Services
Division of Licensing
Division of Administrative Services

MEMBER OF THE FLORIDA CABINET
State Board of Education
Trustees of the Internal Improvement Trust Fund
Administration Commission
Florida Land and Water Adjudicatory Commission
Siting Board
Division of Bond Finance
Department of Revenue
Department of Law Enforcement
Department of Highway Safety and Motor Vehicles
Department of Veterans' Affairs

FLORIDA DEPARTMENT OF STATE
Katherine Harris
Secretary of State
DIVISION OF HISTORICAL RESOURCES

May 2, 2002

Lucy B. Wayne, Ph.D., RPA
SouthArc, Inc.
3700 NW 91st Street
Suite D300
Gainesville, Florida 32606

RECEIVED MAY 8 2002

Re: 1A-32 Archaeological Research Permit Number 0102.51
Lake Jesup, Cameron Ranch and Marl Bed Flats

Dear Dr. Wayne:

The application, which you submitted on behalf of SouthArc, Inc., for an archaeological research permit under Chapter 1A-32 of the Rules of the Department of State, was received by the Division of Historical Resources, Bureau of Archaeological Research (BAR) on April 29, 2002. We have reviewed the information contained in your application and find it to be complete and sufficient.

You are hereby granted a permit to conduct the proposed archaeological field investigations from May 13, 2002 through May 31, 2002, subject to the following stipulations:

(1) As the Principal Investigator, you shall be responsible for the direction of all archaeological investigations and for the preparation of the final written report on the results of the permitted research. The Principal Investigator or another professional archaeologist must be on site during all fieldwork.

(2) **A copy of this permit shall be provided to the land managing agency and another copy shall be carried by field personnel during field work.**

(3) **The effective field investigation dates are also subject to receipt of permission from the land management agency** and, in some instances, the State/Federal dredge-and-fill permitting program. Those agencies may also require work performance conditions relevant to their natural resource management and permitting responsibilities. A copy of the written permission of the land management agency and, when appropriate, the dredge and fill permitting agency/agencies to conduct the subject work shall be provided to the BAR.

(4) Unless approved in writing by this office, no work beyond that described in and attached to your application, and approved in this permit, shall be performed. This permit, however, is valid for up to one year following the requested report due date. Requests for changes in fieldwork and report/artifact due dates may be made and approved by phone or in writing during this time and do not require amendments to the permit.

(5) All work conducted under this permit must meet the report standards and guidelines required by Rule 1A-46, *Florida Administrative Codes*.

(6) Archaeological and historical sites encountered during the permitted work must be recorded on the appropriate Florida Master Site File (FMSF) forms and accompany the final report. FMSF Survey Log sheets must accompany each final report submitted as a requirement of this permit. Contact the FMSF at (850) 245-6440 for additional information on current forms and requirements.

(7) All artifacts and related materials recovered from state-owned lands are the property of the State of Florida, and are hereby loaned to the permit recipient until the completion of the project on June 30, 2002.

(8) The permit recipient agrees to be responsible for the proper curation and conservation of recovered artifacts and other recovered site materials until such time as those artifacts and other site materials are conveyed to the BAR for curation.

(9) The permit recipient further agrees not to remove from a stable site environment artifacts and materials which the permit recipient is unable to properly curate and conserve.

(10) Copies of all notes, maps, photographs, videotapes, and other field records pertaining to research conducted under this permit shall be provided to the BAR following completion of the project.

(11) All artifacts obtained from state-owned or controlled lands shall be accessioned/catalogued in accordance with instructions provided by BAR staff (see attachment). Please call the BAR Conservation and Collections Management Lab at (850) 245-6444 to discuss the manner in which collected artifacts should be bagged and accessioned, as well as to resolve any other collections management issues.

(12) Following completion of the project all artifacts and related materials obtained from state-owned or controlled lands are to be conveyed to the BAR for permanent curation or processing for loan. Loan requests shall be in writing to the BAR and shall include a listing of the items requested for loan. Loan requests also shall include a written commitment from the curation facility to assume responsibility for the loaned materials.

(13) At least one copy of the final written technical report and at least one copy of a popular report describing the results of the permitted research shall be provided to the BAR by June 30, 2002. Copies of any popular report also shall be provided to the land management agency for that agency's site interpretive use. The format of the popular report shall be mutually agreed to by the applicant and the land management agency. **At least one copy of each of these documents must be sent to the Bureau of Archaeological Research, 1A-32 Permit Program, Division of Historical Resources, 500 South Bronough Street, Tallahassee, Florida 32399-0250**, and are in addition to any copies that may be sent to the Division of Historical Resources for other purposes.

(14) In any release of information, including public presentations, media contacts, and the final written report, there shall be acknowledgment that the portion of the project involving state-owned and controlled land was conducted under the terms of an archaeological research permit issued by the Florida Department of State, Division of Historical Resources, Bureau of Archaeological Research.

(15) If unmarked human remains are discovered, the permit recipient shall comply with the provisions of 872.05, *Florida Statutes*, and, when appropriate, Rule 1A-44, *Florida Administrative Code*. Specifically, upon discovery of unmarked human remains, all activities that might further affect those remains shall be halted and the remains protected from further disturbance until an appropriate course of action has been determined by the local medical examiner or by the State Archaeologist, as appropriate.

(16) In issuing this permit, the State assumes no liability for the acts, omissions to act or negligence of the permit recipient, its agents, servants or employees; nor shall the permit recipient exclude liability for its own acts, omissions to act or negligence to the State.

(17) The permit recipient agrees to assume all responsibility for, indemnify, defend and hold the Division of Historical Resources harmless from and against any and all claims, demands, liabilities, or suits of any nature whatsoever arising out of, because of, or due to any act or occurrence of omission or commission arising out of the permit recipient's operations pursuant to this permit and shall investigate all claims at its own expense. In addition, the permit recipient hereby agrees to be responsible for any injury or property damage resulting from any activities conducted by the permit recipient.

(18) The parties hereto agree that the permit recipient, its officers, agents and employees, in performance of this permit, shall act in the capacity of an independent contractor and not as an officer, employee or agent of the State.

If you have any questions about the permit process or about the requirements, please write or call Brenda Swann or State Archaeologist Jim Miller, or contact us by e-mail at bswann@mail.dos.state.fl.us and jmiller@mail.dos.state.fl.us, respectively. Please refer to the permit number in all such contacts.

Sincerely,

Janet Snyder Matthews, Ph.D.
Director, Division of Historical Resources

Please sign in the space below indicating your acceptance of the terms and conditions of this permit. Please return an executed copy to this agency. **This permit will not become effective until an executed copy has been received by the Division of Historical Resources, Bureau of Archaeological Research.** Please call to verify receipt before beginning fieldwork.

I understand and accept the terms of this Chapter 1A-32 Archaeological Research Permit.

Lucy B Wayne
Signature

5/10/02
Date

enclosure (1)

JSM:bns

xc: file

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VICTOR J. HELLER, Assistant Executive Director

OFFICE OF THE EXECUTIVE DIRECTOR
(850)487-3796 TDD (850)488-9542

Eustis Fisheries Research La
601 W. Woodward Avenu
Eustis, FL 3272
352-742-643
FAX 352-742-646
http://fwcnet.state.fl.u

May 9, 2002

Lucy Wayne
SouthArc, Inc.
3700 NW 91st St. Suite D300
Gainesville, FL 32606-7307

Dear Ms. Wayne:

This letter serves as notice to commence the archaeological survey of the Marl Bed Flats and Cameron Ranch properties adjacent to Lake Jesup, Seminole County, Florida.

Sincerely,

Ed Hayes

Ed Hayes
Biological Scientist III

Proposed Scope of Work, Cultural Resources Survey
Cameron Ranch & Marl Bed Flats, Lake Jesup
Florida Fish & Wildlife Conservation Commission

SouthArc, Inc.
April 29, 2002

The Florida Fish & Wildlife Conservation Commission (FFWCC) is planning wildlife enhancement projects at Lake Jesup in Seminole County. The first of these projects involves removing organic sediment from the lake and placing it in an upland disposal facility on approximately 700 acres of property owned by the St. Johns River Water Management District (SJRWMD). A series of holding cells will be constructed to receive the material. The second project involves removal of material from Marl Bed Flats (a high marsh area) during the dry season and placing it in the adjacent uplands. Approximately 500 acres will be impacted; most of this acreage is presently pasture. An archaeological survey of the two impact areas was requested based on the recommendation of the Florida Division of Historic Resources (FDHR).

The FFWCC specified survey only of the 700 acre disposal area and the 500 acre Marl Bed Flats. for this project. Any monitoring or construction crew education will be handled at a future date.

SouthArc is familiar with the project tracts from our previous survey for the Seminole County Expressway Authority Eastern Beltway, which crosses Lake Jesup and transects the Marl Bed Flats. Based on that work and our knowledge of the area surrounding Lake Jesup, both project areas appear to have a relatively low potential for archaeological sites. The Marl Bed Flats is a low, poorly drained area flooded during periods of high water. A dike already exists around this area; the proposed dredging will occur between the dike and the lake edge. An upland area northwest of the dike will be used for disposal; this area also falls within the designated Flats. No archaeological sites are known to exist within the impact areas. Historic records suggest the possibility of a trail through the Flats at the time of the Second Seminole War, but this is not identifiable and has not been verified.

The Cameron Ranch disposal area is located at the interface of the uplands and wetlands. The elevation of this area is also low and a wide band of wetlands separates the uplands from the open water of the lake. The soil survey identifies the proposed impact areas as frequently flooded muck soils.

Background Research

Prior to commencement of the project, additional background research will be conducted on the two tracts. This will include review of material on file at the Florida Master Site File, examination of information in SouthArc's files on Lake Jesup, review of topographic maps, soils maps and both current and older aerial photography, and review of historic information on Lake Jesup.

Fieldwork

After discussing the project with Susan Harp of FDHR, it was determined that the survey approach would focus on anomalies such as areas of higher elevations within the two tracts, and on the interface of the uplands and wetlands. Anomalies will be identified by a combination of careful evaluation of topographic maps, soil surveys and aerial photographs and surface inspection throughout the two tracts. If such anomalies are identified, they will be subjected to subsurface testing on transects or grids at an interval to be determined by the archaeologists. In addition, a transect of test units at 100 meter intervals will be placed along the upland/wetland interface. Test units will be 50 centimeters (cm) square excavated to water and screened through 1/4-inch hardware cloth. Subsurface testing will be supplemented by extensive surface inspection and selective use of a metal detector to look for possible Second Seminole War period material. Should cultural material be recovered, additional test units will be placed to delimit the site and identify its nature. All test unit locations will be plotted on project maps and field notes will record unit location, soil stratigraphy, dominant vegetation, proximity to natural or cultural features, and presence/absence of cultural materials.

Should possible human remains be encountered, excavation will immediately cease in the vicinity of such a find and SouthArc will follow the requirements of Florida Statute 872 concerning human remains.

Analysis

Recovered artifacts will be gently cleaned and air-dried over 1/4-inch hardware cloth. The samples will be sorted by material and identified using accepted regional typologies. Ceramics will be classified based on temper and surface treatment. Lithics will be examined for modifications, evidence of thermal alteration, tool types, and evidence of usage or wear. Bone and faunal material will be identified to species when possible. Historic artifacts will be classified based on material and function, when it can be determined. All material will be both counted and weighed.

The completed catalog will be entered into spreadsheets to facilitate site analysis and to prepare summary tables. If appropriate, the spreadsheet information may be used for mapping of artifact distributions.

The catalog will be correlated with field results and project maps to delineate and define located cultural resources. The goal will be to identify the nature of the site, the cultural period(s) represented and, if possible, the potential significance of the site. It should be noted, however, that survey level data is not always sufficient to complete an assessment of significance for large or complex sites.

Documentation

The background research, field results and data analysis will be correlated to produce the project report following FDHR guidelines. The text will be supported by appropriate maps, graphics, photographs and tables as needed.

One copy of the draft project report will be provided to FFWCC for review. Once the review comments have been received, the final report will be prepared for submission to the Division of Historical Resources by SouthArc and three (3) copies of the this report will be provided to the FFWCC. Florida Master Site File forms will be provided as needed.

APPENDIX B

FLORIDA MASTER SITE FILE
SURVEY RECORD LOG

SURVEY LOG
VERSION 2.0.0
IDENTIFICATION AND BIBLIOGRAPHIC INFORMATION

Electronic form used: *MS20*
Survey Project Name *LAKE JESUP AQUATIC ENHANCEMENT PROJECT*
Report Title *CULTURAL RESOURCES SURVEY AND ASSESSMENT, LAKE JESUP AQUATIC ENHANCEMENT PROJECT, SEMINOLE COUNTY, FLORIDA*
Report Author (last name first) *DICKINSON, MARTIN F.; WAYNE, LUCY B.*
Publication Date (year) *2002*
Total Number of Pages in Report *26*
Publication Info *SOUTHARC, INC., GAINESVILLE, FL*
Fieldwork Supervisor (Name[last,1st]/Org./City) *DICKINSON, MARTIN F./Southarc, Inc., Gainesville./GAINESVILLE*
Key Word/Phrase Describing Survey *LAKE JESUP; MARL BED FLATS*
Survey Sponsor's Name *FL FISH & WILDLIFE CONSERV. CO*
Survey Sponsor's Address/Phone *601 W. WOODWARD AVE., EUSTIS, 352-742-6458*
Survey Sponsor's Code *Florida Game & Freshwater Fish Commission (GFWFC)*
Log Sheet Recorder's Name (last name first) *WAYNE, LUCY B.*
Date Log Sheet Completed *06/27/2002*
Is this a continuation of a previous project? *No Prior Phase I or Other Ongoing Work's Been Done*

MAPPING

County Surveyed *Seminole*
USGS 7.5' Map for Surveyed Area: Name/Latest Revision Date *CASSELBERRY/1980; OVIEDO/1980; OSTEEN/1980*

DESCRIPTION

Field Work Start Date *05/13/2002*
Field Work End Date *06/04/2002*
Number of Distinct Tracts Surveyed *2*
Total Area Surveyed (hectares; 1 acre= 0.405 ha) *486.00*
Total Area Surveyed (acres; 1 hectare=2.47 acres) *1200.00*
Corridor Width (meters; 1 ft=0.3048 meters) *** blank ***
Corridor Width (feet; 1 meter=3.281 feet) *** blank ***
Corridor Length (kilometers; 1 mile=1.609 km) *** blank ***
Corridor Length (miles; 1 kilometer= 0.622 miles) *** blank ***

RESEARCH AND FIELD METHODS

Types of Survey *Archaeological survey (at least in part)*
Other types of survey *** blank ***
Preliminary Method Used *Researched this property at the Florida Site File; Public land surveys records-DNR (Knetsch&Smith 92); Literature/archives/documentary search; Used aerial photography*
Archaeological Method Used/Percent *Controlled surface collection within project area/Method Used at 90-100% of Properties; Screened shovel: smallest nested mesh size 1/4 in/Method Used at 0-20% of the Properties; Unscreened shovel/Method Used at 20-50% of Properties; Remote sensing: includ resistivity and magnetometr/Methos Used at 50-90% of Properties*
Architectural Method Used/Percent *No field work by recorder/Method Used at 90-100% of Properties*
Scope/Intensity/Procedures *SURFACE INSPECT ALL TRACTS, METAL DETECTOR ALL, AIRBOAT INSPECT FLOODED AREA, ATTEMPTS AT SHOVEL TESTING 100 M INTERVALS, 50X50X100CM, 1-4" SCREEN*

SURVEY RESULTS

Sites' Significance Evaluated? *Sites' Significance Was Evaluated by Recorder*
Number of Previously Recorded Sites *** blank ***
List of Previously Recorded Sites *** blank ***
Number of Newly Recorded Sites *** blank ***
List of Newly Recorded Sites *** blank ***
Site Form Used *No Sites Located or Tested/No Forms Used*

SURVEY SEARCH

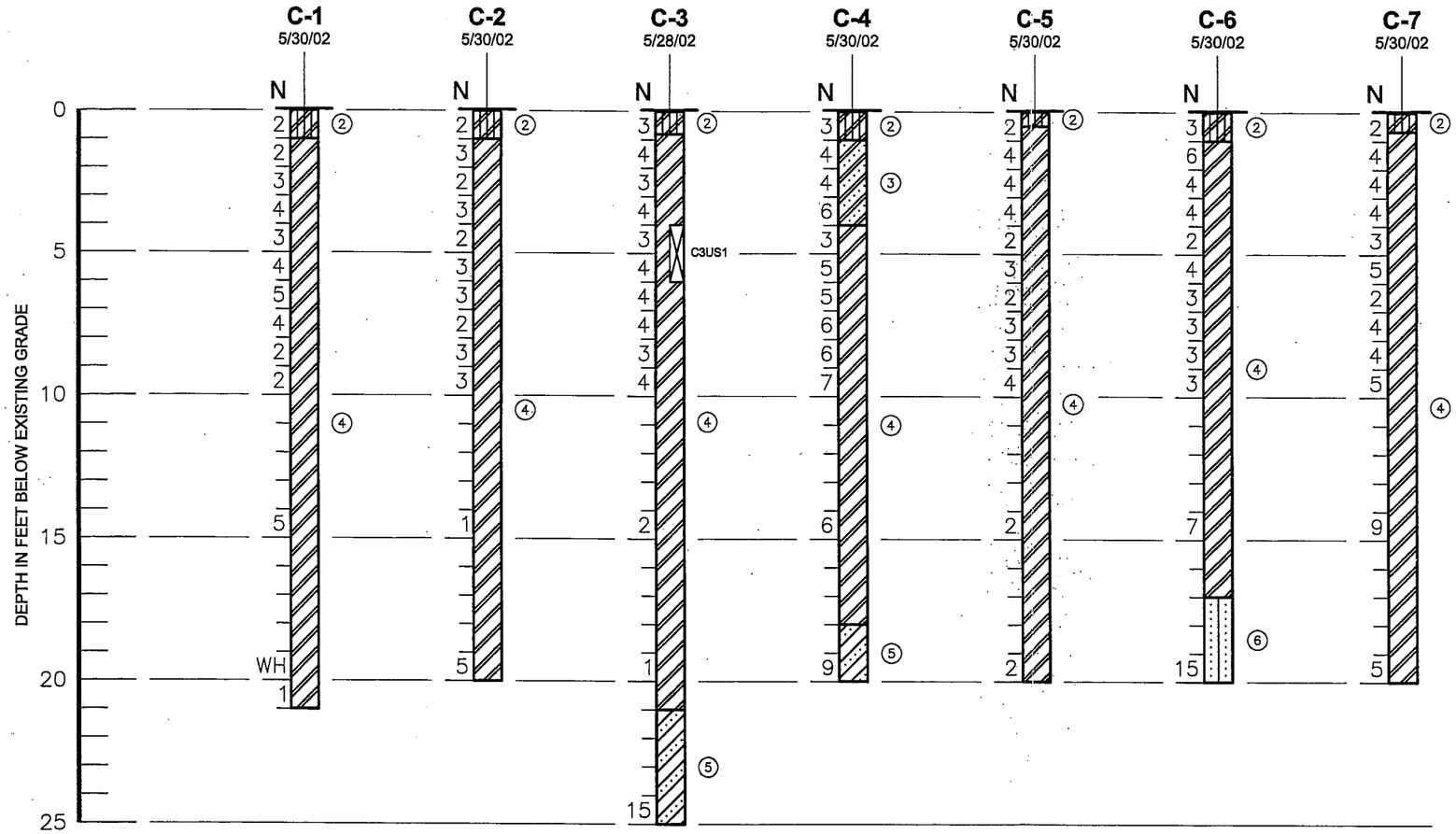
Type of document: *Archaeological field survey*
Other Document Type *** blank ***
Document destination: *** blank ***
Plottability (1): *** blank ***
Plottability (2): *** blank ***

APPENDIX J

Soil Boring Profiles and Piezometer Construction Details for the Cameron/Little Ranch Site
Ace Drilling, June 2002

SOIL PROFILES

VERTICAL SCALE: 1" = 5'



NOTE:
UNDISTURBED SAMPLE / SHELBY TUNES WERE TAKEN ADJACENT TO THEIR RESPECTIVE SPT BOREHOLES.

SOIL LEGEND

1. BLACK HIGHLY FIBROUS ORGANIC SAND AND SILT, [PEAT], (Pt), VERY SOFT / VERY LOOSE
2. DARK GRAY TO BLACK ORGANIC SILTY AND CLAY, TRACE TO SOME SAND, (Pt)(OL)(OH), SOFT TO STIFF
3. GRAY TO MOTTLED GRAY AND YELLOW-BROWN SILTY CLAY, TRACE TO SOME SAND AND LIMESTONE, (CL)(CH), MEDIUM STIFF TO STIFF
4. DARK GRAY TO GRAY TO MOTTLED GRAY AND YELLOW-BROWN SILTY CLAY, TRACE SAND, SOME WITH TRACE ORGANIC MATTER, (CH), VERY SOFT TO STIFF
5. GRAY TO MOTTLED GRAY AND YELLOW-BROWN SLIGHTLY CLAYEY TO CLAYEY FINE SAND, (SP-SC)(SC), VERY LOOSE TO MEDIUM DENSE
6. GRAY TO DARK GRAY-BROWN TO DARK BROWN SLIGHTLY SILTY FINE SAND, (SP-SM), VERY LOOSE TO MEDIUM DENSE
7. LIGHT BROWN TO WHITE FINE SAND, TRACE SILT, (SP)(SP-SM), MEDIUM DENSE TO DENSE

(SP) UNIFIED SOIL CLASSIFICATION GROUP SYMBOL AS DETERMINED BY VISUAL EXAMINATION

N STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT

WH DRILLING EQUIPMENT FELL UNDER WEIGHT OF ROD AND HAMMER

US1 UNDISTURBED SAMPLE LOCATION (SHELBY TUBE)

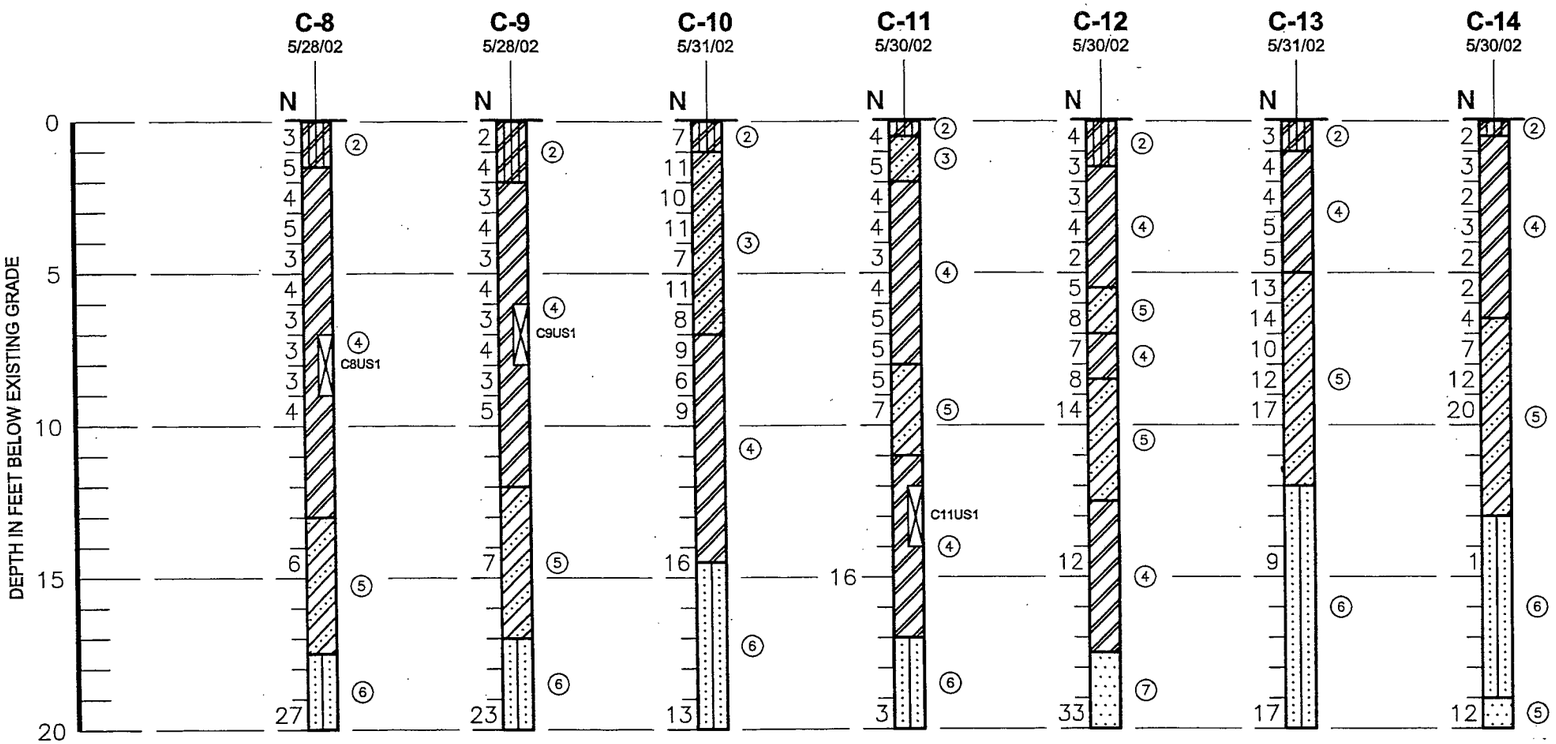
GEOTECHNICAL DRILLING SERVICES
LAKE JESUP AQUATIC ENHANCEMENT PROJECT
CAMERON / LITTLE RANCH SITE
SEMINOLE COUNTY, FLORIDA

FIELD: RK,MK,CT,AM	DATE: 6-13-02		
DRAWN: RR	SCALE: NOTED		
CHECKED: RR	PROJ. NO.: 25508A		
APPROVED: RK	SHEET 1 OF 4		

ACE DRILLING
GEOTECHNICAL AND ENVIRONMENTAL SUBCONTRACT DRILLING SERVICES

SOIL PROFILES

VERTICAL SCALE: 1" = 5'



NOTE:
UNDISTURBED SAMPLE / SHELBY TUNES WERE TAKEN ADJACENT TO THEIR RESPECTIVE SPT BOREHOLES.

SOIL LEGEND

1. BLACK HIGHLY FIBROUS ORGANIC SAND AND SILT, [PEAT], (Pt), VERY SOFT / VERY LOOSE
2. DARK GRAY TO BLACK ORGANIC SILTY AND CLAY, TRACE TO SOME SAND, (Pt)(OL)(OH), SOFT TO STIFF
3. GRAY TO MOTTLED GRAY AND YELLOW-BROWN SILTY CLAY, TRACE TO SOME SAND AND LIMESTONE, (CL)(CH), MEDIUM STIFF TO STIFF
4. DARK GRAY TO GRAY TO MOTTLED GRAY AND YELLOW-BROWN SILTY CLAY, TRACE SAND, SOME WITH TRACE ORGANIC MATTER, (CH), VERY SOFT TO STIFF
5. GRAY TO MOTTLED GRAY AND YELLOW-BROWN SLIGHTLY CLAYEY TO CLAYEY FINE SAND, (SP-SC)(SC), VERY LOOSE TO MEDIUM DENSE
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7. LIGHT BROWN TO WHITE FINE SAND, TRACE SILT, (SP)(SP-SM), MEDIUM DENSE TO DENSE

(SP) UNIFIED SOIL CLASSIFICATION GROUP SYMBOL AS DETERMINED BY VISUAL EXAMINATION

N STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT

WH DRILLING EQUIPMENT FELL UNDER WEIGHT OF ROD AND HAMMER

US1 UNDISTURBED SAMPLE LOCATION (SHELBY TUBE)

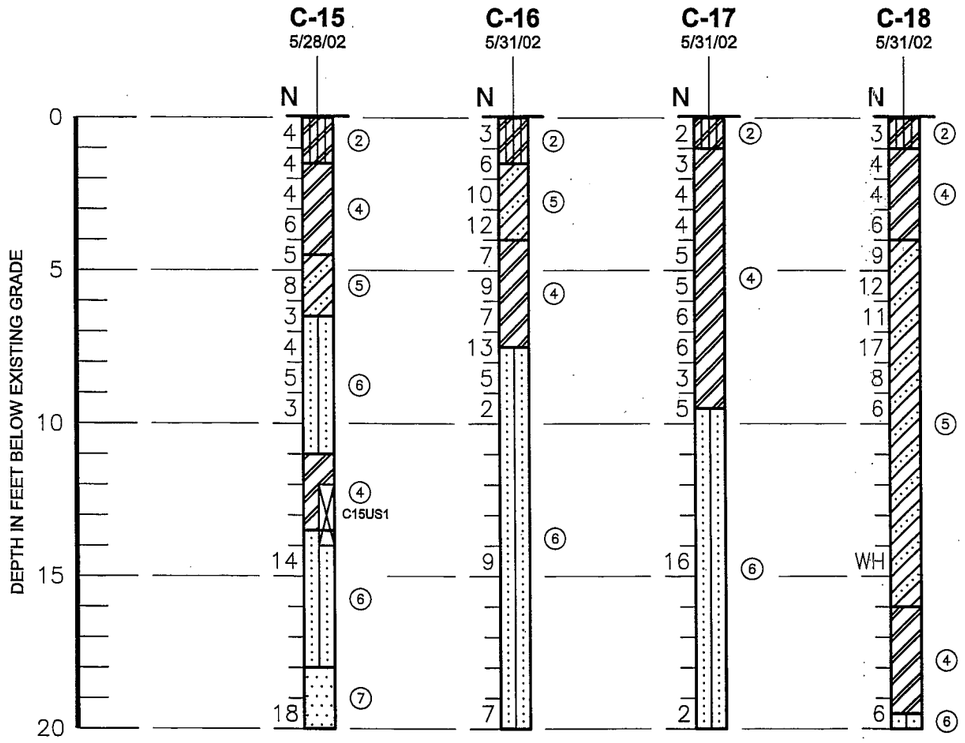
FIELD: RK,MK,CT,AM	DATE: 6-13-02		
DRAWN: RR	SCALE: NOTED		
CHECKED: RR	PROJ. NO.: 25508A		
APPROVED: RK	SHEET 2 OF 4		

GEOTECHNICAL DRILLING SERVICES
LAKE JESUP AQUATIC ENHANCEMENT PROJECT
CAMERON / LITTLE RANCH SITE
SEMINOLE COUNTY, FLORIDA

ACE DRILLING
GEOTECHNICAL AND ENVIRONMENTAL SUBCONTRACT DRILLING SERVICES

SOIL PROFILES

VERTICAL SCALE: 1" = 5'



NOTE:
UNDISTURBED SAMPLE / SHELBY TUBES WERE TAKEN ADJACENT TO THEIR RESPECTIVE SPT BOREHOLES.

SOIL LEGEND

1. BLACK HIGHLY FIBROUS ORGANIC SAND AND SILT, [PEAT], (Pt), VERY SOFT / VERY LOOSE
2. DARK GRAY TO BLACK ORGANIC SILTY AND CLAY, TRACE TO SOME SAND, (Pt)(OL)(OH), SOFT TO STIFF
3. GRAY TO MOTTLED GRAY AND YELLOW-BROWN SILTY CLAY, TRACE TO SOME SAND AND LIMESTONE, (CL)(CH), MEDIUM STIFF TO STIFF
4. DARK GRAY TO GRAY TO MOTTLED GRAY AND YELLOW-BROWN SILTY CLAY, TRACE SAND, SOME WITH TRACE ORGANIC MATTER, (CH), VERY SOFT TO STIFF
5. GRAY TO MOTTLED GRAY AND YELLOW-BROWN SLIGHTLY CLAYEY TO CLAYEY FINE SAND, (SP-SC)(SC), VERY LOOSE TO MEDIUM DENSE
6. GRAY TO DARK GRAY-BROWN TO DARK BROWN SLIGHTLY SILTY FINE SAND, (SP-SM), VERY LOOSE TO MEDIUM DENSE
7. LIGHT BROWN TO WHITE FINE SAND, TRACE SILT, (SP)(SP-SM), MEDIUM DENSE TO DENSE

(SP) UNIFIED SOIL CLASSIFICATION GROUP SYMBOL AS DETERMINED BY VISUAL EXAMINATION

N STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT

WH DRILLING EQUIPMENT FELL UNDER WEIGHT OF ROD AND HAMMER

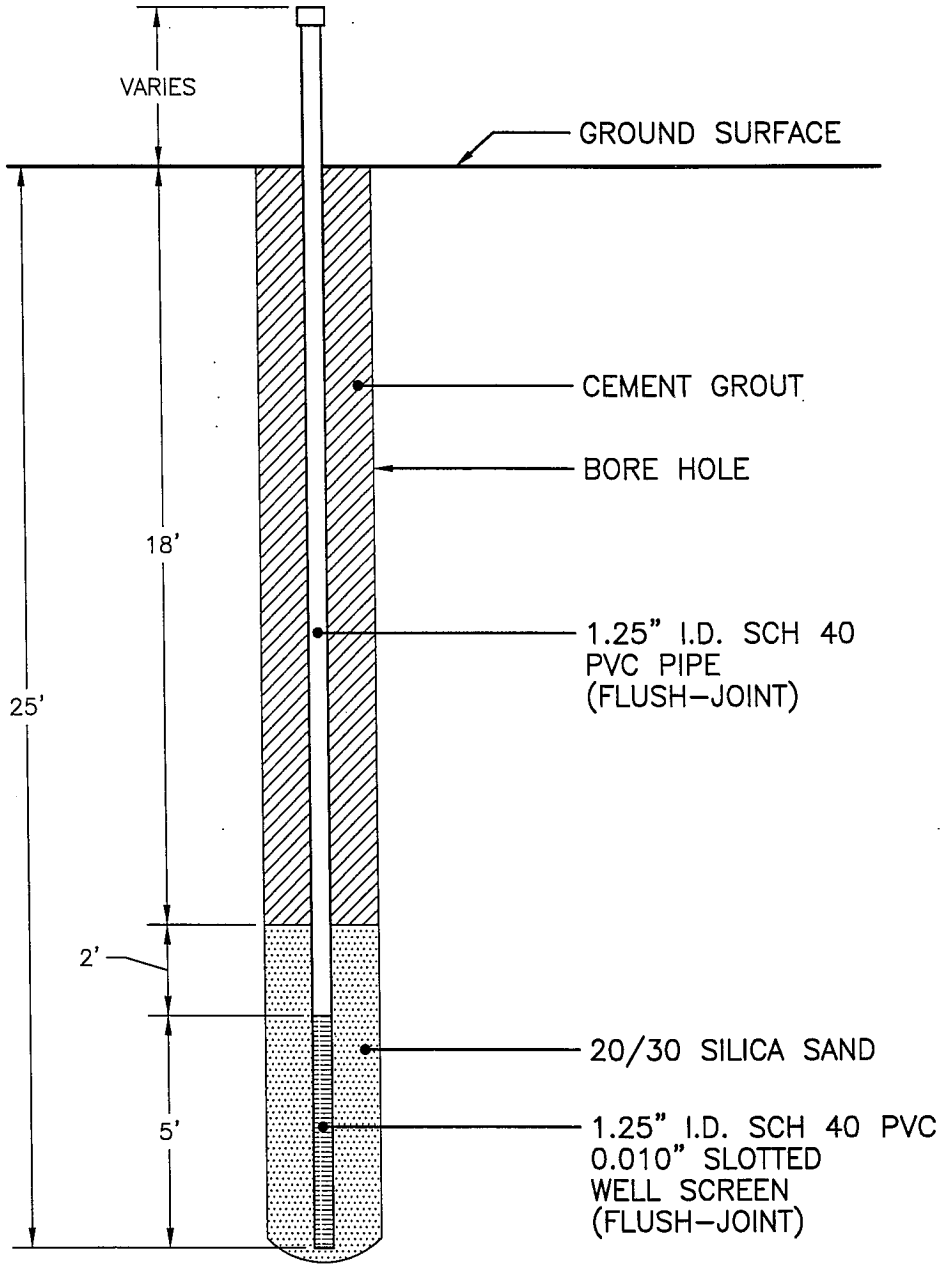
UNDISTURBED SAMPLE LOCATION (SHELBY TUBE)

GEOTECHNICAL DRILLING SERVICES
LAKE JESUP AQUATIC ENHANCEMENT PROJECT
CAMERON / LITTLE RANCH SITE
SEMINOLE COUNTY, FLORIDA

FIELD:	RK,MK,CT,AM	DATE:	6-13-02
DRAWN:	RR	SCALE:	NOTED
CHECKED:	RR	PROJ. NO.:	25508A
APPROVED:	RK		SHEET 3 OF 4

ACE DRILLING
GEOTECHNICAL AND ENVIRONMENTAL SUBCONTRACT DRILLING SERVICES

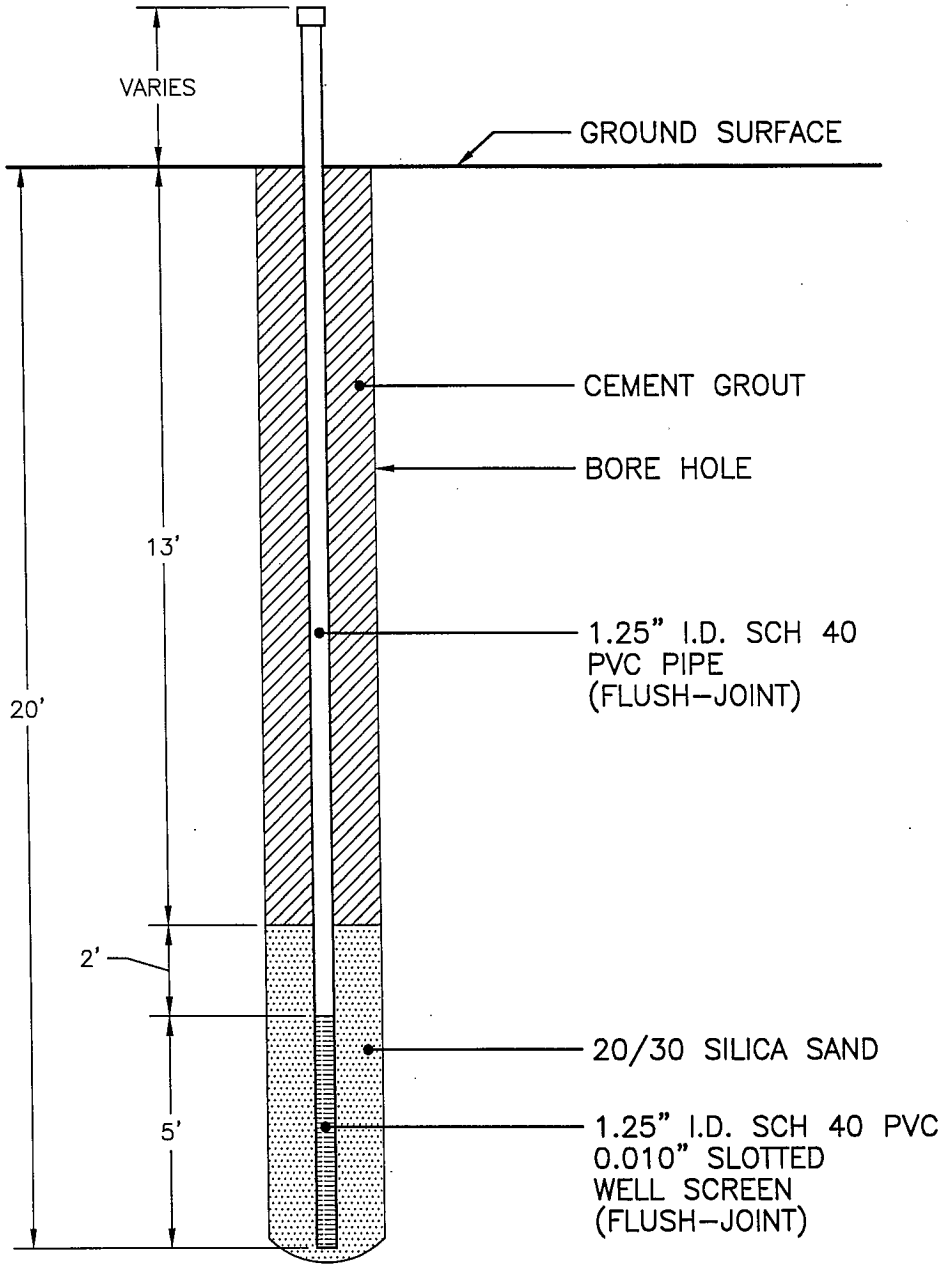
PIEZOMETER PC–3 CONSTRUCTION DETAIL



NOTE: SURFACE WATER LEVEL = 6.5' ABOVE LAND SURFACE

ACE DRILLING GEOTECHNICAL AND ENVIRONMENTAL SUBCONTRACT DRILLING SERVICES		GEOTECHNICAL DRILLING SERVICES **LAKE JESUP AQUATIC ENHANCEMENT PROJECT** SEMINOLE COUNTY, FLORIDA	
FIELD: RM,MK,CT,AM	CHECKED: RR	DATE: 6–13–02	PROJ. NO.: 02
DRAWN: RR	APPROVED: RK	SCALE: NTS	FIGURE 1

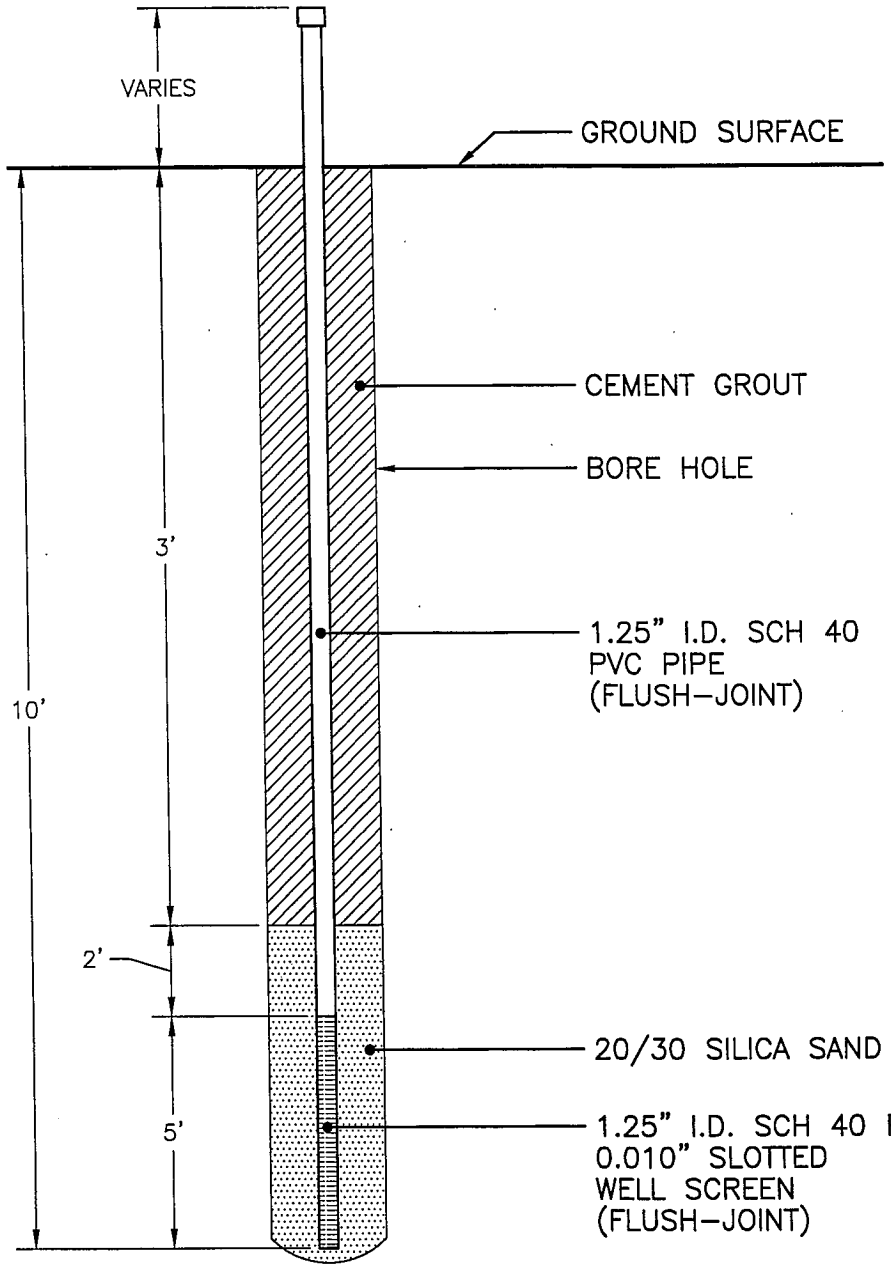
PIEZOMETER PC–8 CONSTRUCTION DETAIL



NOTE: GROUNDWATER LEVEL = 6.7' BELOW LAND SURFACE

ACE DRILLING GEOTECHNICAL AND ENVIRONMENTAL SUBCONTRACT DRILLING SERVICES		GEOTECHNICAL DRILLING SERVICES **LAKE JESUP AQUATIC ENHANCEMENT PROJECT** SEMINOLE COUNTY, FLORIDA	
FIELD: RM,MK,CT,AM	CHECKED: RR	DATE: 6–13–02	PROJ. NO.: 02
DRAWN: RR	APPROVED: RK	SCALE: NTS	FIGURE 2

PIEZOMETER PC–15 CONSTRUCTION DETAIL



NOTE: GROUNDWATER LEVEL = 3.2' BELOW LAND SURFACE

ACE DRILLING GEOTECHNICAL AND ENVIRONMENTAL SUBCONTRACT DRILLING SERVICES		GEOTECHNICAL DRILLING SERVICES **LAKE JESUP AQUATIC ENHANCEMENT PROJECT** SEMINOLE COUNTY, FLORIDA	
FIELD: RM,MK,CT,AM	CHECKED: RR	DATE: 6–13–02	PROJ. NO.: 02
DRAWN: RR	APPROVED: RK	SCALE: NTS	FIGURE 3

APPENDIX K

Laboratory Investigation Results for Cameron/Little Ranch Soil Samples
M3S Laboratories, August 2002

SUMMARY OF LABORATORY SOIL ANALYSIS

Lake Jesup Aquatic Enhancement Project
Cameron/Little Ranch Site
Project No.: 25508A – Lake Jesup

Sample ID	Natural Moisture Content	*Percent Finer No. 200
C – 1 / 2	40.3	85.0
C – 2 / 2	45.6	79.0
C – 3 / 2	39.3	73.0
C – 4 / 2	34.4	70.1
C – 5 / 2	50.3	79.8
C – 6 / 2	41.3	68.2
C – 7 / 2	27.0	69.8
C – 8 / 2	36.2	69.1
C – 9 / 2	37.9	73.1
C – 10 / 2	21.4	52.4
C – 11 / 2	40.5	75.7
C – 12 / 2	42.2	69.0
C – 13 / 2	27.4	48.1
C – 14 / 2	60.3	86.9
C – 15 / 2	25.7	38.8
C – 16 / 2	13.7	32.8
C – 17 / 2	34.3	55.0
C – 18 / 2	23.6	31.3

*FM1-T-088 -- Florida Method of Test for Particle Size Analysis of Soils.

M3S

SUMMARY OF LABORATORY SOIL ANALYSIS

Lake Jesup Aquatic Enhancement Project
Cameron/Little Ranch Site
Project No.: 25508A – Lake Jesup

Sample ID	Natural Moisture Content	*Percent Organic Content
C – 1 / 1	---	7.1
C – 5 / 1	---	8.8
C – 7 / 1	---	18.8
C– 13 / 1	---	6.7
C– 14 / 1	---	9.7
C – 1 / 3	38.7	---
C – 2 / 3	43.8	---
C – 3 / 3	40.0	---
C – 4 / 3	31.7	---
C – 5 / 3	44.7	---
C – 6 / 3	41.4	---
C – 7 / 3	40.7	---

**FM1-T-267 -- Florida Method of Test for Determination of Organic Content in Soils By Loss On Ignition

M3S

SUMMARY OF LABORATORY SOIL ANALYSIS

Lake Jesup Aquatic Enhancement Project
Cameron/Little Ranch Site
Project No.: 25508A – Lake Jesup

Sample ID	Natural Moisture Content	Percent Organic Content
C – 8 / 3	38.1	---
C – 9 / 3	47.5	---
C – 10 / 3	23.8	---
C – 11 / 3	34.7	---
C – 12 / 3	36.7	---
C – 13 / 3	19.8	---
C – 14 / 3	47.9	---
C – 15 / 3	25.5	---
C – 16 / 3	25.1	---
C – 17 / 3	29.8	---
C – 18 / 3	21.4	---

**FM1-T-267 -- Florida Method of Test for Determination of Organic Content in Soils By Loss On Ignition

M3S

SUMMARY OF LABORATORY SOIL ANALYSIS

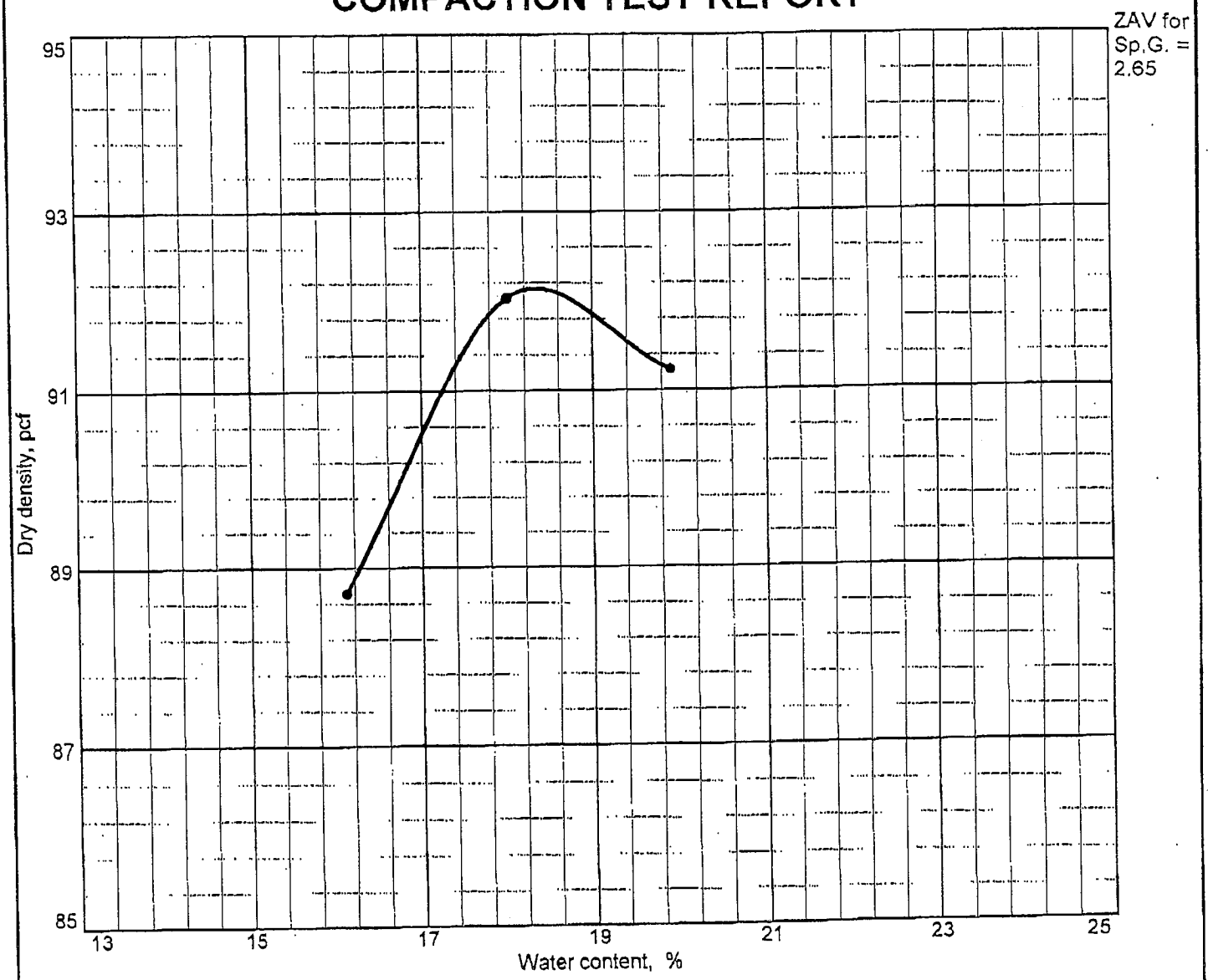
Lake Jesup Aquatic Enhancement Project
Camerpm/Little Ranch Site
Project No.: 25508A

Boring No.	C-3	C-8	C-9	C-11	C-15
Depth	4-6'	7-9'	6-8'	12-14'	12-14'
Natural Moisture Content (%)	33.2	43.2	41.5	29.2	49.5
Dry Unit Weight (pcf)	69.6	76.4	77.9	92.0	68.5
*Percent Finer No. 200	67.0	89.6	87.1	72.7	57.1
Liquid Limit	87	---	120	101	---
Plastic Limit	18	---	21	19	---
**Plasticity Index	69	---	99	82	---
***Permeability Rate (cm/sec.)	9.4 x 10-8	---	3.5 x 10-8	4.8 x 10-8	---

*FM1-T-088 -- Florida Method of Test for Particle Size Analysis of Soils.
**FM1-T-090 -- Plastic Limit and Plasticity Index of Soils.
***ASTM D 5084 – Flexible Wall Permeability with Backpressure Saturation.

M3S

COMPACTION TEST REPORT



Test specification: ASTM D 1557-78 Method C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	---	---	---	2.65	---	---	0.0	78.6

TEST RESULTS

Maximum dry density = 92.1 pcf

Optimum moisture = 18.3 %

MATERIAL DESCRIPTION

Composite Samples : C1 - C5
Gray Fine Sandy Clay

Project No. 25508A **Client:** Parsons Brinkerhoff

Project: Lake Jesup Aquatic Enhancement

• **Location:** Cameron/Little Ranch Site

Remarks:

COMPACTION TEST REPORT

M3S LABORATORIES, INC.

Plate

COMPACTION TEST REPORT

Date:

Project No.: 25508A
Project: Lake Jesup Aquatic Enhancement

Location: Cameron/Little Ranch Site
Elev./Depth:
Remarks:

MATERIAL DESCRIPTION

Description: Composite Samples : C1 - C5
Gray Fine Sandy Clay

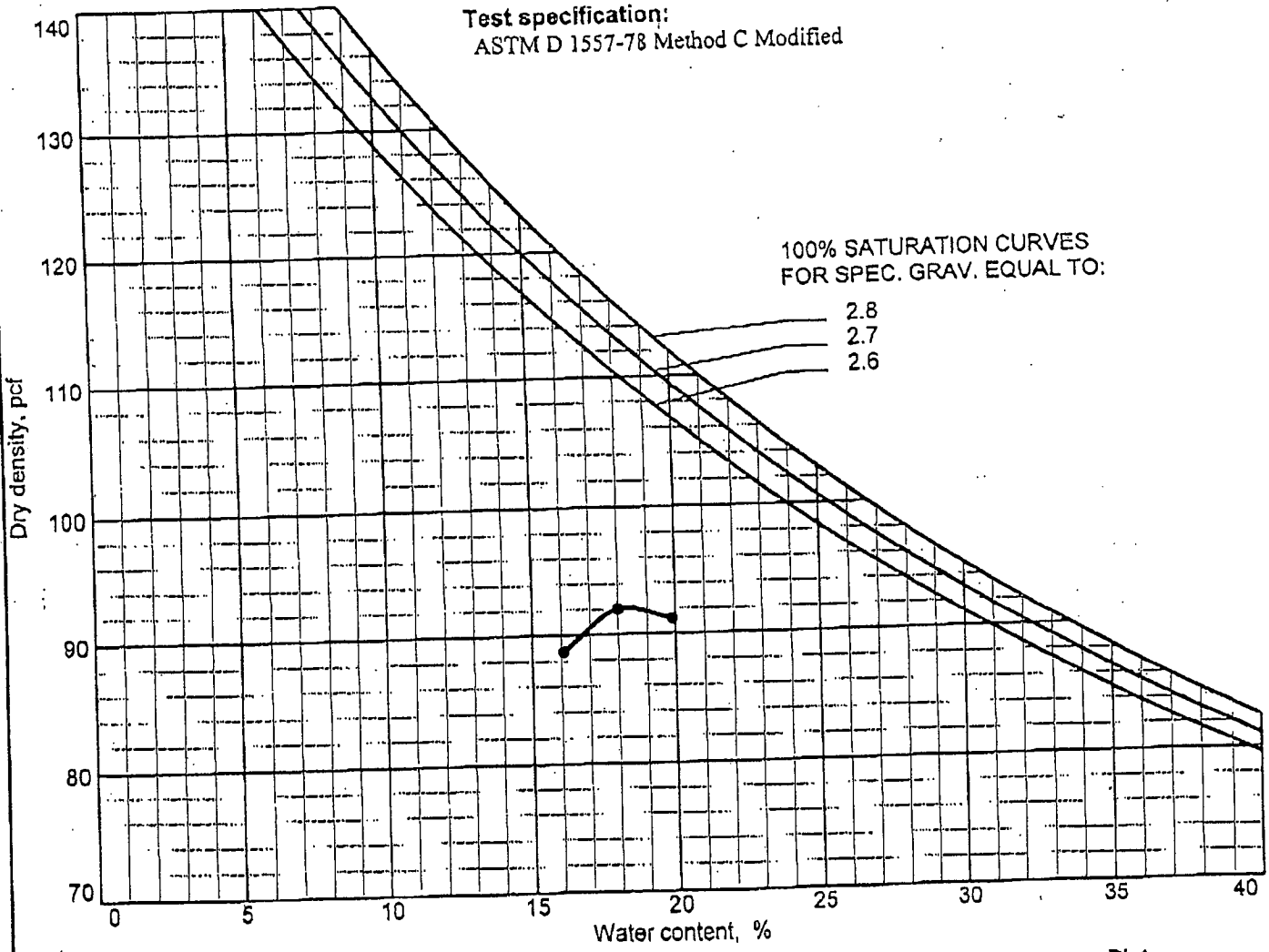
Classifications - USCS: --- AASHTO: ---

Nat. Moist. = --- %
Liquid Limit = ---
% > 3/4 in. = 0.0 %

Sp.G. = 2.65
Plasticity Index = ---
% < No.200 = 78.6 %

TEST RESULTS
Maximum dry density = 92.1 pcf
Optimum moisture = 18.3 %

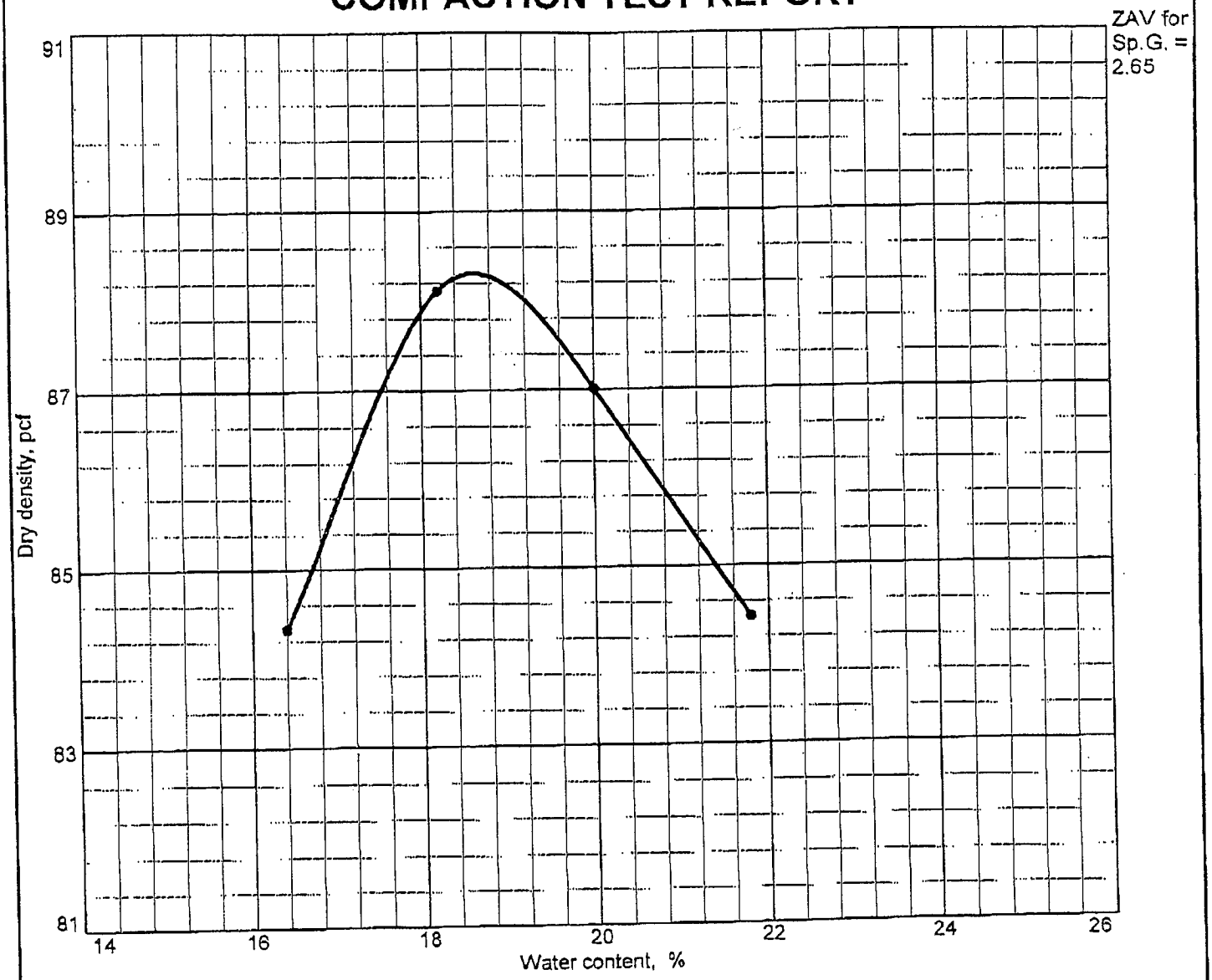
Test specification:
ASTM D 1557-78 Method C Modified



Plate

M3S LABORATORIES, INC.

COMPACTION TEST REPORT



Test specification: ASTM D 698-78 Method C Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 In.	% < No.200
	USCS	AASHTO						
	---	---	---	2.65	---	---	0.0	76.1

TEST RESULTS

Maximum dry density = 88.3 pcf

Optimum moisture = 18.6 %

MATERIAL DESCRIPTION

Composite Samples : C6 - C10
Gray Fine Sandy Clay

Project No. 25508A **Client:** Parsons Brinkerhoff

Project: Lake Jesup Aquatic Enhancement

Location: Cameron/Little Ranch Site

Remarks:

COMPACTION TEST REPORT

M3S LABORATORIES, INC.

Plate

COMPACTION TEST REPORT

Date:

Project No.: 25508A
Project: Lake Jesup Aquatic Enhancement

Location: Cameron/Little Ranch Site
Elev./Depth:
Remarks:

MATERIAL DESCRIPTION

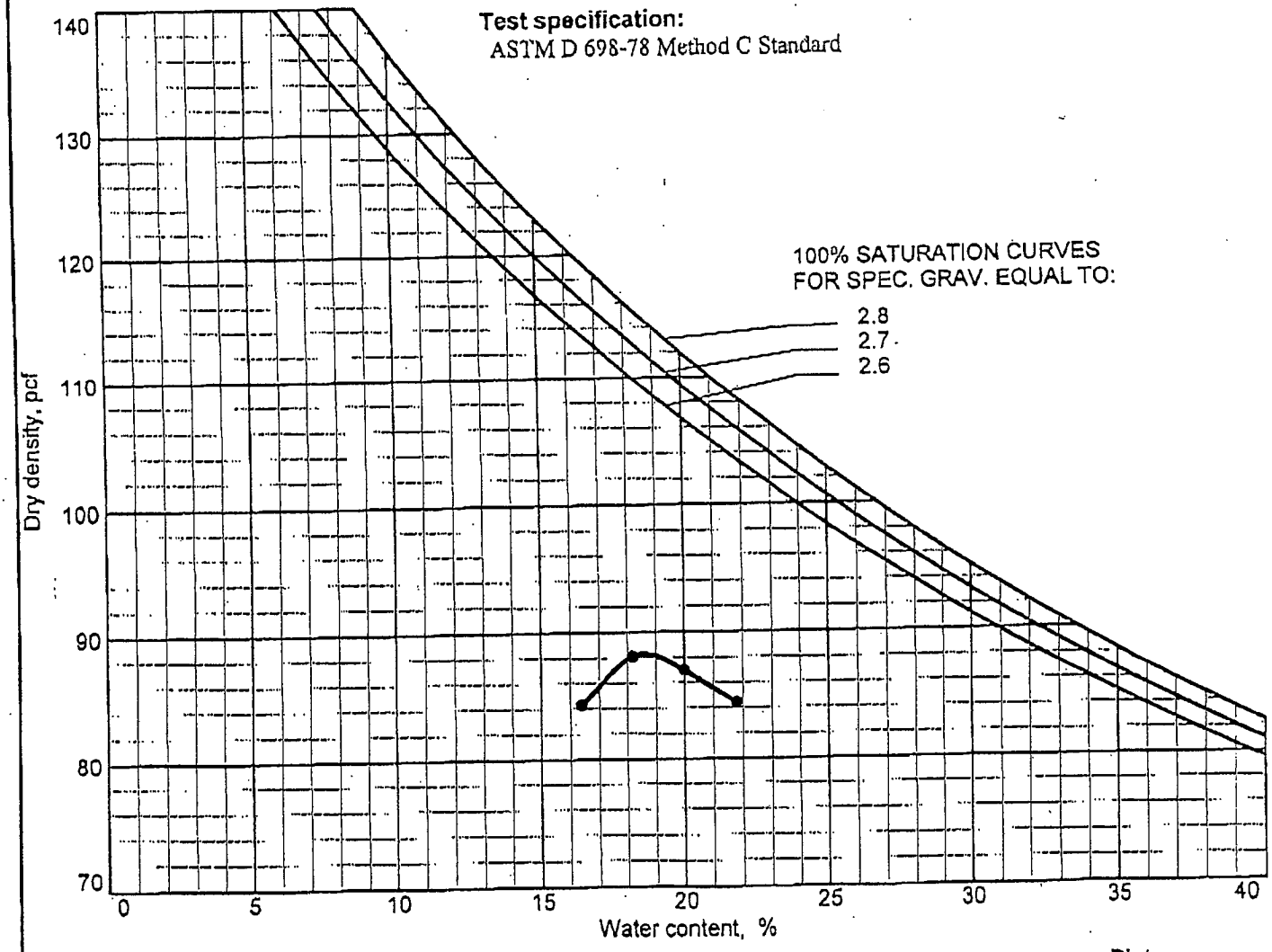
Description: Composite Samples : C6 - C10
Gray Fine Sandy Clay

Classifications - **USCS:** ML **AASHTO:** A-4(0)

Nat. Moist. = --- %
Liquid Limit = ---
% > 3/4 in. = 0.0 %

Sp.G. = 2.75
Plasticity Index = ---
% < No.200 = 76.1 %

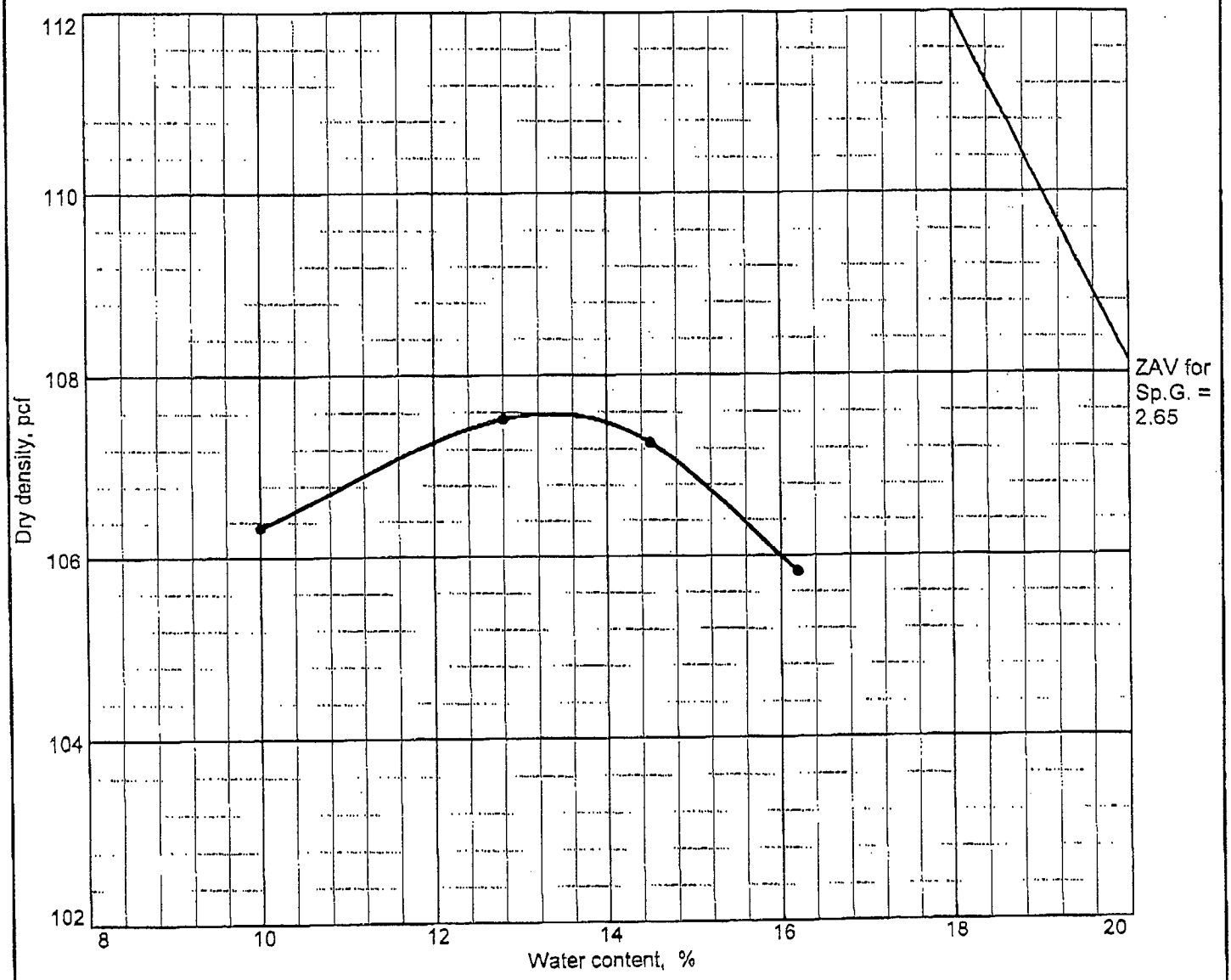
TEST RESULTS
Maximum dry density = 88.3 pcf
Optimum moisture = 18.6 %



Plate

M3S LABORATORIES, INC.

COMPACTION TEST REPORT



Test specification: ASTM D 1557-78 Method C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	---	---	---	2.65	---	NP	0	9.4

TEST RESULTS

Maximum dry density = 107.6 pcf

Optimum moisture = 13.4 %

MATERIAL DESCRIPTION

Composite Samples: C-15, C-17, C-18
Gray Slightly Silty Sand

Project No. 25508A **Client:** Parsons Brinkerhoff

Project: Lake Jesup Aquatic Enhancement

• **Location:** Cameron/Little Ranch Site

Remarks:

COMPACTION TEST REPORT

M3S LABORATORIES, INC.

Plate

COMPACTION TEST REPORT

Date:

Project No.: 25508A
Project: Lake Jesup Aquatic Enhancement

Location: Cameron/Little Ranch Site
Elev./Depth:
Remarks:

MATERIAL DESCRIPTION

Description: Composite Samples: C-15, C-17, C-18
Gray Slightly Silty Sand

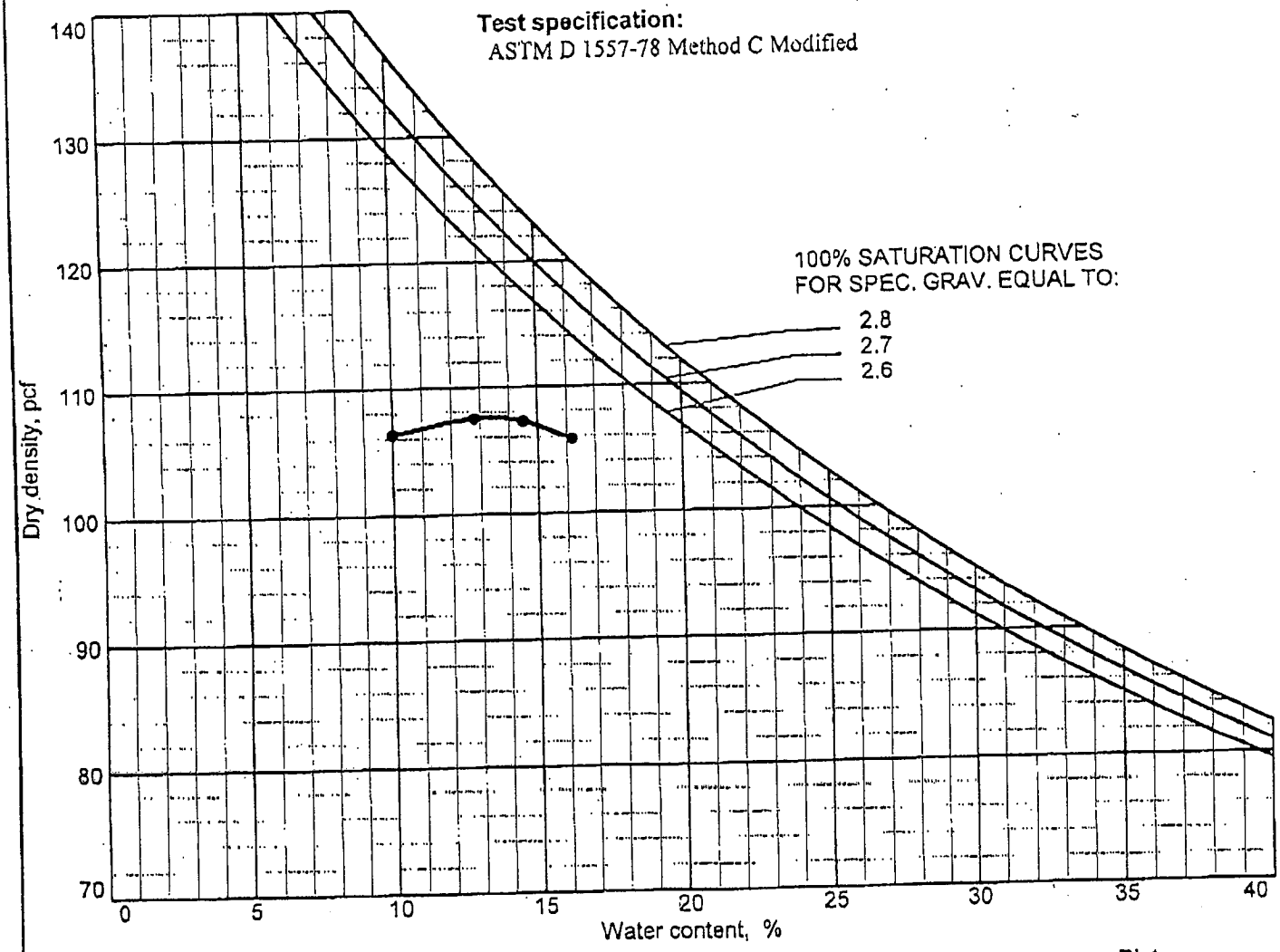
Classifications - **USCS:** --- **AASHTO:** ---

Nat. Moist. = --- %
Liquid Limit = ---
% > 3/4 in. = 0.0 %

Sp.G. = 2.65
Plasticity Index = NP
% < No.200 = 9.4 %

TEST RESULTS
Maximum dry density = 107.6 pcf
Optimum moisture = 13.4 %

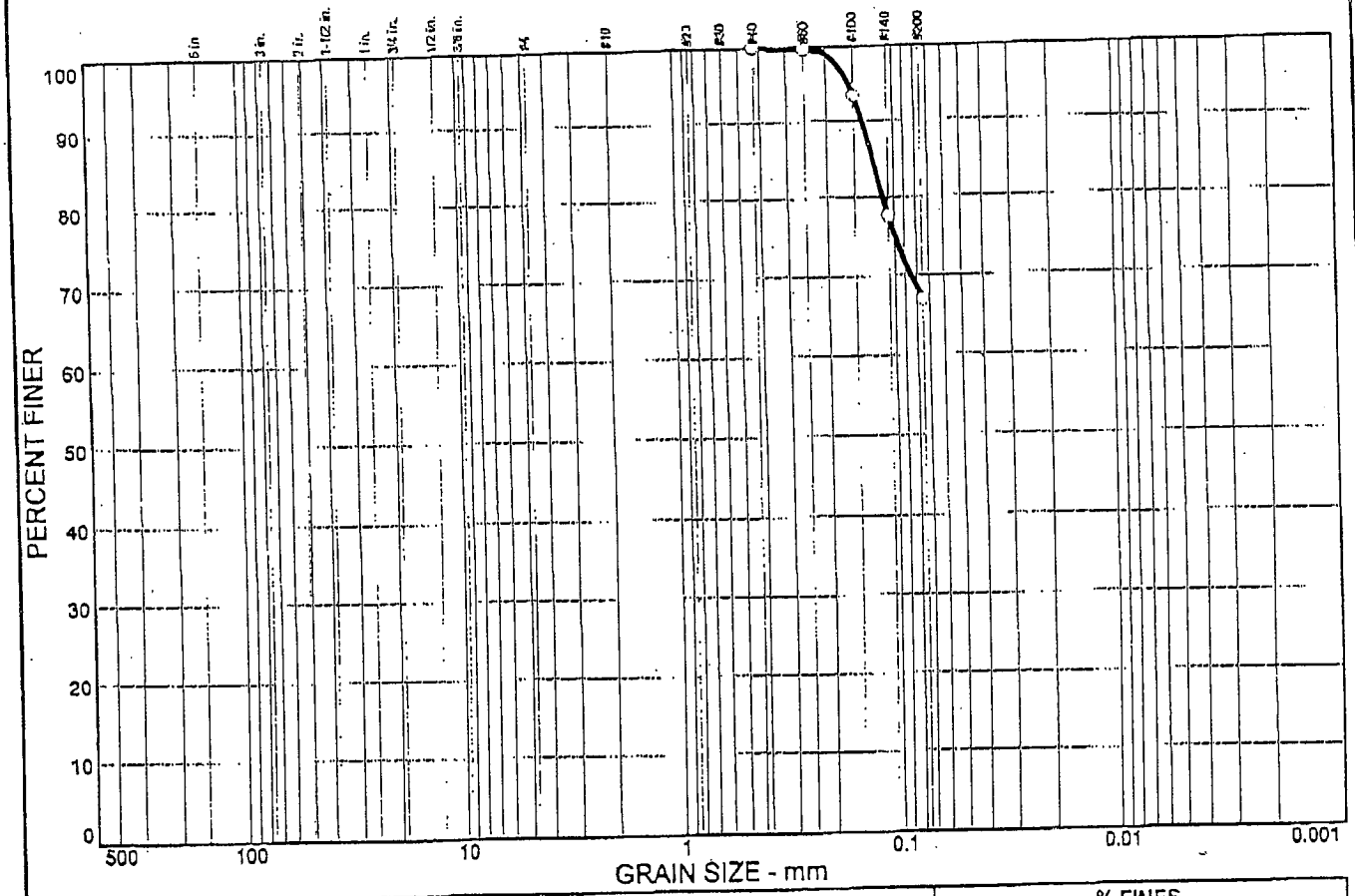
Test specification:
ASTM D 1557-78 Method C Modified



Plate

M3S LABORATORIES, INC.

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.0	33.0	67.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#40	100.0		
#60	99.7		
#100	93.5		
#140	77.6		
#200	67.0		

* (no specification provided)

Soil Description

Sandy Fat Clay

Atterberg Limits

PL= 18 LL= 87 PI= 69

Coefficients

D_{85}= 0.124 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(45)

Remarks

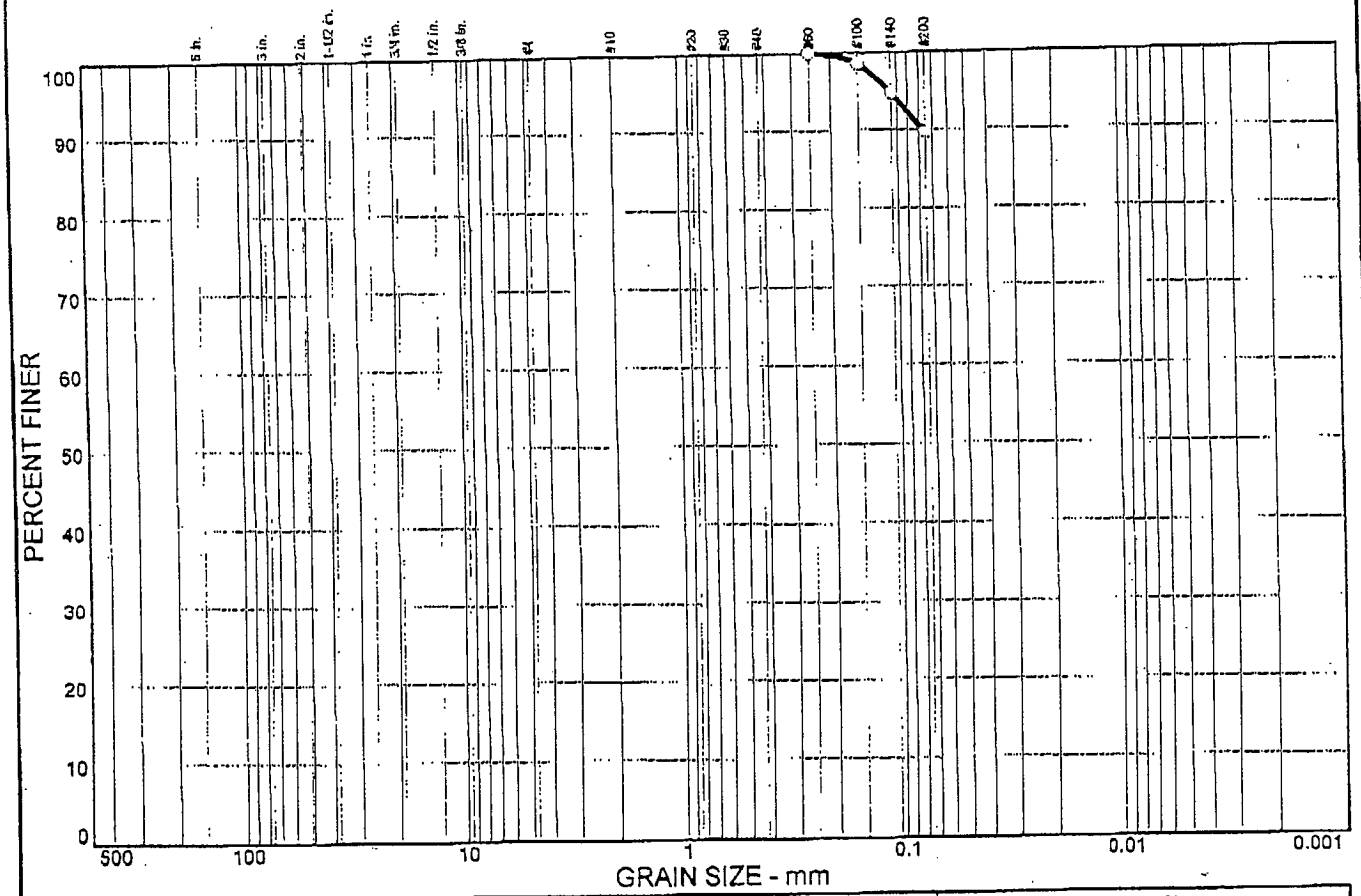
Hydraulic Conductivity : 9.4 x 10-8 cm/sec.
Dry Unit Weight : 69.6 pcf
F.M.=0.06

Sample No.: C-3 **Source of Sample:** **Date:** 8-16-02
Location: C-3 **Elev./Depth:** 4-6'

M3S LABORATORIES, INC.

Client: Parsons Brinkerhoff
Project: Lake Jesup Aquatic Enhancement Project
Project No: 25508A **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.0	10.4	89.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#60	100.0		
#100	98.6		
#140	94.8		
#200	89.6		

* (no specification provided)

Soil Description

Fat Clay

Atterberg Limits

PL= --- LL= --- PI= ---

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_U= C_C=

Classification

USCS= AASHTO=

Remarks

Natural Moisture Content : 43.2 %
Dry Unit Weight : 76.4pcf
F.M.=0.01

Sample No.: C-8
Location: C-8

Source of Sample:

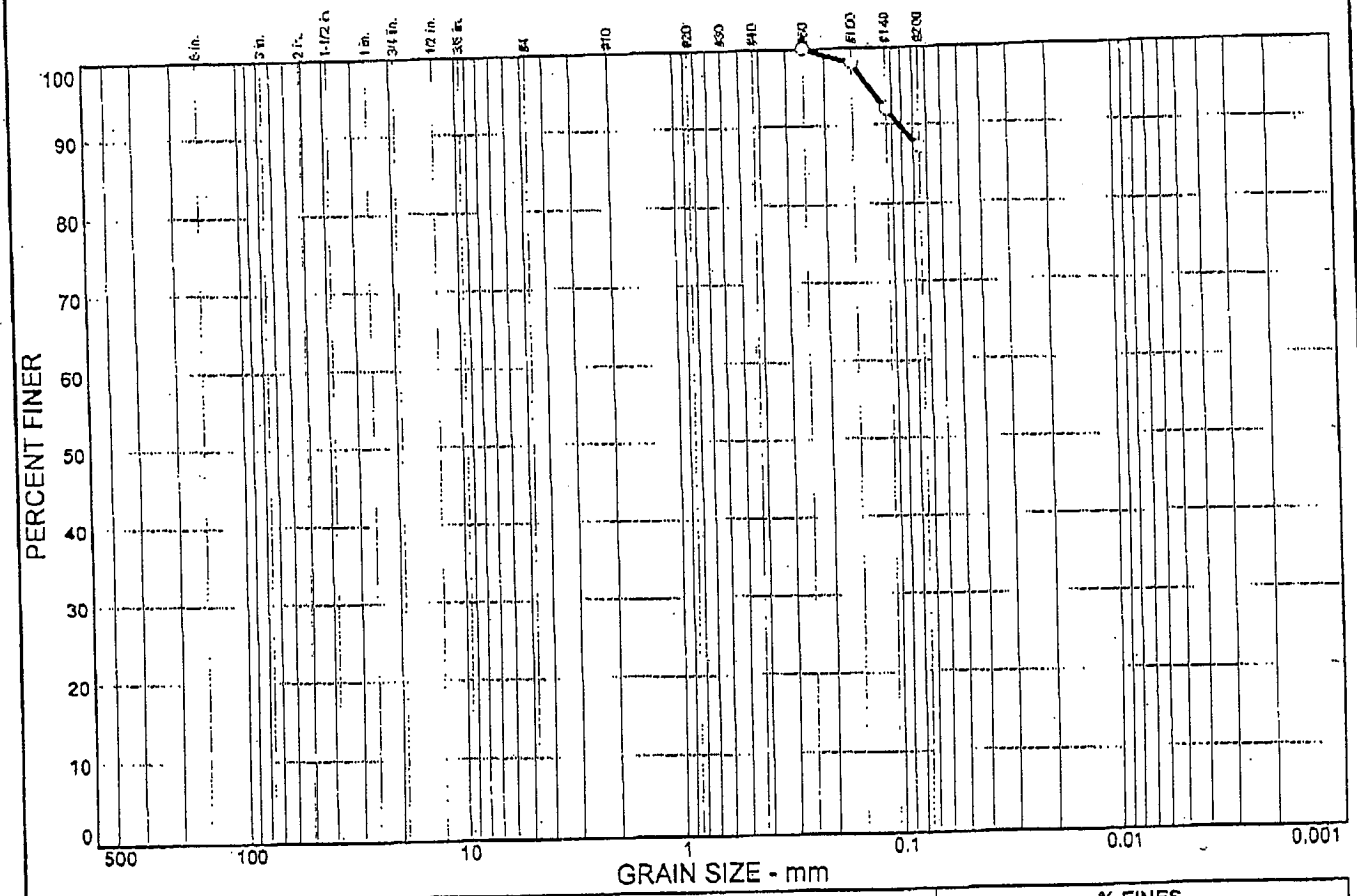
Date: 8-16-02
Elev./Depth: 7-9'

M3S LABORATORIES, INC.

Client: Parsons Brinkerhoff
Project: Lake Jesup Aquatic Enhancement Project

Project No: 25508A **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.0	12.9	87.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#60	100.0		
#100	98.1		
#140	92.1		
#200	87.1		

* (no specification provided)

Soil Description

Fat Clay

Atterberg Limits

PL= 21 LL= 120 PI= 99

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(95)

Remarks

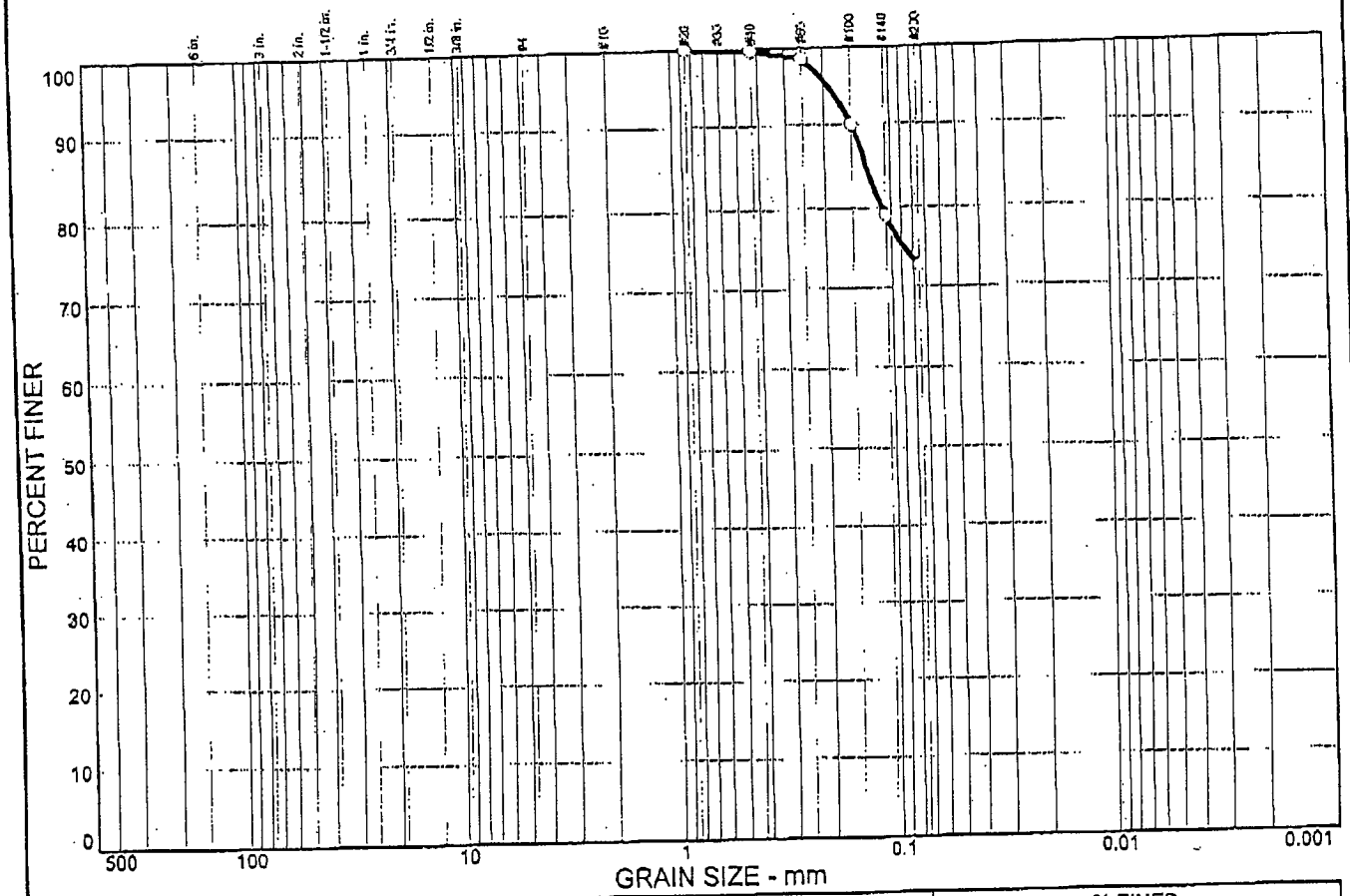
Hydraulic Conductivity : 3.5 x 10-8 cm/sec.
Dry Unit Weight : 77.9 pcf
F.M.=0.02

Sample No.: C-9 **Source of Sample:** **Date:** 8-16-02
Location: C-9 **Elev./Depth:** 6-8'

M3S LABORATORIES, INC.

Client: Parsons Brinkerhoff
Project: Lake Jesup Aquatic Enhancement Project
Project No: 25508A **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.3	27.0	72.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#20	100.0		
#40	99.7		
#60	98.6		
#100	90.0		
#140	79.1		
#200	72.7		

* (no specification provided)

Soil Description

Fat Clay w/Sand

Atterberg Limits

PL= 19 LL= 101 PI= 82

Coefficients

D_{85}= 0.128 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

Remarks

Hydraulic Conductivity : 4.8 x 10-8 cm/sec.
Dry Unit Weight : 92.0 pcf
F.M.=0.10

Sample No.: C-11
Location: C-11

Source of Sample:

Date: 8-16-02
Elev./Depth: 12-14'

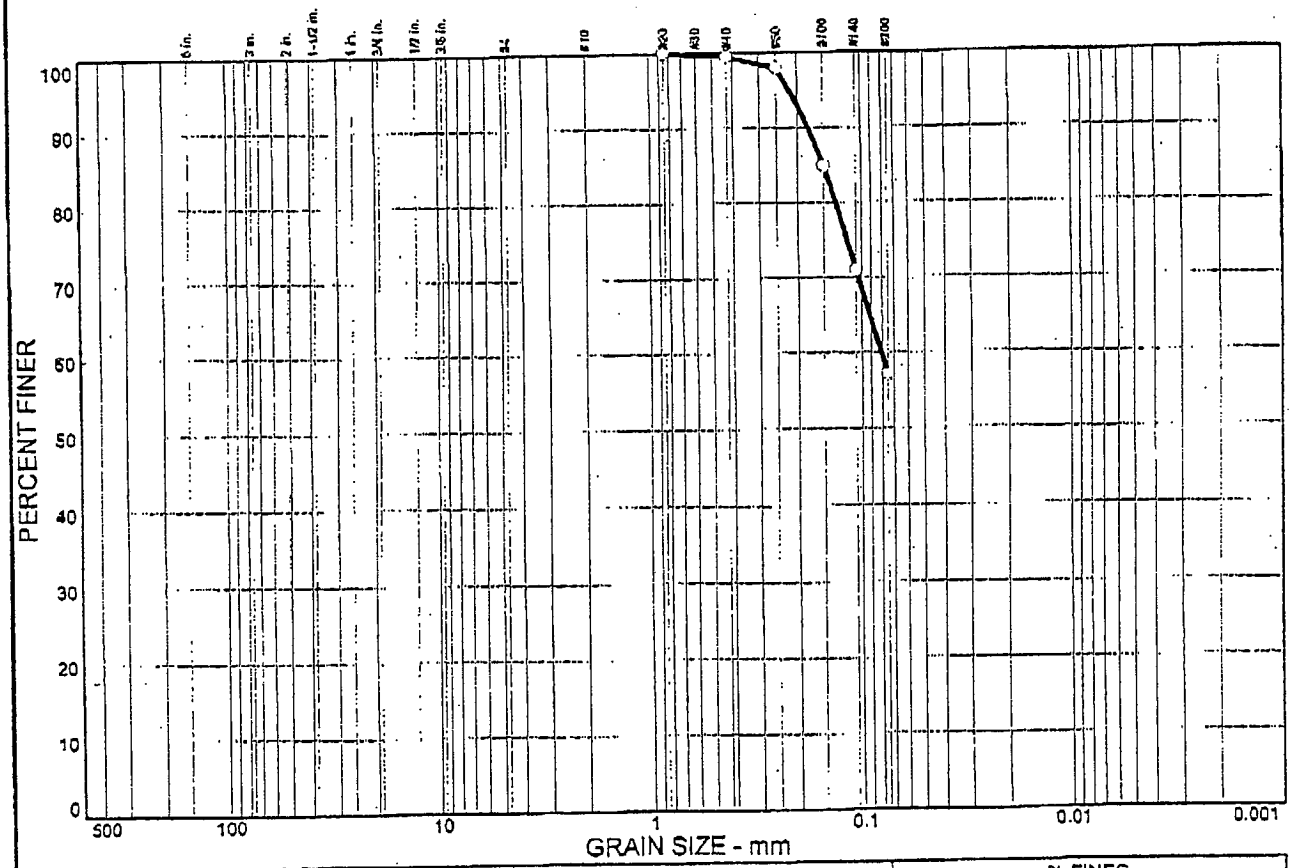
M3S LABORATORIES, INC.

Client: Parsons Brinkerhoff
Project: Lake Jesup Aquatic Enhancement Project

Project No: 25508A

Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.5	42.4	57.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#20	100.0		
#40	99.5		
#60	98.0		
#100	84.9		
#140	71.0		
#200	57.1		

* (no specification provided)

Soil Description

Sandy Silt

Atterberg Limits

PL= --- LL= --- PI= ---

Coefficients

D_{85}= 0.150 D_{60}= 0.0807 D_{50}=
D_{30}= D_{15}= D_{10}=
C_U= C_C=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Natural Moisture Content : 49.5 %
Dry Unit Weight : 68.5 pcf
F.M.=0.15

Sample No.: C-15
Location: C-15

Source of Sample:

Date: 8-16-02
Elev./Depth: 12-14'

M3S LABORATORIES, INC.

Client: Parsons Brinkerhoff
Project: Lake Jesup Aquatic Enhancement Project

Project No: 25508A

Plate

APPENDIX L

Preliminary Sizing Analysis of Cameron/Little Ranch Site Confined Disposal Facility, October 2002

Lake Jesup Aquatic Enhancement Project

Preliminary Sizing Analysis of Cameron/Little Ranch Confined Disposal Facility

In-Situ Condition (0)		
Total In-Situ Dredge Volume	**20,300,000**	cubic yards
	548,100,000	cubic feet
Measured Average Solids Content	**14.2**	%
Measured Average Specific Gravity (Gs) =	**1.63**	
Calculated Average Water Content	604	%
Calculated Average Dry Density	9.38	pcf
Calculated Average Total Density	66.02	pcf

	As-Being-Dredged Condition (1)			**End-of-Dredging Condition (2)**		
	Conservative	**Best Scenario**	**Units**	**Conservative**	**Best Scenario**	**Units**
Estimated Average Solids Content	**7**	**12**	**%**	**15**	**20**	**%**
Average Water Content	1329	733	%	567	400	%
Total Solids Weight of Sediment (Constant)	5,138,630,157	5,138,630,157	pounds	5,138,630,157	5,138,630,157	pounds
Total Sediment Weight (Solids and Water)	73,409,002,246	42,821,917,977	pounds	34,257,534,381	25,693,150,786	pounds
Total Water Weight	68,270,372,089	37,683,287,820	pounds	29,118,904,224	20,554,520,629	pounds
Total Water Volume	1,094,076,476	603,898,843	cubic feet	466,649,106	329,399,369	cubic feet
Total Solids Volume of Sediment (Constant)	50,521,376	50,521,376	cubic feet	50,521,376	50,521,376	cubic feet
Total Sediment Volume (Solids and Water)	42,392,513	24,237,786	cubic yards	19,154,462	14,071,139	cubic yards
Average Total Density of Sediment	64.14	65.43	pcf	66.24	67.63	pcf
Average Dry Density of Sediment	4.49	7.85	pcf	9.94	13.53	pcf
Estimated Slurry Rate for two 8-10" Auger-Head Dredges	**4,000**	gpm				
Estimated Slurry Production Rate for 24 hrs/day @ 75% efficiency	21,390	cubic yards/day				
Estimated In-Situ Production Rate for 24 hrs/day @ 75% efficiency	10,545	18,076	cubic yards/day			
Estimated Dredging Period for 24 hrs/day @ 75% efficiency	1,925	1,123	days			
At an Estimated Average Solids Content of	7	12	%			
Required Sediment Storage Volume at End-of-Dredging Condition (2)	**16,612,800**	cubic yards	**<-- (Avg. of "Conservative" and "Best Scenario" Volumes)**			
Change in Volume at End-of-Dredging	-18.2	%				
Total Effective Settling Area (acres) (See table below)	**356**	**345**	**333**	**322**	**311**	**300**
Total Dike Height (feet)	**10**	**15**	**20**	**25**	**30**	**35**
Freeboard (feet)	**3**	**3**	**3**	**3**	**3**	**3**
Average Sediment Height (feet)	7.0	12.0	17.0	22.0	27.0	32.0
Average Storage Volume of Settling Cells (cubic yards)	4,022,417	6,670,506	9,136,919	11,426,833	13,545,460	15,498,028
Corresponding In-Situ Sediment Volume (cubic yards)	**4,915,189**	**8,151,020**	**11,164,852**	**13,963,011**	**16,551,865**	**18,937,804**

Notes:

1.63 = Input Value

CDF Perimeter, Area, and Volume Analysis

Disposal Area	Dike Height (feet)	Berm Slope (H:V)	Berm Top Width (feet)	Berm Bottom Width (feet)	Dike Length (feet)	Inside Toe of Berm Area (sf)	Inside Toe of Berm Area (acres)	Effective Area (acres)	Storage Volume (cubic yards)	Corresp. In-Situ Sediment Volume (cubic yards)
Cell #1	10	2.5	12	62	10,720	3,872,843	88.9	91.1	1,028,389	1,256,639.11
	15	2.5	12	87	10,617	3,613,853	83.0	86.6	1,676,934	2,049,128.25
	20	2.5	12	112	10,513	3,360,044	77.1	82.3	2,256,243	2,757,014.16
	25	2.5	12	137	10,409	3,111,416	71.4	78.0	2,768,474	3,382,935.09
	30	2.5	12	162	10,306	2,867,970	65.8	73.8	3,215,787	3,929,528.92
	35	2.5	12	187	10,202	2,629,730	60.4	69.7	3,600,372	4,399,472.05
Cell #2	10	2.5	12	62	7,113	5,815,648	133.5	135.5	1,529,885	1,869,441.88
	15	2.5	12	87	7,072	5,611,488	128.8	132.2	2,558,566	3,126,438.08
	20	2.5	12	112	7,031	5,410,691	124.2	128.9	3,535,400	4,320,079.83
	25	2.5	12	137	6,990	5,213,257	119.7	125.7	4,461,764	5,452,049.04
	30	2.5	12	162	6,950	5,019,184	115.2	122.6	5,339,046	6,524,043.06
	35	2.5	12	187	6,909	4,828,474	110.8	119.5	6,168,630	7,537,753.06
Cell #3	10	2.5	12	62	8,477	5,550,137	127.4	129.6	1,464,143	1,789,108.06
	15	2.5	12	87	8,433	5,313,063	122.0	125.8	2,435,006	2,975,453.36
	20	2.5	12	112	8,387	5,079,899	116.6	122.0	3,345,276	4,087,757.69
	25	2.5	12	137	8,342	4,850,645	111.4	118.2	4,196,595	5,128,026.52
	30	2.5	12	162	8,297	4,625,301	106.2	114.6	4,990,627	6,098,292.97
	35	2.5	12	187	8,251	4,403,868	101.1	111.0	5,729,026	7,000,579.15
Interior Dike	10	2.5	12	62	2,640	--	--	--	--	--
(btwn #2 and #3)	15	2.5	12	87	2,614	--	--	--	--	--
	20	2.5	12	112	2,586	--	--	--	--	--
	25	2.5	12	137	2,557	--	--	--	--	--
	30	2.5	12	162	2,528	--	--	--	--	--
	35	2.5	12	187	2,499	--	--	--	--	--
Settling Cell	10	2.5	12	62	28,950	15,238,628	349.8	356.2	4,022,417	4,915,189
Totals	15	2.5	12	87	28,735	14,538,405	333.8	344.6	6,670,506	8,151,020
	20	2.5	12	112	28,517	13,850,635	318.0	333.1	9,136,919	11,164,852
	25	2.5	12	137	28,298	13,175,318	302.5	321.9	11,426,833	13,963,011
	30	2.5	12	162	28,080	12,512,455	287.2	311.0	13,545,460	16,551,865
	35	2.5	12	187	27,861	11,862,072	272.3	300.2	15,498,028	18,937,804
Polishing Pond	4	2.5	12	32	5,848	1,097,134	25.2	25.5	82,352	--
	6	2.5	12	42	5,808	1,040,334	23.9	24.5	158,426	--
	8	2.5	12	52	5,768	984,336	22.6	23.6	228,355	--
	10	2.5	12	62	5,728	929,140	21.3	22.6	292,273	--

Notes:

Perimeter computed along centerline of berm

Effective area includes storage along slope of interior berm