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## **Agricultural Uses of Yazoo River Dredged Material**

### **Report 1**

### **Cotton Production on Dredged Material in a Thick-Layer Confined Disposal Facility**

*by Richard A. Price, Paul R. Schroeder  
Environmental Laboratory*

*Larry E. Banks, Johnny G. Sanders, David R. Johnson  
U.S. Army Engineer District, Vicksburg*

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### Cotton Production on Dredged Material in a Thick-Layer Confined Disposal Facility

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Report 1 of a series

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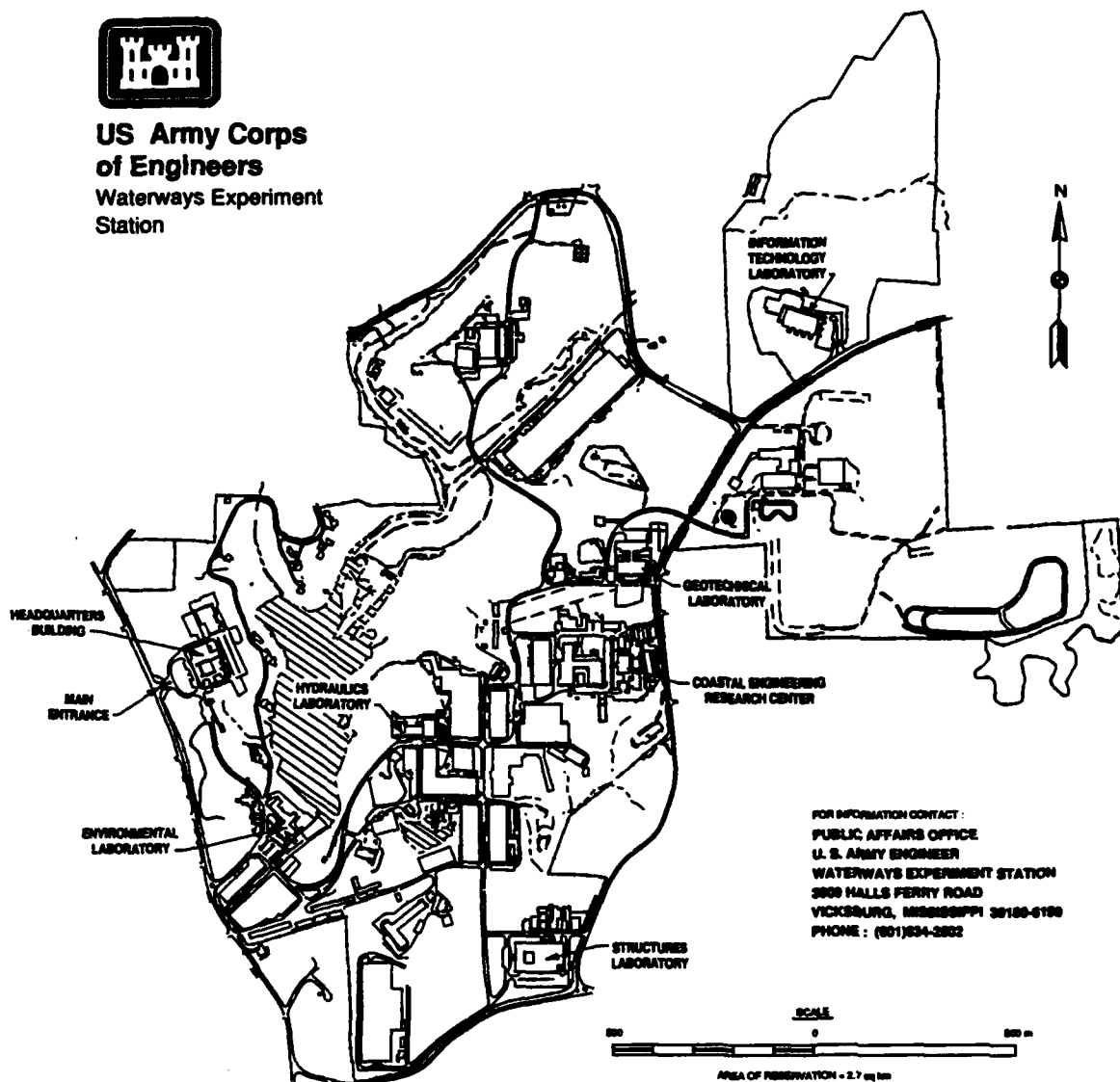
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# Preface

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The study reported herein was conducted by the Fate and Effects Branch (FEB), Environmental Processes and Effects Division (EPED), Environmental Laboratory (EL), of the U.S. Army Engineer Waterways Experiment Station (WES). The study was conducted for and sponsored by the U.S. Army Engineer District, Vicksburg.

The study was conducted by Dr. Bobby L. Folsom, Jr., Principal Investigator, Mr. Richard A. Price, FEB, and Dr. Paul R. Schroeder, Engineering Applications Branch, (EAB), Environmental Engineering Division (EED). Technical assistance in conduct of field sampling and laboratory tests was provided by Ms. Donna Garrett, Ms. Brenda Allen, and Mr. Keith Fessel, FEB. Assistance was provided by Ms. Elizabeth Tominey and Ms. Erica Seals, FEB, in the preparation of tables and figures. This report was written by Mr. Price under the direct supervision of Dr. Charles R. Lee, Team Leader, Contaminant Assessment and Monitoring Team, EPED.

The study was conducted under the direct supervision of Dr. Folsom, Team Leader, Plant Bioassay Team, Dr. Lloyd R. Saunders, Chief, FEB, Mr. Donald L. Robey, Chief, EPED, and Dr. John Harrison, Director, EL.

At the time of publication of this report, Dr. Robert W. Whalin was Director of WES. COL Leonard G. Hassell, EN, was Commander.

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# Conversion Factors, SI to Non-SI Units of Measurement

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SI units of measurement used in this report can be converted to non-SI units as follows:

| Multiply          | By     | To Obtain   |
|-------------------|--------|-------------|
| centimeters       | 0.3937 | inches      |
| meters            | 3.281  | feet        |
| kilometers        | 0.6214 | miles       |
| liters            | 0.2642 | gallons     |
| hectares          | 2.471  | acres       |
| kilograms/hectare | 0.8922 | pounds/acre |
| bales/hectare     | 2.471  | bales/acre  |

# **1 Introduction**

---

## **Background**

Channel improvement and levee construction in and along the Yazoo River drainage basin were authorized by the U.S. Congress to alleviate flooding of residential areas, towns, and farmland in that part of the state of Mississippi known as "The Delta," a fertile area lying between the Mississippi and Yazoo Rivers. The work was tasked to the U.S. Army Engineer District, Vicksburg. Much of the work was completed on the lower portion of the Yazoo River during the 1970's. Hydraulic dredging operations placed dredged material in large (approximately 12 ha), deep (approximately 4.5 m), confined disposal facilities (CDFs) constructed near the Yazoo River channel. Most of the CDFs were not filled to capacity with dredged material and were designed to be used years later to contain additional dredged material resulting from future maintenance dredging operations. Many of the CDFs were constructed on privately owned land, and use of the land by the Corps of Engineers was generally under a right-of-way purchase. Although landowners retained title to the land on which CDFs were constructed, reuse of the land for agricultural purposes or to account for crop reduction acreage was eliminated.

## **The Problem**

Many of the previous CDFs were constructed on what is considered some of the most productive cotton land in the delta area. A few farmers had tried, with little success, to produce a profitable crop on CDFs that were sufficiently filled. Farm equipment often became mired to their axles while attempting to till the dredged material. Many of the landowners made no attempt to utilize the CDFs after witnessing some of the difficulties encountered by neighboring landowners. Since the CDFs were allowed to become fallow, willow trees and assorted weeds became established and water was generally ponded on the lower end of most CDFs. The Corps began having difficulty in acquiring additional easements from landowners along the upper portion of the Yazoo River. The landowners referred to the CDFs as "spoil pits" and did not want them placed on their land.

A study to provide for a dredged material disposal alternative that would enhance agricultural utilization was begun by the Vicksburg District. The U.S. Army Engineer Waterways Experiment Station (WES), Environmental Laboratory was asked to assist the Vicksburg District in support of this initiative. If such an initiative could successfully result in productive cotton land, then landowners would be more willing to allow placement of dredged material on their land and consequently would provide disposal sites for future dredging projects.

## **Objectives**

This study was divided into two phases. Phase I concentrated on dredged material in an old, thick-layer CDF. Phase II will be conducted on a newly constructed, thin-layer CDF on marginal cotton land. The objectives of phase I were to (a) determine response of cotton to Yazoo River dredged material as a growth medium and (b) to produce a substantial cotton crop on a representative deep-layer CDF. The objectives of phase II are to determine dredged material and disposal site soil mixes possible in a thin-layer CDF and cotton response to those mixes. This report will focus only on phase I.

## 2 Site Selection, Evaluation, and Preparation

---

### Site Selection and Evaluation

In selecting an existing thick-layer CDF, investigators desired to have one located in an agricultural area in cotton production and which had received minimal disturbance. The selected CDF (4A) was located in an area adjacent to the Yazoo River levee about 9.7 km north of Yazoo City, MS, and was surrounded by productive cotton land (Figure 1). Water was ponded on the lower portion of CDF 4A (Figure 2), and the middle and upper portions of the CDF were colonized by small trees and assorted weeds (Figure 3). The upper portion of the CDF had previously been cleared of trees, and a windrow from the clearing operation remained on the CDF. Other than the windrow, which was also colonized with weeds, there was no indication of disturbance on the site. Preliminary core sampling indicated that ponded water on the lower portion of the CDF was affecting moisture content and subsurface drainage on the middle and upper portions of the CDF. It was necessary to remove the excess water from the site prior to any use of heavy equipment on the CDF.

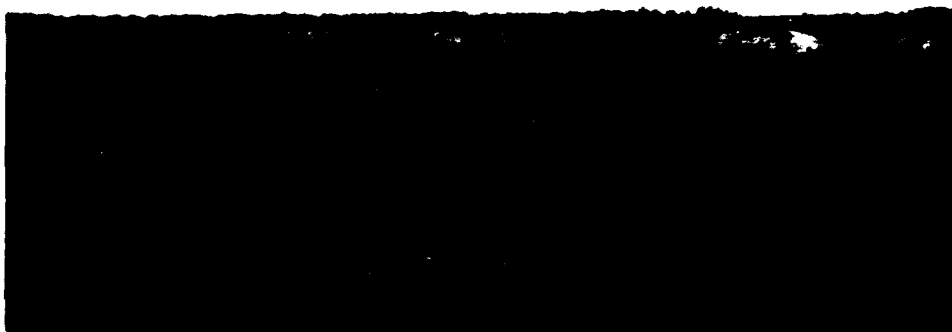


Figure 1. CDF 4A surrounded by cotton fields



Figure 2. Water ponded on the lower end of CDF 4A



Figure 3. Assorted weeds and trees on the upper portion of CDF 4A

## Site Drainage and Preparation

Corps personnel breached the levee at the lower portion of the CDF (Figure 4), thereby allowing trapped water to escape. Once most of the water had drained and desiccation started, a backhoe was used to dig a series of ditches (Figure 5) to provide a conduit for additional water removal during storm events and additional drying of the lower end of the CDF. Tractor-driven rotary mowers were used to cut down the weeds and smaller trees. A bulldozer was then used to remove trees that were not removed by mowing and to roughly level the middle and upper portions of the site.



Figure 4. Breaching the Dike on the lower end of CDF 4A



Figure 5. Digging drainage trenches in the lower end of CDF 4A

## **Results and Discussion**

Three months after water was removed, CDF 4A provided limited support of heavy equipment. Sheets of plywood had to be placed for additional support for the backhoe to accomplish ditching. Core samples taken after surface water removal indicated areas within the lower portion of the CDF were only 1 to 1.2 m above the original soil surface layer. Where the original soil surface had been removed for levee construction, the dredged material was as thick as 2.7 m in the lower portion of the CDF. The ditches provided for good drainage of the CDF, except for a few sink areas in the lower end of the CDF where the elevation was below that of the drainage ditch outside of the CDF.

## **3 Site Characterization**

---

### **Methods and Materials**

#### **Sampling grids**

The CDF was divided into 30.5- by 30.5-m grids using a 91-m tape and laser transit (Hewlett-Packard Model 3810B). The grids were marked with wire flagging and labeled as shown in Figure 6. This grid system provided an easy method of accurately sampling the entire CDF.

#### **Core samples**

Core samples were collected from the center of each grid, rows A-H, down to a depth of 46 cm with a hand-operated soil auger having a bucket diameter of 7 cm. Samples from each core were collected at 0- to 15-, 15- to 30-, and 30- to 45-cm depths. Soil cores in grids I-Z were initially collected to a depth of 45 cm and later to a depth of 1.5 m in 30-cm increments. Additional samples were collected from the I-M and N-Z grid areas to a depth of 30 cm. Samples were placed in wax-lined soil collection bags and transported to the WES for physical and chemical analyses.

Core samples were also collected, for comparative purposes, from the cotton field just north of CDF 4A and from a productive cotton field near Egypt, MS, the site of phase II testing.

#### **Particle size analysis**

Particle size analyses of core samples were accomplished using the method of Day (1956) as modified by Patrick (1958). Particle size was characterized according to content of sand ( $>50\ \mu\text{m}$ ), silt ( $<50\ \mu\text{m}$  and  $>2\ \mu\text{m}$ ) and clay ( $<2\ \mu\text{m}$ ).

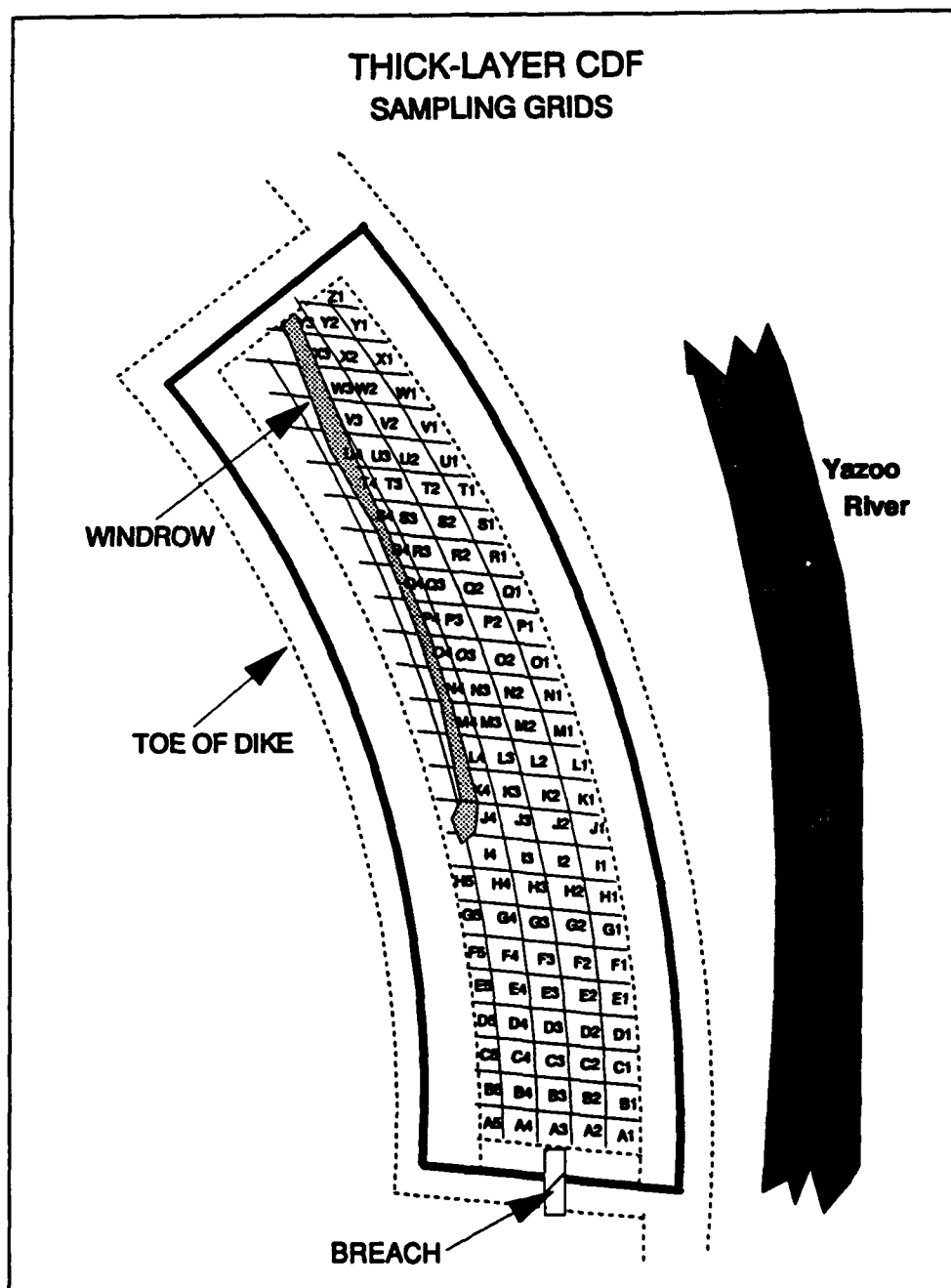


Figure 6. Sampling grids on CDF

### Determination of pH

To determine pH, 10 g oven dry weight (ODW to nearest 0.001 g) of dredged material was weighed into a tall 50-ml Pyrex glass beaker, and 20 ml of distilled water was added. The mixture was stirred with a polyethylene rod until all particles were saturated. Then, the mixture was stirred with a magnetic stirrer for 1 min every 15 min for 45 min. After 45 min, the pH electrode was placed into the solution above the surface of

the dredged material and the pH was read on a pH meter (Folsom, Lee, Bates 1981).

### **Organic matter**

Organic matter (OM) was determined by weight loss on ignition at 550 °C in accordance with procedure No. 209E of the American Public Health Association (1976). A 5-g subsample (ODW) was weighed to the nearest 0.001 g and dried at 105 ± 2 °C until constant weight (48 hr). A 5-g sample of the oven-dried sediment was weighed to the nearest 0.001 g and combusted at 550 ± 5 °C for 24 hr in a muffle furnace. The sample was allowed to cool to room temperature in a moisture desiccator and then reweighed to the nearest 0.001 g. Weight loss on ignition was calculated and reported as percent OM using the following formula:

$$\% \text{ OM} = \frac{\text{weight oven-dry sample} - \text{weight combusted sample}}{\text{weight oven-dry sample}} \times 100$$

### **Sample digestion and heavy metals analysis**

Heavy metal concentrations were determined on composite dredged material samples and on National Bureau of Standards Reference Material (NBS) 1646. A 1-g (ODW) (weighed to the nearest 0.001 g) sample was placed into a 120-ml Teflon PFA vessel, and 10 ml of concentrated nitric acid was added. A cap was placed on the vessel and sealed at 16.3 joules of torque. Vessels containing the dredged material composites, one NBS 1646 standard, and one acid blank were placed in a digestion turntable and venting tubes were attached. The turntable was placed in a MDS-81-D microwave digestion unit (CEM Corporation, Matthews, NC), set into 360-deg rotation, and heated at 600 watts (W) for 2 min 30 sec and then at 480 W for 10 min. After cooling to room temperature, each vessel was hand-vented to release pressure and then uncapped. After uncapping, 5 ml of 30 percent hydrogen peroxide was added to each vessel and allowed to effervesce. When the effervescence stopped, each solution was quantitatively filtered through a Whatman No. 41 filter and diluted with distilled water to 100 ml. The resultant acid digest was analyzed by inductively coupled plasma emission spectrometry (ICP) or direct-current plasma emission spectrometry (DCP). Mercury was determined by cold-vapor atomic absorption spectrometry (CVAAS).

### **Agricultural analysis**

Agricultural analysis, normally conducted for agricultural soils, was conducted on dredged material samples collected from each grid in rows I-Z at the 0- to 30-cm depth in 1988 and from composited samples collected at the 0- to 30-cm depth in 1990. The analysis included pH, cation exchange capacity, exchangeable bases, available phosphorus, organic matter, base

saturation and fertilizer recommendations and was performed by Pettiet Agricultural Services in Leland, MS. The methods used for each test are listed in Appendix A.

## Results and Discussion

### Particle size distribution

The results of the particle size analysis for each grid are provided in Appendix B. Particle size distribution of the 0- to 45-cm depth across the site is presented in Figure 7. Based on particle size distribution, CDF 4A was divided into three sections: A-H, I-M, and N-Z. Grids A-H consisted largely of clay, I-M consisted largely of silt, and N-Z consisted largely of sand. Table 1 is a comparison of mean particle size and texture classification for each section with those of two productive cotton fields at Egypt and Yazoo City, MS. The calculated mean of the A-H grids resulted in a soil classification of silty clay. Grids A-H had a mean sand content of only 2 percent while the clay and silt made up 50.1 and 47.9 percent, respectively. The high clay content results in a poorly drained material not considered ideal for cotton production without extensive efforts to increase drainage. Since waterlogging is the most common restriction to cotton production (Monroe 1987), grids A-H were eliminated as a medium for cotton growth in this study.

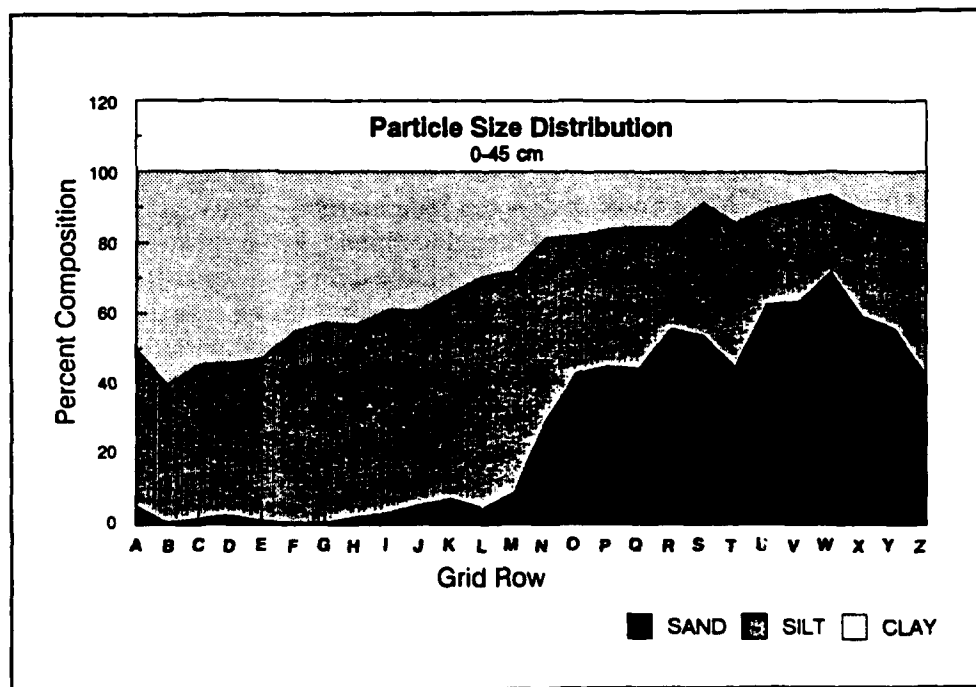


Figure 7. Particle size distribution in CDF 4A, 0-45 cm

**Table 1**  
**Comparison of Particle Size Characteristics of Composites**  
**from CDF 4A and from Productive Cotton Fields**

| Parameter      | CDF4A Grids |                 |      | Cotton Field   |                 |
|----------------|-------------|-----------------|------|----------------|-----------------|
|                | A-H         | I-M             | N-Z  | Yazoo City, MS | Egypt, MS       |
| Sand (%)       | 2.0         | 5.5             | 51.3 | 27.5           | 13.5            |
| Silt (%)       | 47.9        | 60.5            | 35.3 | 52.5           | 57.4            |
| Clay (%)       | 50.1        | 34.0            | 13.4 | 20.0           | 29.1            |
| Classification | Silty clay  | Silty clay loam | Loam | Silt loam      | Silty clay loam |

The mean particle size distributions for grids I-M and N-Z are shown to be very similar to those of the two cotton field soils. Although the mean particle size distribution in the I-M grids exhibits half the sand content and slightly higher silt and clay contents compared with the Egypt, MS, cotton field, the soil classification was the same. The particle size distribution in the Yazoo City cotton field has higher sand and less silt and clay contents than the Egypt, MS, field. Sand content is higher and silt and clay contents are lower in the N-Z grids than both the I-M grids and the Yazoo City field. With respect to textural classes, the fineness of the materials would fall in the order of I-M grids > Egypt field > Yazoo City field > N-Z grids. Table 2 provides a better understanding of the basic texture of these soils and the importance of particle size distribution of the CDF 4A dredged material and area cotton fields. Both the N-Z grids and Yazoo City field have a medium texture while the I-M grids and Egypt field have a moderately fine texture. One must recall the fact that CDF 4A was not designed for agricultural use and no attempt was made to evenly apply and mix the Yazoo River dredged material during disposal. However, in phase II of this project, the dredged material will be disposed into a CDF and mixed in such a manner as to provide the most beneficial medium for cotton production that is economically feasible. With that in mind, if one calculates the entire sampling grid area (A-Z) a particle size distribution of 23.8 percent sand, 44.8 percent silt, and 31.4 percent clay or a clay loam textural class is obtained. This calculation probably underestimates the silt and sand contents, since core samples were not collected from the entire depth of dredged material to the original soil surface, and a medium textured classification would be a better estimate. However, either a medium or moderately fine texture puts Yazoo River dredged material within the range of suitable agricultural soils for cotton production in the Mississippi Delta area.

**Table 2**  
**General Terms Used to Describe Soil Texture in Relation**  
**to Basic Soil Textural Class Names<sup>1</sup>**

| General Terms |                   | Basic Soil Textural Class Names                   |
|---------------|-------------------|---------------------------------------------------|
| Common Names  | Texture           |                                                   |
| Sandy soils   | Coarse            | Sandy<br>Loamy sands                              |
| Loamy soils   | Moderately coarse | Sandy loam<br>Fine sandy loam                     |
|               | Medium            | Very fine sandy loam<br>Loam<br>Silt loam<br>Silt |
|               | Moderately fine   | Clay loam<br>Sandy clay loam<br>Silty clay loam   |
| Clayey soils  | Fine              | Silty clay<br>Clay                                |

<sup>1</sup> Brady (1974)

Particle size distribution was also determined on the 0- to 150-cm core samples taken in 30-cm increments from each grid (I-Z). Mean particle size distribution of each grid row is presented by depth in Figures 8-12. These figures indicate some variability with depth in the distribution of sand, silt, and clay as was evident during core sample collection, where stratified layers of sand, silt, clay, or organic matter were identified. However, general distribution of clay decreased from the I to M grids while the sand content increased from the N to Y grids. Overall distribution of sand in the 120- to 150-cm depth is decreased, replaced by higher silt content.

Analysis of the mean of particle size distribution by depth over the entire I-Z grid area indicated little variability with depth, except for sand and silt in the 120- to 150-cm depth, Table 3. Mean particle size distribution of the 0- to 150-cm depth for the I-Z grids was 20.4 percent sand, 59.2 percent silt, and 20.2 percent clay, yielding a silt loam classification, the same classification as the Yazoo City cotton field. Consequently, these data suggest that the Yazoo River dredged material has the physical characteristics that when equally distributed and mixed will have the same physical properties as those of productive area cotton fields. In other words, although it is not the intention to return existing CDFs along the Yazoo River to agricultural use, future CDF construction and Yazoo River dredged material disposal have the potential of improving marginal farmland into land more conducive to cotton production.

**Table 3**  
**Mean Particle Size**  
**Distribution by Depth**

| Depth, cm | % Clay | % Silt | % Sand |
|-----------|--------|--------|--------|
| 0-30      | 18.3   | 51.2   | 30.6   |
| 30-60     | 19.4   | 52.6   | 27.9   |
| 60-90     | 20.3   | 52.6   | 27.2   |
| 90-120    | 20.3   | 52.8   | 26.9   |
| 120-150   | 20.3   | 59.2   | 20.4   |

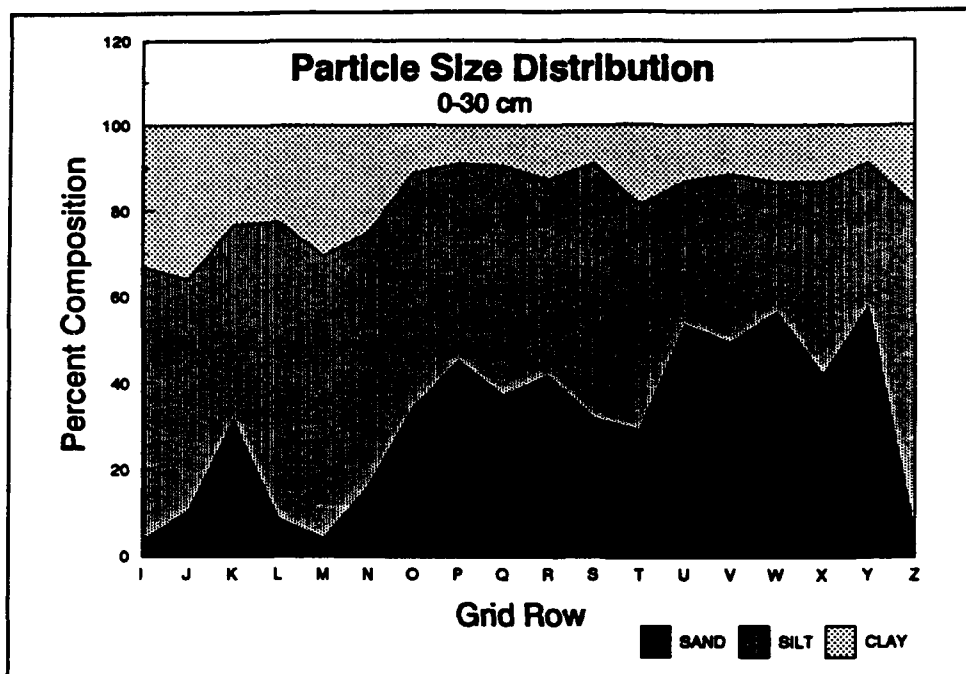


Figure 8. Particle size distribution in I-Z grids, 0-30 cm

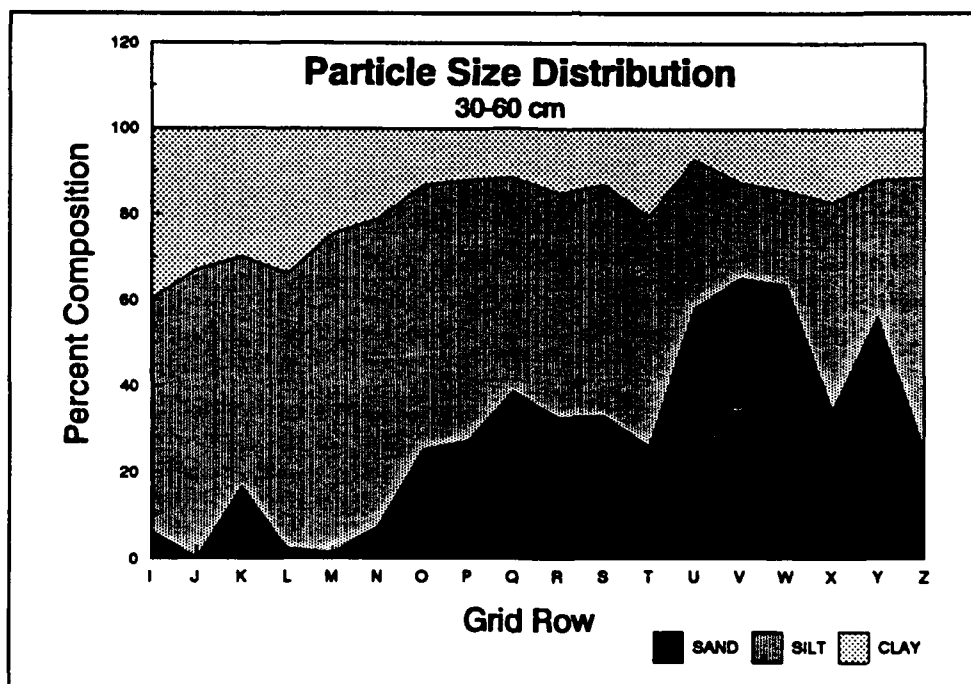


Figure 9. Particle size distribution in I-Z grids, 30-60 cm

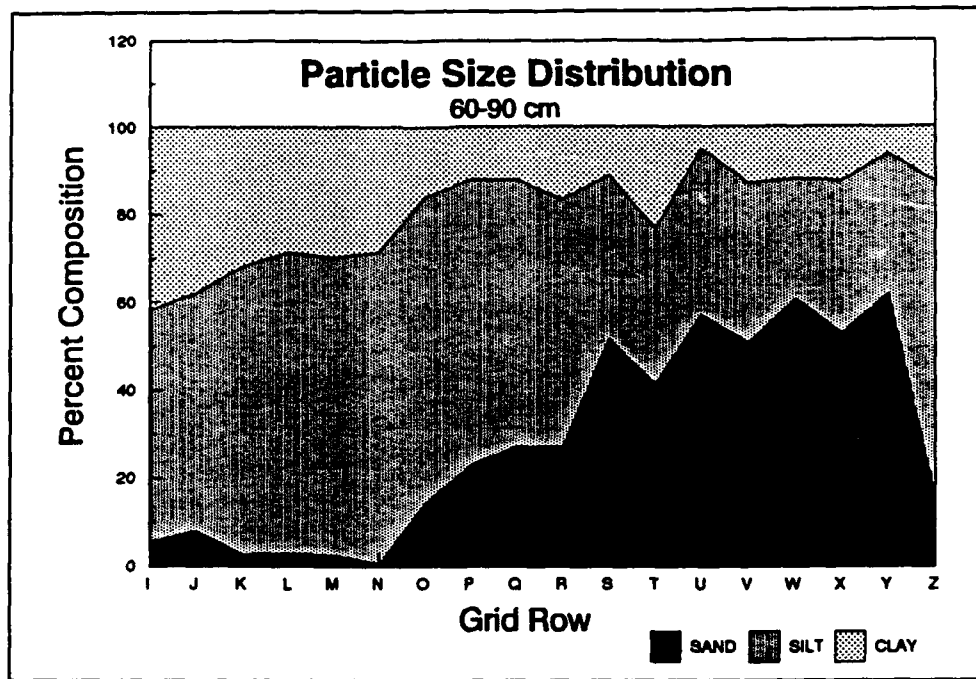


Figure 10. Particle size distribution in I-Z grids, 60-90 cm

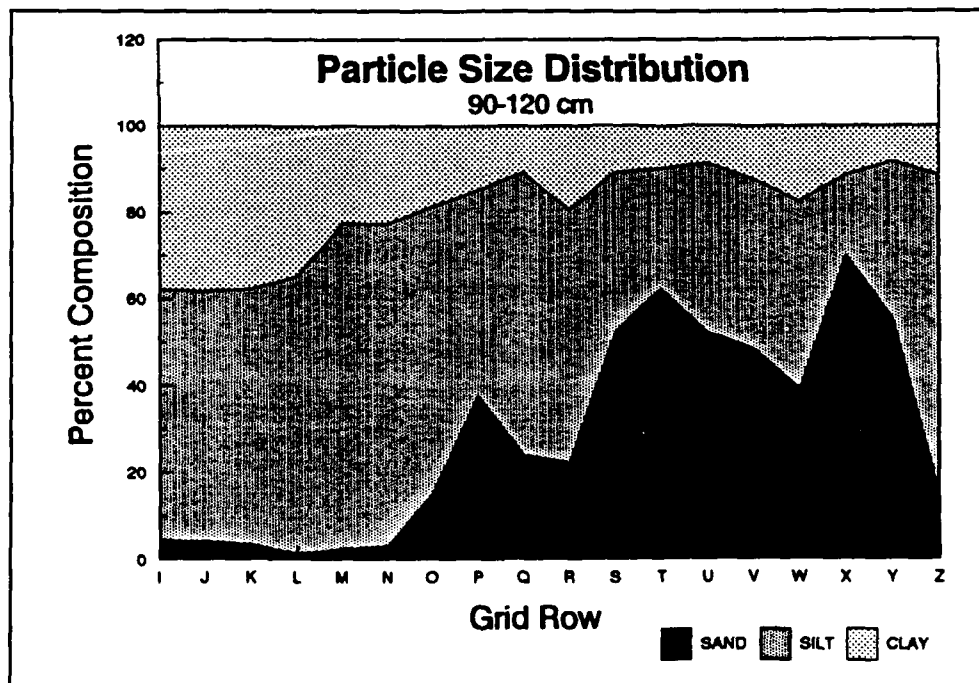


Figure 11. Particle size distribution in I-Z grids, 90-120 cm

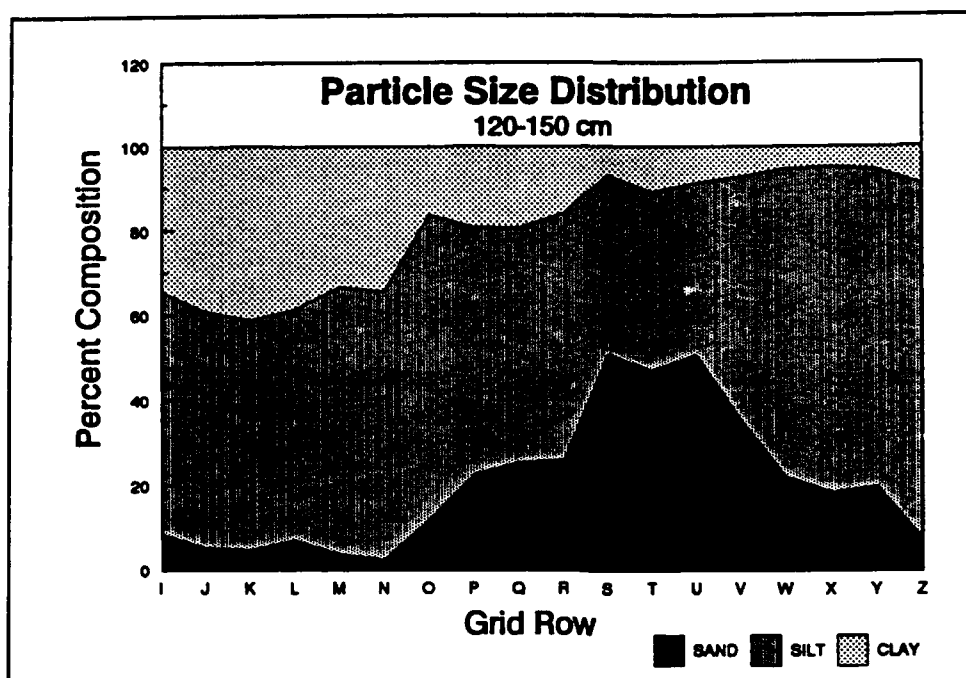


Figure 12. Particle size distribution in I-Z grids, 120-150 cm

### Fertility

Mean fertility levels of the I-M and N-Z composites and the productive cotton field near Egypt, MS, are presented in Table 4. Agricultural analysis indicated that mean nutrient levels in the I-M and N-Z grids were very similar to nutrient levels in the Egypt, MS, cotton field. The Egypt field has been under cotton production for many years and soil nutrient levels have been managed for efficient cotton production. Organic matter content in the N-Z grids was considerably lower than the Egypt cotton field. Adequate organic matter is important for desirable physical and chemical properties of soils and optimum growth of higher plants. The concentration of

**Table 4**  
**Comparison of Fertility Characteristics of Dredged Material Composites and a Productive Cotton Field**

| Parameter         | Grids I-M | Grids N-Z | Cotton Field, Egypt, MS |
|-------------------|-----------|-----------|-------------------------|
| pH                | 5.8       | 6.0       | 6.2                     |
| Phosphorus, mg/kg | 35        | 38        | 37                      |
| Potassium, mg/kg) | 124       | 97        | 131                     |
| Magnesium, mg/kg  | 579       | 300       | 286                     |
| Calcium, mg/kg    | 2021      | 1106      | 2198                    |
| Organic matter, % | 0.72      | 0.37      | 0.96                    |

organic matter in the soil is also important in the selection of application rates of herbicides and fertilizers. However, increasing organic matter content is easily accomplished with organic amendments or green manuring (incorporation of a green cover crop), and the low organic matter in the N-Z grids was not considered a significant problem in the course of this study.

## pH

A soil pH of 6.0 to 6.5 is considered desirable for vigorous plant growth and the suppression of certain diseases (Blasingame 1983). Although the agricultural analysis indicated some pH values in the I-Z grids were below 6.0, these were not low enough to justify liming. However, pH values outside of desirable ranges, while not requiring immediate corrective action, do require yearly monitoring, since liming may be necessary in subsequent years.

The pH values (Appendix B) determined at the WES by the method described previously (Folsom, Lee, and Bates 1981) were found to be lower than values reported by Pettiet Agricultural Services. Samples analyzed by Pettiet Agricultural Services were obtained from the 0- to 45-cm sample collection in 1988 prior to site disturbance and from 0- to 30-cm samples collected in 1990. Samples analyzed at the WES were obtained from the 0- to 30-cm reach of the 0- to 150-cm core samples collected in 1989 after leveling and tillage of the site. Somewhat lower pH values might be expected after tillage due to better aeration and oxidation of the dredged

material. Composites for the I-M and N-Z grids were prepared and sent to Pettiet Agricultural Services for analysis to compare with values obtained at the WES. Results are shown in Table 5. The 1988 Pettiet pH values differ from the WES values by 1.3 and 1.0 for the I-M and N-Z, respectively. The 1990 Pettiet values differed by 0.9 and 1.0. After inquiry, it was discovered that pH values at Pettiet Agricultural Services were adjusted by 0.9 to correlate with the

| <b>Table 5</b><br><b>Comparison of Laboratory pH Results</b> |                            |             |                     |
|--------------------------------------------------------------|----------------------------|-------------|---------------------|
| <b>Composite</b>                                             | <b>Pettiet Ag Services</b> |             | <b>WES<br/>1989</b> |
|                                                              | <b>1988</b>                | <b>1990</b> |                     |
| I-M                                                          | 5.83                       | 5.62        | 4.50                |
| N-Z                                                          | 6.01                       | 5.97        | 5.00                |

percent base saturation. Most agricultural laboratories adjust pH values to correlate with the percent base saturation for a more accurate determination of lime needs. Taking the 0.9 adjustment into account, the WES pH values are almost perfectly in agreement with the Pettiet pH values.

Although the pH values were not considered optimum for cotton growth, liming to raise the pH was not considered economically feasible since only a small amount of lime would be necessary. However, lime would probably be necessary after the first year of cotton production and yearly monitoring of the pH is suggested.

## Heavy metals analysis

Yazoo River dredged material was not believed to contain contaminants at levels of concern. However, selected heavy metals concentrations were determined to assess any potential problems with uptake by cotton plants. Total mean concentrations in composites of grids I-M and N-Z were compared to various criteria concerning heavy metal content in surface soils (Table 6). Concentrations of lead, zinc, and copper were well below allowable limits for application to surface soils and below recommended soil concentrations. Concentration of cadmium was below the 2.5 mg/kg soil concentration for plant uptake and therefore was not a concern for uptake by cotton plants. Elevated levels of cadmium in Yazoo River dredged material are not surprising due to the historical use of phosphate fertilizers in the Yazoo River drainage basin. Phosphorus fertilizers are known as important sources of cadmium as an impurity (Kabata-Pendias and Pendias, 1984). Cadmium concentrations in urban gardens in the United States may range from 0.02 to 13.6 mg/kg on a dry weight basis (Chaney 1980). Although the total cadmium concentrations in the I-M and N-Z composites are below the recommended limitations, uptake and bioaccumulation of cadmium by some agricultural food and forage crops may be of concern. Further study should be conducted to address potential bioaccumulation of cadmium by food or forage plants growing in Yazoo River dredged material. Likewise, crop rotation of food and forage crops with cotton would require further study to evaluate potential cadmium uptake by rotational crops. In addition, should cotton land created with Yazoo River dredged material be converted into other agricultural use, further study of plant uptake of cadmium by the proposed crops or plants should be conducted. A regulated limitation for soil cadmium in the Netherlands is 1.0 mg/kg for agricultural crops that are consumed by humans or by animals that will eventually be consumed by humans (Lee et al. 1991).

**Table 6**  
**Metal Concentrations in Soils (mg/kg)**

| Parameter | Composite |     | Maximum Application <sup>1</sup> | Recommended Limitations <sup>2</sup> |
|-----------|-----------|-----|----------------------------------|--------------------------------------|
|           | I-M       | N-Z |                                  |                                      |
| Arsenic   | 9         | 10  | —                                | —                                    |
| Cadmium   | 1.1       | 0.9 | 2.5                              | 2.5 (EPA 1979)<br>(ph 5.5)           |
| Copper    | 17        | 8.5 | 125                              | 125 (Logan and Chaney 1983)          |
| Lead      | 17        | 10  | 500 <sup>3</sup>                 | 500 (EPA 1977)                       |
| Zinc      | 70        | 35  | 250                              | 250 (Logan and Chaney 1983)          |

<sup>1</sup> Maximum recommended application of municipal sludge-applied metals to medium-textured cropland soils to prevent phytotoxicity of crops or crops that might have adverse human or animal consumption health effects. EPA, US Department of Agriculture, USFDA (1981)

<sup>2</sup> Recommended limitations on potentially toxic constituents in surface (0-15 cm) soils.

<sup>3</sup> Maximum allowable lead content in soil for human exposure as related to direct soil ingestion in the United Kingdom and in the United States.

## 4 Greenhouse Study

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### Methods and Materials

#### Dredged material collection

Dredged material was collected from CDF 4A to conduct the greenhouse portion of the study. Material was collected with a shovel from each grid to a depth of 30 cm and placed in 19-L buckets. Five buckets of dredged material were collected from each grid. Samples were collected and composited from each bucket of the five buckets to supply a sample from each grid for agricultural analysis. The material in the buckets was separately placed in two dump trucks by section (I-M and N-Z) for preparation of two composites. The material was transported to the WES and dumped in two separate piles in an open-end hangar building. The material was turned and mixed daily until completely air dried. Samples were collected from each of the two composites for final physical and chemical analysis.

**Table 7**  
**Fertilizer Treatments,**  
**mg/kg, in Phase I**  
**Greenhouse Test**

| Treatment | N   | P  | K  |
|-----------|-----|----|----|
| Control   | 0   | 0  | 0  |
| N1P0K0    | 50  | 0  | 0  |
| N2P0K0    | 75  | 0  | 0  |
| N1P1K0    | 50  | 30 | 0  |
| N2P1K0    | 75  | 30 | 0  |
| N1P0K1    | 50  | 0  | 30 |
| N2P0K1    | 75  | 0  | 30 |
| N1P1K1    | 50  | 30 | 30 |
| N2P1K1    | 75  | 30 | 30 |
| N3P2K2    | 150 | 60 | 60 |

#### Preparation for cotton plant bioassay

Air-dried amounts equivalent to 13.2 kg oven-dried weight of each composite of grids I-M and N-Z were placed into polyethylene mixing trays. Fertilizer additions were prepared by mixing reagent grade chemicals into 1.5 L of distilled water. Reagent grade  $\text{NH}_4\text{NO}_3$ ,  $\text{Na}_2\text{HPO}_4$ , and KCL were used for nitrogen (N), phosphorus (P), and potassium (K), respectively. The fertilizer treatment solutions were added to the dredged material and thoroughly mixed. The fertilized dredged material was then placed in a 19.9-L greenhouse container containing a layer of sand and foam. Fertilizer treatments are listed in Table 7 and were prepared in replicates of four for each dredged material composite.

## **Greenhouse operation and growing techniques**

Five cotton (*Gossypium hirsutum* L. var. DPL 50) seeds were planted in each pot and allowed to germinate. After reaching a height of 8 cm, seedlings were thinned to the most vigorous three and upon reaching 15 cm, were thinned to the most vigorous two. The replicates, randomly placed on tables in the greenhouse, were subjected to a controlled environment. Day length of 16 hr was maintained by using light fixtures whose face was 130 cm from the top of the greenhouse container. The 130-cm height allows maximum potential plant growth to occur without damage from the heat produced. Lights are arranged in a pattern of alternating high pressure sodium lamps and high pressure multivapor halide lamps. Alternating lamps provide an even photosynthetic active radiation (PAR) distribution pattern of  $1200 \mu\text{Einsteins}/\text{m}^2/\text{sec}$ . The temperature of the greenhouse was maintained at  $32.2 \pm 2^\circ\text{C}$  maximum during the day and  $21.1 \pm 2^\circ\text{C}$  minimum at night to simulate a summer environment. Relative humidity was maintained as close to 100 percent as possible, but never less than 50 percent. Soil/sediment moisture content was maintained between 30 and 60 MPa (field capacity is 30 MPa) by adding reverse osmosis (RO) water as necessary. Soil moisture tensiometers, placed in each container, were monitored daily and water was added when tensiometers read greater than 60 MPa. RO water was added to the surface of the dredged material to fill the container and allowed to infiltrate downward. Additional water was added, if necessary, to bring the moisture content to field capacity.

## **Plant growth and observation**

Plants were visually monitored throughout the growth period for indications of disease, nutrient deficiency, and insect infestations. Height of plants was measured twice during the growth period and recorded (Appendix C). Plants from each container were measured and an average for each treatment was determined.

## **Insect control**

Whiteflies and aphids were identified on the plants and were controlled with periodic applications of Diazonon and Orthene at the manufacturer's labeled recommendations.

## **Harvest and yield determination**

After 116 days, watering was discontinued to allow drying of the plants, thereby facilitating boll opening. After 130 days, most bolls were open (Figure 13) and the seed lint from each container was harvested and placed in paper bags. The bags were placed in a forage dryer at  $70^\circ\text{C}$  for 48 hr before weighing to determine the oven-dry weight of seed lint in

grams/container. An estimate in bales/ha yield was determined by the following calculation:

$$\frac{\text{bales}}{\text{ha}} = \frac{\text{grams seed lint/pot} \times 135,905 \text{ plants/ha} \times 38\% \text{ lint/seed lint}}{1,000 \text{ g/kg} \times 2 \text{ plants/cont} \times 217.7 \text{ kg/bale}}$$

$$\frac{\text{bales}}{\text{ha}} = \text{grams seed lint/pot} \times 0.1186$$

where

Seed lint = lint fibers plus seed

Average cotton plant population/ha = 135,905

Lint weight = about 38 percent of total seed lint weight

Standard weight of cotton bale = 217.7 kg



Figure 13. Harvesting cotton in greenhouse after 130 days of growth

## Results and Discussion

### Appearance and growth

Seedling emergence and initial growth appeared normal in both the I-M and N-Z composites. An ice storm, 1 month after planting, caused power failure in the greenhouse for 4 days and temperatures fell to 6 °C before emergency heaters were supplied. Slight damage from the low temperatures was observed on some leaves, but growth resumed normally when

temperatures were regulated. Vegetative growth response to treatments varied between composites. Cotton did not respond well to the higher rates of N during initial stages of growth and higher vegetative yields were obtained with the N1 rates (Table 8). Initial response of cotton, grown in the I-M composite, to increasing N was not significantly different, but final vegetative growth was greater with the higher N rates. Normally, in a field situation, N applied at high rates is split into two applications rather than a single application, as occurred in the greenhouse study. Splitting the N application prevents possible damage to the crop as well as reduces loss by leaching, surface runoff, and/or volatilization before the plant can utilize it. Some loss of N may have occurred in the N-Z due to higher sand composition and fewer adsorption sites. Plants in the N-Z composite may have initially incurred some inhibiting effects in the high N treatments and the 4 days of cold temperatures may have limited response to N in both composites.

**Table 8**  
**Cotton Plant Growth Response to Treatments**

| Treatment | Plant Height, cm   |        |          |        |
|-----------|--------------------|--------|----------|--------|
|           | February           |        | April    |        |
|           | I-M                | N-Z    | I-M      | N-Z    |
| Control   | 40.1A <sup>1</sup> | 27.3CD | 52.6D    | 35.3C  |
| N1P0K0    | 37.7A              | 32.8BC | 60.3BCD  | 53.9AB |
| N2P0K0    | 41.5A              | 33.8B  | 62.5ABCD | 49.5AB |
| N1P1K0    | 43.5A              | 37.8AB | 63.1ABCD | 56.7A  |
| N2P1K0    | 42.2A              | 36.7AB | 67.5ABC  | 53.7AB |
| N1P0K1    | 39.6A              | 37.2AB | 60.9BCD  | 52.3AB |
| N2P0K1    | 40.4A              | 37.1AB | 69.8AB   | 51.8AB |
| N1P1K1    | 42.4A              | 42.2A  | 57.4CD   | 54.7AB |
| N2P1K1    | 41.9A              | 34.9B  | 66.3ABC  | 48.3B  |
| N3P2K2    | 41.3A              | 22.2D  | 73.2A    | 56.1AB |

<sup>1</sup> Means in a column with the same letter are not significantly different by Waller-Duncan K-ratio T test.

Vegetative response to P and K additions was not readily determined, but appeared to be highly variable between treatments. The available P levels of 35 and 38 mg/kg in I-M and N-Z composites, respectively, are above the 7.5 mg/kg (16.8 kg/ha) in soils considered well supplied with available P (Jones 1979). Excessive P fertilization may, in fact, reduce N absorption and micronutrient uptake by plants (Anderson 1977), but the effects of P on N absorption were not determined using plant tissue analysis in this test. Exchangeable K concentrations in the I-M composite were above the 60-100 mg/kg levels reported by Hearn (1981) as the minimum critical level below which deficiency is likely to occur. The 97 mg/kg exchangeable K concentration in the N-Z composite is barely within the critical level range; however, treatments with K additions did not significantly improve vegetative appearance. Again, the 4 days of cold temperatures may have limited response to both P and K additions. The cotton plants were

observed daily for indications of disease, pests, and nutrient deficiency. No diseases were noted; however, symptoms indicative of boron and sulfur deficiency were observed, but were not severe enough to verify. Whiteflies (*SI ssp*) and aphids were detected and controlled with applications of Diazanon and Orthene.

### Total lint yields

Average yield of seed lint in grams/pot is presented in Table 9. Overall, the I-M composite produced higher yields than the N-Z composite for each treatment except N1P1K1. Yields increased in the I-M composite as N rate increased with the N3P2K2 treatment producing statistically higher yields than the other treatments. Affects of P and K on lint yield were variable in both composites. N rate had a variable affect on lint yield in the N-Z composite. Although the N2P1K0 treatment produced the highest yield, it was not statistically different than the N1P1K1 and N3P2K2 treatments. This indicates that excessive N in the N-Z composite had no beneficial effect on lint yield. To estimate ginned lint yield on a kg/ha basis, grams seed lint/pot is multiplied by 25.8, assuming 135,905 plants/ha and 38 percent ginning percentage. Appendix C, Table C2, lists the seed lint yield for each treatment in grids I-M and N-Z.

**Table 9**  
**Comparison of Seed Lint**  
**Yields, g/pot, Between**  
**Treatments and Composites**

| Treatment | I-M Yield           | N-Z Yield |
|-----------|---------------------|-----------|
| Control   | 13.6E <sup>1</sup>  | 0.8E      |
| N1P0K0    | 23.1D+ <sup>2</sup> | 14.9BC+   |
| N2P0K0    | 30.1B               | 16.8BC    |
| N1P1K0    | 23.5CB              | 11.8D     |
| N2P1K0    | 25.7CB              | 20.3A     |
| N1P0K1    | 23.1CD+             | 14.2CD+   |
| N2P0K1    | 24.7CB              | 14.8BC    |
| N1P1K1    | 17.7ED+             | 17.4AB+   |
| N2P1K1    | 30.1B               | 16.5BC    |
| N3P2K2    | 50.9A               | 17.3AB    |

<sup>1</sup> Means in a column with the same letter are not significantly different by Waller-Duncan K-ratio T test.

<sup>2</sup> Means in a row with a + are not significantly different by t-test at alpha = 0.05.

Yield of estimated ginned lint is presented in Figure 14. The average yield of the I-M and N-Z composites with a fertilizer rate of N2P0K0 would be 594 kg/ha or 2.7 bales/ha. Most cotton research in the greenhouse is conducted to assess response to herbicides and determine disease and pest resistance. Lint yield response to fertilizers is usually conducted in the field. For a greenhouse cotton plant bioassay to accurately predict lint yields under field conditions, extensive greenhouse testing and field verification would be required. However, to provide some perspective to the relevance of greenhouse lint yields to field conditions, some assumptions were made to express the results on a kg/ha basis. Greater rooting volume was expected to contribute to higher lint yields on the CDF than in the greenhouse, using equivalent fertilizer applications.

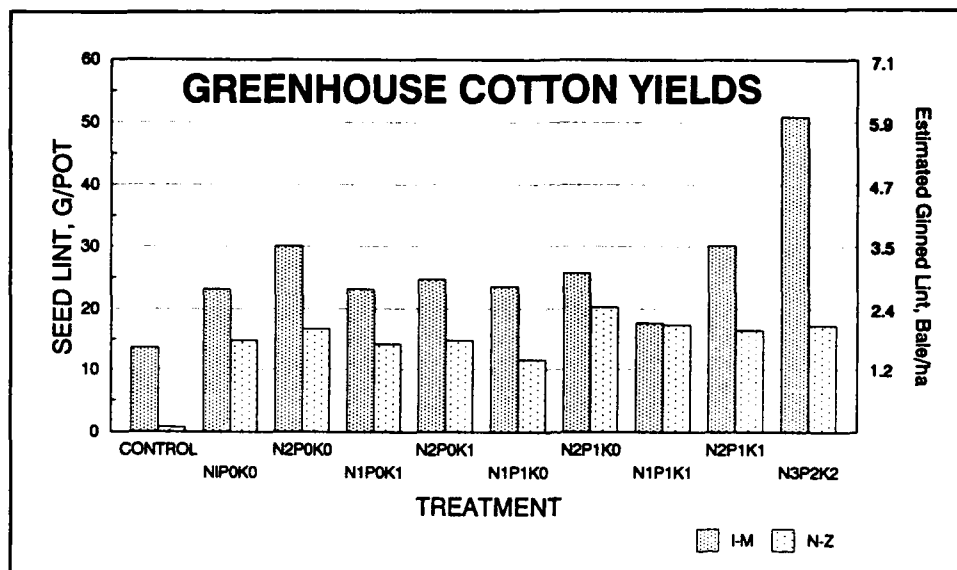


Figure 14. Estimated yields in bales/ha from the greenhouse test

## 5 Field Test

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### Methods and Materials

#### Site preparation production methods

The entire I-Z grids of the CDF field site were prepared for planting cotton. A bulldozer was used to fill in depressions and roughly level the site (Figure 15). The site was then disked with a tractor-drawn disk and two passes were made with a chisel plow. However, due to unfavorable weather conditions, local farmers fell behind in planting their crops and it became impossible to locate a farmer willing to give up valuable time to plant CDF 4A. As a result, the CDF was not planted in 1989.

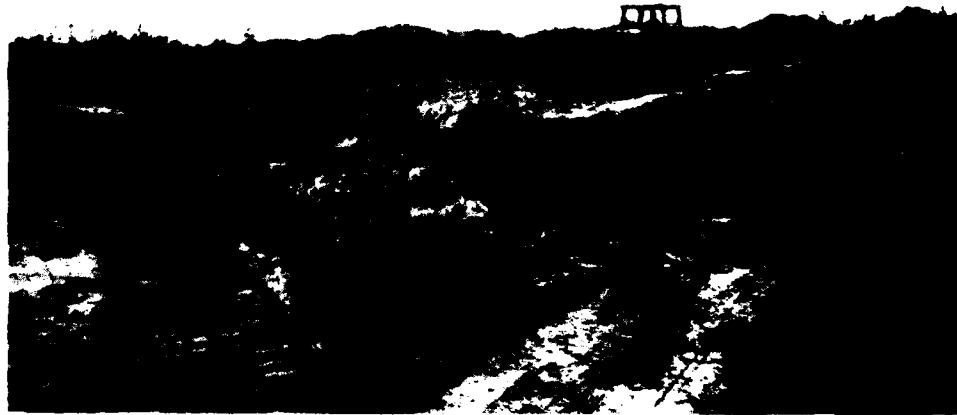


Figure 15. Bulldozer used to roughly level the test area

The following year, the landowner agreed to provide all necessary equipment, materials, and labor to produce a cotton crop on CDF 4A. Preparation began by leveling the site with a land plane. Soil preparation and planting methods were the same as those in surrounding cotton fields, except that rows were not hipped prior to planting. Preplant herbicides were incorporated and the site was planted with Delta Pine and Land DPL-20

cotton on 10 May 1990. A pre-emergent herbicide was applied immediately after planting to eliminate existing weeds. The cotton was cultivated twice and post-emergent herbicides were applied. Insects were controlled with applications of insecticide as necessary. Nitrogen fertilizer was applied at the rate of 79 kg/ha preplant and 79 kg/ha side dress.

### **Harvest and yield determination**

At the end of October, two strips (eight rows) totaling an area equal to 0.4047 ha (1 acre) were marked on the site. A mechanical cotton picker was used to harvest the cotton from the two strips. The harvested seed lint was placed in a cart and transported to a cotton gin for processing. The processed lint was weighed to determine the total lint yield in kg/ha.

## **Results and Discussion**

After leveling the site with a bulldozer in April 1989, significant rainfall inhibited area farmers' ability to plant and obtain a successful stand of cotton in fields surrounding the CDF. The landowner was scheduled to plant cotton on the CDF during the 1989 growing season, however, due to circumstances beyond his and the investigators' control, cotton planting was not possible. Another farmer was contracted to disk and chisel plow the site in late May 1989. Since the site had not been land leveled, depressions were still present on the site and the farmer's tractor became mired in a wet spot on one occasion. The dredged material did break up easily and was very workable with farm implements. The tilled site is shown in Figure 16.



Figure 16. Test area (I-Z grids) after tillage in May 1989

For the 1990 growing season, CDF 4A was land leveled and prepared for planting by the landowner. Cotton was planted on 10 May 1990 and is shown in the early stages of growth in Figure 17. The cotton appeared very healthy except in depressions on the upper portion of the site (Figure 18) where excessive water inhibited plant growth. Cotton was chest high at maturity in the middle portion of the test site (Figure 19). The 0.4-ha (1-acre) harvested sample yielded 352 kg of ginned lint or 1.6 bales, shown at harvest in Figure 20. For comparison, the average yield on CDF 4A equates to 870 kg/ha. Although yield was not determined by grid row, the N-Q grids appeared to have some of the higher lint yields. The predominantly silt and clay I-M grids did have excessive water at times due to slower drainage. This slightly inhibited growth during periods of frequent rainfall, but was probably of more benefit during extended periods of no rainfall. The lint yield in the I-M grids did not appear to be much less than the N-Q grids. The lowest yields appeared to be in the sandier S-Z grids where drainage was excessive in some areas and depressions held water for extended periods in other areas. The response to particle size distribution in the field demonstration was similar to the response in the greenhouse as demonstrated by the reduced yield in the sandier material.



Figure 17. Cotton in early stage of growth on CDF 4A



Figure 18. Cotton growth inhibited by waterlogging in depressions



Figure 19. Cotton near maturity in the N-Q grid row area

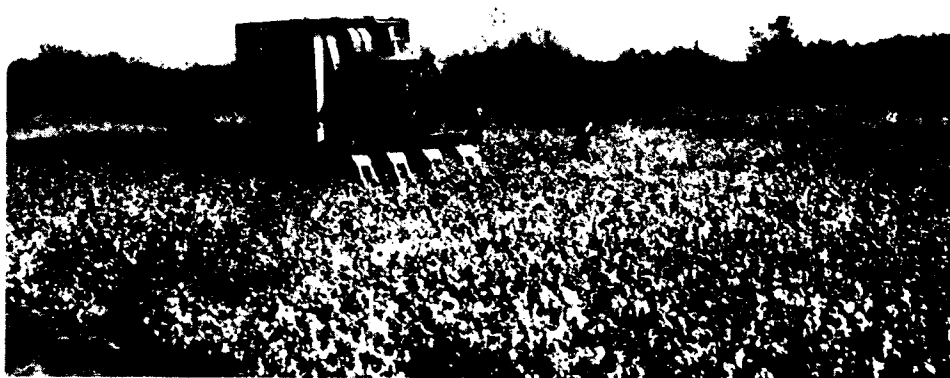


Figure 20. Cotton at harvest on CDF 4A

Cotton yield estimates from Yazoo and surrounding counties are compared with the yield from CDF 4A in Table 10. The average ginned lint yield for Yazoo County cotton fields in 1990 was 954 kg/ha (Knight and McWilliams 1992). Yields from additional counties bordering Yazoo County and the Yazoo River are also presented. The average yield from CDF 4A was slightly lower than average yields from surrounding counties except for Leflore County. This indicates that the yield from CDF 4A was considered a substantial yield for the area production year. This is significant since many of the area cotton fields are more extensively managed for fertility and are irrigated.

**Table 10**  
**Comparison of CDF 4A Yield with Yields of Yazoo and**  
**Surrounding Counties<sup>1</sup>**

|              | County |        |           |         |        | CDF 4A |
|--------------|--------|--------|-----------|---------|--------|--------|
|              | Yazoo  | Holmes | Humphreys | Leflore | Warren |        |
| Yield, kg/ha | 954    | 957    | 969       | 858     | 919    | 870    |

<sup>1</sup> County yield estimates (Knight and McWilliams 1992).

## 6 Conclusions

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This study demonstrated that Yazoo River dredged material is a soil medium capable of producing substantial cotton lint yields. The greenhouse study indicated that cotton growing in Yazoo River dredged material responds well to added N fertilizer and additions of P and K were not necessary for initial production of cotton. The yield response to particle size distribution in the field demonstration was similar to the response in the greenhouse. Lint yield in the field was higher than lint yield in the greenhouse under comparable fertilizer treatments. The use of greenhouse bioassays for predicting lint yields under field conditions will require further research to develop a prediction coefficient. However, greenhouse bioassays were shown to be a valuable tool for evaluating yield response of cotton to various growing mediums and amendments. Future plant bioassays for cotton response to dredged material should include a known productive cotton soil as a reference for comparisons.

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# **Appendix A**

## **Laboratory Methods**

### **for Agricultural Soil Analysis**

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The following laboratory tests were conducted by Pettiet Agricultural Services, Soil and Plant Testing Laboratory, Leland, MS.

| Test for                                                                                                                                                                                                                                                                                                                               | Test Methods                                                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| pH                                                                                                                                                                                                                                                                                                                                     | Glass pH electrode measure of a 1:2 soil-to-water mixture.                                                                                                                                                                                                                                                  |
| Lime                                                                                                                                                                                                                                                                                                                                   | Glass pH electrode measure of a 1:2 soil-to-buffer mixture using the Mississippi State University (p-nitrophenol) lime solution.                                                                                                                                                                            |
| P, K, Ca, & Mg                                                                                                                                                                                                                                                                                                                         | Using the Mehlich 3 extract <sup>1</sup> (0.2N CH <sub>3</sub> COOH; 0.25 NH <sub>4</sub> NO <sub>3</sub> ; 0.015N NH <sub>4</sub> F; 0.013N HNO <sub>3</sub> ; 0.01M EDTA). Phosphorus was determined colorimetrically; potassium by atomic emission; calcium and magnesium by atomic absorption analyses. |
| CEC & % base saturation                                                                                                                                                                                                                                                                                                                | Calculated by summation of the base nutrients and acidity shown by the lime test.                                                                                                                                                                                                                           |
| Organic matter                                                                                                                                                                                                                                                                                                                         | Using modified Debolt version of the Wakley-Black method (0.5M matter NA <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> and 11.5N H <sub>2</sub> SO <sub>4</sub> digestion mixture). <sup>2</sup> Reduced chromium was determined by colorimetric methods.                                                     |
| <sup>1</sup> Mehlich (1984). "Mehlich 3 Soil Test Extractant," <i>Comm. Soil Sci. and Plant Anal.</i> , 15(12), 1406-1416.<br><sup>2</sup> American Society of Agronomy, Inc. (1965). "Organic Matter Methods. Methods of Soil Analyses, Vol. 2, Chemical and Microbiological Properties," Agronomy Monograph Series No. 9, 1372-1375. |                                                                                                                                                                                                                                                                                                             |

# **Appendix B**

## **Physical and Chemical Data of Dredged Material**

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Table B1  
Particle Size Distribution in Grids A-H  
(0- to 15-, 15- to 30-,  
and 30- to 45-cm depths)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>Depth</u> | <u>%Clay</u> | <u>%Silt</u> | <u>%Sand</u> |
|------------|------------|-------------|--------------|--------------|--------------|--------------|
| 1          | 1          | 1           | 15           | 20.0         | 52.5         | 27.5         |
| 2          | A          | 3           | 45           | 55.0         | 42.5         | 2.5          |
| 3          | A          | 3           | 15           | 52.5         | 47.5         | 0.0          |
| 4          | A          | 4           | 15           | 42.5         | 52.5         | 5.0          |
| 5          | A          | 2           | 30           | 62.5         | 37.5         | 0.0          |
| 6          | A          | 3           | 30           | 72.5         | 27.5         | 0.0          |
| 7          | A          | 4           | 45           | 52.5         | 47.5         | 0.0          |
| 8          | A          | 1           | 30           | 32.5         | 55.0         | 12.5         |
| 9          | A          | 2           | 15           | 40.0         | 47.5         | 12.5         |
| 10         | A          | 1           | 45           | 27.5         | 55.0         | 17.5         |
| 11         | A          | 2           | 45           | 57.5         | 40.0         | 2.5          |
| 12         | A          | 5           | 15           | 52.5         | 45.0         | 2.5          |
| 13         | A          | 5           | 45           | 57.5         | 40.0         | 2.5          |
| 14         | A          | 1           | 15           | 35.0         | 47.5         | 17.5         |
| 15         | A          | 5           | 30           | 60.0         | 40.0         | 0.0          |
| 16         | A          | 4           | 30           | 47.5         | 45.0         | 7.5          |
| 17         | B          | 1           | 45           | 62.5         | 35.0         | 2.5          |
| 18         | B          | 3           | 30           | 60.0         | 40.0         | 0.0          |
| 19         | B          | 4           | 45           | 70.0         | 30.0         | 0.0          |
| 20         | B          | 2           | 15           | 62.5         | 37.5         | 0.0          |
| 21         | B          | 5           | 15           | 65.0         | 35.0         | 0.0          |
| 22         | B          | 1           | 15           | 65.0         | 35.0         | 0.0          |
| 23         | B          | 3           | 45           | 55.0         | 45.0         | 0.0          |
| 24         | B          | 5           | 45           | 62.5         | 37.5         | 0.0          |
| 25         | B          | 4           | 15           | 55.0         | 45.0         | 0.0          |
| 26         | B          | 4           | 30           | 65.0         | 35.0         | 0.0          |
| 27         | B          | 2           | 45           | 67.5         | 32.5         | 0.0          |
| 28         | B          | 1           | 45           | 52.5         | 47.5         | 0.0          |
| 29         | B          | 2           | 30           | 60.0         | 40.0         | 0.0          |
| 30         | B          | 5           | 30           | 60.0         | 37.5         | 2.5          |
| 31         | B          | 3           | 15           | 50.0         | 47.5         | 2.5          |
| 32         | B          | 1           | 30           | 50.0         | 50.0         | 0.0          |
| 33         | C          | 3           | 45           | 55.0         | 45.0         | 0.0          |
| 34         | C          | 5           | 15           | 60.0         | 40.0         | 0.0          |
| 35         | C          | 1           | 45           | 65.0         | 35.0         | 0.0          |
| 36         | C          | 3           | 15           | 55.0         | 45.0         | 0.0          |
| 37         | C          | 4           | 30           | 57.5         | 42.5         | 0.0          |
| 38         | C          | 1           | 15           | 37.5         | 57.5         | 5.0          |
| 39         | C          | 4           | 15           | 57.5         | 42.5         | 0.0          |
| 40         | C          | 2           | 15           | 55.0         | 45.0         | 0.0          |
| 41         | C          | 5           | 45           | 57.5         | 40.0         | 2.5          |
| 42         | C          | 3           | 30           | 50.0         | 47.5         | 2.5          |
| 43         | C          | 5           | 30           | 57.5         | 40.0         | 2.5          |
| 44         | C          | 1           | 30           | 37.5         | 55.0         | 7.5          |
| 45         | C          | 2           | 45           | 52.5         | 45.0         | 2.5          |

(Continued)

(Sheet 1 of 3)

Table B1 (Continued)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>Depth</u> | <u>%Clay</u> | <u>%Silt</u> | <u>%Sand</u> |
|------------|------------|-------------|--------------|--------------|--------------|--------------|
| 46         | C          | 4           | 45           | 55.0         | 42.5         | 2.5          |
| 47         | C          | 2           | 30           | 65.0         | 35.0         | 0.0          |
| 48         | D          | 4           | 45           | 55.0         | 42.5         | 2.5          |
| 49         | D          | 2           | 30           | 42.5         | 45.0         | 12.5         |
| 50         | D          | 2           | 15           | 60.0         | 40.0         | 0.0          |
| 51         | D          | 4           | 15           | 62.5         | 37.5         | 0.0          |
| 52         | D          | 1           | 30           | 60.0         | 35.0         | 5.0          |
| 53         | D          | 1           | 15           | 60.0         | 37.5         | 2.5          |
| 54         | D          | 5           | 15           | 62.5         | 37.5         | 0.0          |
| 55         | D          | 3           | 15           | 57.5         | 42.5         | 0.0          |
| 56         | D          | 5           | 30           | 60.0         | 40.0         | 0.0          |
| 57         | D          | 1           | 45           | 60.0         | 40.0         | 0.0          |
| 58         | D          | 5           | 45           | 50.0         | 47.5         | 2.5          |
| 59         | D          | 3           | 30           | 47.5         | 52.5         | 0.0          |
| 60         | D          | 2           | 45           | 30.0         | 57.5         | 12.5         |
| 61         | D          | 3           | 45           | 47.5         | 50.0         | 2.5          |
| 62         | D          | 4           | 30           | 57.5         | 42.5         | 0.0          |
| 63         | E          | 3           | 30           | 47.5         | 52.5         | 0.0          |
| 64         | E          | 5           | 30           | 47.5         | 50.0         | 2.5          |
| 65         | E          | 5           | 15           | 47.5         | 42.5         | 10.0         |
| 66         | E          | 2           | 30           | 57.5         | 40.0         | 2.5          |
| 67         | E          | 4           | 45           | 45.0         | 55.0         | 0.0          |
| 68         | E          | 5           | 45           | 62.5         | 37.5         | 0.0          |
| 69         | E          | 3           | 45           | 60.0         | 40.0         | 0.0          |
| 70         | E          | 2           | 45           | 60.0         | 40.0         | 0.0          |
| 71         | E          | 1           | 15           | 57.5         | 42.5         | 0.0          |
| 72         | E          | 4           | 30           | 50.0         | 50.0         | 0.0          |
| 73         | E          | 4           | 15           | 50.0         | 50.0         | 0.0          |
| 74         | E          | 3           | 15           | 50.0         | 50.0         | 0.0          |
| 75         | E          | 1           | 30           | 57.5         | 42.5         | 0.0          |
| 76         | E          | 2           | 15           | 47.5         | 52.5         | 0.0          |
| 77         | F          | 1           | 45           | 47.5         | 50.0         | 2.5          |
| 78         | F          | 3           | 15           | 45.0         | 55.0         | 0.0          |
| 79         | F          | 2           | 30           | 52.5         | 47.5         | 0.0          |
| 80         | F          | 4           | 15           | 42.5         | 57.5         | 0.0          |
| 81         | F          | 5           | 45           | 47.5         | 52.5         | 0.0          |
| 82         | F          | 1           | 30           | 52.5         | 45.0         | 2.5          |
| 83         | F          | 1           | 15           | 45.0         | 55.0         | 0.0          |
| 84         | F          | 5           | 30           | 47.5         | 50.0         | 2.5          |
| 85         | F          | 4           | 45           | 45.0         | 55.0         | 0.0          |
| 86         | F          | 3           | 30           | 40.0         | 60.0         | 0.0          |
| 87         | F          | 2           | 45           | 42.5         | 57.5         | 0.0          |
| 88         | F          | 5           | 15           | 50.0         | 50.0         | 0.0          |
| 89         | F          | 2           | 15           | 47.5         | 52.5         | 0.0          |
| 90         | F          | 3           | 45           | 37.5         | 62.5         | 0.0          |
| 91         | F          | 4           | 30           | 37.5         | 62.5         | 0.0          |
| 92         | G          | 5           | 45           | 40.0         | 60.0         | 0.0          |
| 93         | G          | 2           | 30           | 37.5         | 62.5         | 0.0          |

(Continued)

(Sheet 2 of 3)

Table B1 (Concluded)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>Depth</u> | <u>%Clay</u> | <u>%Silt</u> | <u>%Sand</u> |
|------------|------------|-------------|--------------|--------------|--------------|--------------|
| 94         | G          | 4           | 45           | 40.0         | 55.0         | 5.0          |
| 95         | G          | 1           | 45           | 42.5         | 57.5         | 0.0          |
| 96         | G          | 5           | 30           | 42.5         | 55.0         | 2.5          |
| 97         | G          | 1           | 15           | 40.0         | 60.0         | 0.0          |
| 98         | G          | 1           | 30           | 40.0         | 60.0         | 0.0          |
| 99         | G          | 4           | 30           | 37.5         | 62.5         | 0.0          |
| 100        | G          | 2           | 45           | 52.5         | 47.5         | 0.0          |
| 101        | G          | 4           | 15           | 45.0         | 55.0         | 0.0          |
| 102        | G          | 2           | 15           | 45.0         | 55.0         | 0.0          |
| 103        | G          | 3           | 45           | 45.0         | 55.0         | 0.0          |
| 104        | G          | 3           | 30           | 50.0         | 50.0         | 0.0          |
| 105        | G          | 3           | 30           | 40.0         | 60.0         | 0.0          |
| 106        | G          | 5           | 15           | 47.5         | 52.5         | 0.0          |
| 107        | G          | 3           | 15           | 40.0         | 60.0         | 0.0          |
| 108        | H          | 1           | 15           | 42.5         | 57.5         | 0.0          |
| 109        | H          | 3           | 15           | 40.0         | 57.5         | 2.5          |
| 110        | H          | 2           | 15           | 40.0         | 57.5         | 2.5          |
| 111        | H          | 3           | 45           | 45.0         | 47.5         | 7.5          |
| 112        | H          | 4           | 15           | 45.0         | 55.0         | 0.0          |
| 113        | H          | 5           | 15           | 55.0         | 45.0         | 0.0          |
| 114        | H          | 5           | 45           | 45.0         | 55.0         | 0.0          |
| 115        | H          | 4           | 30           | 35.0         | 65.0         | 0.0          |
| 116        | H          | 3           | 30           | 37.5         | 62.5         | 0.0          |
| 117        | H          | 5           | 30           | 50.0         | 47.5         | 2.5          |
| 118        | H          | 2           | 45           | 45.0         | 55.0         | 0.0          |
| 119        | H          | 4           | 45           | 32.5         | 55.0         | 12.5         |
| 120        | H          | 1           | 30           | 45.0         | 55.0         | 0.0          |
| 121        | H          | 2           | 30           | 42.5         | 57.5         | 0.0          |
| 122        | H          | 1           | 45           | 47.5         | 47.5         | 5.0          |

(Sheet 3 of 3)

Table B2  
Particle Size Distribution in Grids I-Z  
(0- to 45-cm depth)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>%Sand</u> | <u>%Silt</u> | <u>%Clay</u> |
|------------|------------|-------------|--------------|--------------|--------------|
| 1          | I          | 1           | 7.50         | 51.250       | 41.250       |
| 2          | I          | 2           | 5.00         | 53.750       | 41.250       |
| 3          | I          | 3           | 0.00         | 61.250       | 38.750       |
| 4          | I          | 4           | 1.25         | 63.750       | 35.000       |
| 5          | J          | 1           | 22.50        | 47.500       | 30.000       |
| 6          | J          | 2           | 0.00         | 56.875       | 43.125       |
| 7          | J          | 3           | 0.00         | 59.375       | 40.625       |
| 8          | J          | 4           | 0.00         | 56.875       | 43.125       |
| 9          | K          | 1           | 27.50        | 46.250       | 26.250       |
| 10         | K          | 2           | 1.25         | 59.375       | 39.375       |
| 11         | K          | 3           | 0.00         | 64.375       | 35.625       |
| 12         | K          | 4           | 1.25         | 63.750       | 35.000       |
| 13         | L          | 1           | 6.25         | 67.500       | 26.250       |
| 14         | L          | 2           | 5.00         | 66.250       | 28.750       |
| 15         | L          | 3           | 6.25         | 63.750       | 30.000       |
| 16         | L          | 4           | 1.25         | 65.000       | 33.750       |
| 17         | M          | 1           | 8.75         | 62.600       | 28.750       |
| 18         | M          | 2           | 13.75        | 60.000       | 26.250       |
| 19         | M          | 3           | 10.00        | 61.250       | 28.750       |
| 20         | M          | 4           | 3.75         | 67.500       | 28.700       |
| 21         | N          | 1           | 7.50         | 67.500       | 25.000       |
| 22         | N          | 2           | 52.50        | 32.500       | 15.000       |
| 23         | N          | 3           | 40.00        | 40.000       | 20.000       |
| 24         | N          | 4           | 17.50        | 67.500       | 15.000       |
| 25         | O          | 1           | 2.50         | 70.000       | 27.500       |
| 26         | O          | 2           | 62.50        | 22.500       | 15.000       |
| 27         | O          | 3           | 32.50        | 50.000       | 17.500       |
| 28         | O          | 4           | 75.00        | 12.500       | 12.500       |
| 29         | P          | 1           | 5.00         | 75.000       | 20.000       |
| 30         | P          | 2           | 50.00        | 37.500       | 12.500       |
| 31         | P          | 3           | 62.50        | 20.000       | 17.500       |
| 32         | P          | 4           | 62.50        | 22.500       | 15.000       |
| 33         | Q          | 1           | 32.50        | 50.000       | 17.500       |
| 34         | Q          | 2           | 65.00        | 20.000       | 15.000       |
| 35         | Q          | 3           | 42.50        | 42.500       | 15.000       |
| 36         | Q          | 4           | 37.50        | 47.500       | 15.000       |
| 37         | R          | 1           | 47.50        | 40.000       | 12.500       |
| 38         | R          | 2           | 62.50        | 17.500       | 20.000       |
| 39         | R          | 3           | 57.50        | 30.000       | 12.500       |
| 40         | R          | 4           | 55.00        | 27.500       | 17.500       |
| 41         | S          | 1           | 45.00        | 42.500       | 12.500       |
| 42         | S          | 2           | 55.00        | 40.000       | 5.000        |
| 43         | S          | 3           | 50.00        | 40.000       | 10.000       |
| 44         | S          | 4           | 65.00        | 27.500       | 7.500        |
| 45         | T          | 1           | 52.50        | 40.000       | 7.500        |
| 46         | T          | 2           | 55.00        | 20.000       | 25.000       |
| 47         | T          | 3           | 22.50        | 60.000       | 17.500       |

(Continued)

Table B2 (Concluded)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>%Sand</u> | <u>%Silt</u> | <u>%Clay</u> |
|------------|------------|-------------|--------------|--------------|--------------|
| 48         | T          | 4           | 50.00        | 42.500       | 7.500        |
| 49         | U          | 1           | 52.50        | 27.500       | 20.000       |
| 50         | U          | 2           | 42.50        | 47.500       | 10.000       |
| 51         | U          | 3           | 70.00        | 22.500       | 7.500        |
| 52         | U          | 4           | 85.00        | 10.000       | 5.000        |
| 53         | V          | 1           | 67.50        | 25.000       | 7.500        |
| 54         | V          | 2           | 80.00        | 12.500       | 7.500        |
| 55         | V          | 3           | 42.50        | 47.500       | 10.000       |
| 56         | W          | 1           | 60.00        | 32.500       | 7.500        |
| 57         | W          | 2           | 80.0         | 15.0         | 5.0          |
| 58         | W          | 3           | 75.0         | 17.5         | 7.5          |
| 59         | X          | 1           | 42.5         | 37.5         | 20.0         |
| 60         | X          | 2           | 70.0         | 25.0         | 5.0          |
| 61         | X          | 3           | 65.0         | 27.5         | 7.5          |
| 62         | Y          | 1           | 75.0         | 17.5         | 7.5          |
| 63         | Y          | 2           | 52.5         | 40.0         | 7.5          |
| 64         | Y          | 3           | 40.0         | 37.5         | 22.5         |
| 65         | Z          | 1           | 42.5         | 42.5         | 15.0         |

Table B3  
Agricultural Analysis of Grids I-Z  
(0- to 45-cm samples)

| <u>Grid</u> | <u>pH</u> | <u>TA</u> | <u>P</u> | <u>K</u> | <u>Mg</u> | <u>Ca</u> | <u>OM</u> | <u>CEC</u> | <u>Lime</u> |
|-------------|-----------|-----------|----------|----------|-----------|-----------|-----------|------------|-------------|
| I1          | 5.4       | 7.5       | 56       | 324      | 1322      | 4620      | 0.89      | 25         | 2           |
| I2          | 5.98      | 4.4       | 64       | 345      | 1524      | 5330      | 0.68      | 24.5       | 0           |
| I3          | 5.36      | 7.5       | 65       | 282      | 1138      | 4080      | 1         | 22.8       | 2           |
| I4          | 5.84      | 4.9       | 61       | 335      | 1387      | 4750      | 1.06      | 23         | 0           |
| J1          | 5.42      | 6.2       | 65       | 246      | 969       | 3520      | 0.8       | 19.4       | 1.5         |
| J2          | 5.66      | 5.8       | 69       | 277      | 1249      | 4340      | 0.93      | 22.2       | 0           |
| J3          | 5.47      | 6.3       | 75       | 285      | 1100      | 3890      | 0.72      | 21         | 1.5         |
| J4          | 6.03      | 4.8       | 61       | 313      | 1386      | 4720      | 0.91      | 22.8       | 0           |
| K1          | 5.83      | 3.9       | 74       | 178      | 942       | 3350      | 0.55      | 16.4       | 0           |
| K2          | 5.78      | 5.2       | 70       | 299      | 1236      | 4320      | 0.86      | 21.5       | 0           |
| K3          | 5.59      | 5.1       | 66       | 220      | 1056      | 3690      | 0.82      | 19         | 0           |
| K4          | 5.73      | 4.6       | 67       | 280      | 1161      | 4170      | 0.79      | 20.2       | 0           |
| L1          | 5.72      | 3.7       | 74       | 187      | 933       | 3270      | 0.56      | 16         | 0           |
| L2          | 5.99      | 3.2       | 79       | 221      | 1143      | 3920      | 0.63      | 18         | 0           |
| L3          | 5.96      | 3.7       | 83       | 215      | 1208      | 4260      | 0.92      | 19.7       | 0           |
| L4          | 5.86      | 4         | 80       | 236      | 1214      | 4160      | 0.58      | 19.8       | 0           |
| M1          | 5.96      | 3.2       | 79       | 195      | 1001      | 3490      | 0.59      | 16.3       | 0           |
| M2          | 6.49      | 2.2       | 73       | 135      | 996       | 3440      | 0.29      | 15.1       | 0           |
| M3          | 6.3       | 2.9       | 78       | 189      | 1124      | 3770      | 0.35      | 17.3       | 0           |
| M4          | 6.22      | 3.1       | 68       | 189      | 1076      | 3730      | 0.43      | 17.2       | 0           |
| N1          | 5.92      | 3         | 74       | 251      | 841       | 2960      | 0.34      | 14.2       | 0           |
| N2          | 5.36      | 2.9       | 98       | 183      | 370       | 1620      | 0.14      | 8.7        | 1           |
| N3          | 6.14      | 2.5       | 77       | 239      | 684       | 2570      | 0.83      | 12.1       | 0           |
| N4          | 6.03      | 1.8       | 57       | 154      | 502       | 1840      | 0.3       | 8.7        | 0           |
| O1          | 5.97      | 2.8       | 63       | 259      | 838       | 2970      | 0.51      | 14         | 0           |
| O2          | 5.73      | 2         | 72       | 164      | 394       | 1590      | 0.21      | 7.8        | 0           |
| O3          | 5.72      | 2.6       | 67       | 175      | 463       | 1820      | 0.52      | 9.3        | 0           |
| O4          | 5.67      | 2.7       | 87       | 191      | 406       | 1390      | 0.24      | 8.1        | 0           |
| P1          | 5.69      | 2.8       | 64       | 152      | 567       | 2060      | 0.24      | 10.5       | 0           |
| P2          | 5.95      | 2.2       | 69       | 139      | 477       | 1720      | 0.24      | 8.7        | 0           |
| P3          | 5.91      | 2.7       | 94       | 215      | 487       | 1730      | 0.64      | 9.3        | 0           |
| P4          | 5.85      | 2.2       | 81       | 125      | 492       | 1750      | 0.15      | 8.8        | 0           |
| Q1          | 6.07      | 1.9       | 66       | 134      | 545       | 1930      | 0.15      | 9.2        | 0           |
| Q2          | 5.93      | 2.2       | 82       | 119      | 487       | 1740      | 0.17      | 8.7        | 0           |
| Q3          | 6.32      | 1.7       | 70       | 181      | 500       | 1790      | 0.4       | 8.5        | 0           |
| Q4          | 5.86      | 2.2       | 67       | 126      | 450       | 1760      | 0.16      | 8.6        | 0           |
| R1          | 6.83      | 1.2       | 59       | 229      | 994       | 3330      | 0.22      | 14         | 0           |
| R2          | 6.65      | 1.5       | 56       | 282      | 712       | 2540      | 0.63      | 11.2       | 0           |
| R3          | 6.02      | 2.3       | 59       | 149      | 496       | 1890      | 0.46      | 9.3        | 0           |
| R4          | 5.75      | 3.5       | 95       | 149      | 541       | 2320      | 0.24      | 11.7       | 0           |
| S1          | 6.33      | 1.9       | 69       | 140      | 540       | 2010      | 0.24      | 9.4        | 0           |
| S2          | 6.4       | 2         | 69       | 142      | 539       | 2010      | 0.3       | 9.5        | 0           |
| S3          | 6.83      | 1.3       | 82       | 198      | 707       | 2530      | 0.31      | 10.8       | 0           |
| S4          | 6.49      | 1.2       | 61       | 178      | 597       | 2220      | 0.9       | 9.5        | 0           |
| T1          | 6.35      | 1.4       | 70       | 143      | 596       | 2010      | 0.17      | 9.1        | 0           |
| T2          | 6.85      | 1.3       | 80       | 463      | 1269      | 4680      | 0.4       | 18.9       | 0           |
| T3          | 6.28      | 2.2       | 62       | 271      | 855       | 3350      | 0.67      | 14.5       | 0           |
| T4          | 6.26      | 2.3       | 78       | 164      | 567       | 2060      | 0.21      | 10         | 0           |

(Continued)

Table B3 (Concluded)

| <u>Grid</u> | <u>pH</u> | <u>TA</u> | <u>P</u> | <u>K</u> | <u>Mg</u> | <u>Ca</u> | <u>OM</u> | <u>CEC</u> | <u>Lime</u> |
|-------------|-----------|-----------|----------|----------|-----------|-----------|-----------|------------|-------------|
| U1          | 6.23      | 2.3       | 66       | 324      | 942       | 3810      | 0.28      | 16.2       | 0           |
| U2          | 6.32      | 1.6       | 54       | 198      | 672       | 2360      | 0.31      | 10.6       | 0           |
| U3          | 5.78      | 2.6       | 86       | 171      | 478       | 1780      | 0.27      | 9.3        | 0           |
| U4          | 5.99      | 2         | 87       | 130      | 380       | 1420      | 0.21      | 7.3        | 0           |
| V1          | 5.64      | 3         | 74       | 119      | 434       | 1700      | 0.2       | 9.2        | 0           |
| V2          | 5.75      | 2.8       | 81       | 145      | 442       | 1640      | 0.24      | 8.9        | 0           |
| V3          | 5.55      | 3.2       | 67       | 137      | 486       | 1840      | 0.44      | 10         | 0           |
| W1          | 5.69      | 2.4       | 73       | 139      | 452       | 1690      | 0.24      | 8.7        | 0           |
| W2          | 5.71      | 2.4       | 77       | 124      | 400       | 1460      | 0.3       | 7.9        | 0           |
| W3          | 5.76      | 2         | 85       | 163      | 385       | 1500      | 0.24      | 7.6        | 0           |
| X1          | 5.83      | 3.7       | 72       | 242      | 879       | 3090      | 0.39      | 15.4       | 0           |
| X2          | 5.55      | 2.7       | 109      | 351      | 392       | 1390      | 0.4       | 8.3        | 1           |
| X3          | 5.89      | 2.5       | 87       | 190      | 567       | 2170      | 0.21      | 10.5       | 0           |
| Y1          | 5.85      | 3         | 82       | 148      | 502       | 2120      | 0.38      | 10.6       | 0           |
| Y2          | 5.84      | 2.9       | 77       | 215      | 624       | 2240      | 0.43      | 11.4       | 0           |
| Y3          | 6.13      | 4         | 95       | 292      | 1152      | 4150      | 0.34      | 19.5       | 0           |
| Z1          | 5.82      | 4.2       | 86       | 328      | 851       | 2970      | 1.62      | 15.6       | 0           |

Table B4  
Particle Size Distribution in Grids I-Z  
(0- to 30-, 30- to 60-, 60- to 90-,  
90- to 120-, and 120- to 150-cm depths)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>Depth</u> | <u>%Clay</u> | <u>%Silt</u> | <u>%Sand</u> |
|------------|------------|-------------|--------------|--------------|--------------|--------------|
| 1          | I          | 1           | 30           | 23.4131      | 62.4350      | 14.1519      |
| 2          | I          | 1           | 60           | 24.3465      | 53.8186      | 21.8350      |
| 3          | I          | 1           | 90           | 21.6616      | 61.1621      | 17.1764      |
| 4          | I          | 1           | 120          | 28.4827      | 64.7333      | 6.7840       |
| 5          | I          | 1           | 150          | 28.6309      | 65.0703      | 6.2988       |
| 6          | I          | 2           | 30           | 42.5080      | 57.4920      | 0.0000       |
| 7          | I          | 2           | 60           | 44.5876      | 52.0188      | 3.3936       |
| 8          | I          | 2           | 90           | 40.6504      | 55.0747      | 4.2748       |
| 9          | I          | 2           | 120          | 39.8301      | 58.4174      | 1.7525       |
| 10         | I          | 2           | 150          | 37.1649      | 58.4019      | 4.4332       |
| 11         | I          | 3           | 30           | 39.4425      | 60.5575      | 0.0000       |
| 12         | I          | 3           | 60           | 44.5726      | 55.4274      | 0.0000       |
| 13         | I          | 3           | 90           | 46.6916      | 53.3084      | 0.0000       |
| 14         | I          | 3           | 120          | 31.1850      | 59.7713      | 9.0437       |
| 15         | I          | 3           | 150          | 23.2678      | 54.2916      | 22.4405      |
| 16         | I          | 4           | 30           | 25.7865      | 74.2135      | 0.0000       |
| 17         | I          | 4           | 60           | 45.7636      | 54.2364      | 0.0000       |
| 18         | I          | 4           | 90           | 58.0297      | 41.9703      | 0.0000       |
| 19         | I          | 4           | 120          | 51.6726      | 48.3274      | 0.0000       |
| 20         | I          | 4           | 150          | 48.4001      | 51.0890      | 0.5109       |
| 21         | J          | 1           | 30           | 36.5344      | 44.3633      | 19.1023      |
| 22         | J          | 1           | 30           | 23.2138      | 43.8483      | 32.9378      |
| 23         | J          | 1           | 90           | 21.8285      | 48.7930      | 29.3785      |
| 24         | J          | 1           | 120          | 24.3340      | 61.4754      | 14.1906      |
| 25         | J          | 1           | 150          | 27.0828      | 61.9035      | 11.0137      |
| 26         | J          | 2           | 30           | 39.2259      | 60.1464      | 0.6276       |
| 27         | J          | 2           | 60           | 36.7358      | 62.9756      | 0.2886       |
| 28         | J          | 2           | 90           | 37.7211      | 59.8335      | 2.4454       |
| 29         | J          | 2           | 120          | 35.3774      | 62.8931      | 1.7296       |
| 30         | J          | 2           | 150          | 32.3583      | 59.5392      | 8.1025       |
| 31         | J          | 3           | 30           | 38.9307      | 61.0693      | 0.0000       |
| 32         | J          | 3           | 60           | 27.2727      | 72.7273      | 0.0000       |
| 33         | J          | 3           | 90           | 60.2732      | 39.7268      | 0.0000       |
| 34         | J          | 3           | 120          | 48.9936      | 51.0064      | 0.0000       |
| 35         | J          | 3           | 150          | 48.2057      | 50.8838      | 0.9106       |
| 36         | J          | 4           | 30           | 42.1607      | 57.8393      | 0.0000       |
| 37         | J          | 4           | 60           | 35.1379      | 64.8621      | 0.0000       |
| 38         | J          | 4           | 90           | 32.0349      | 67.9651      | 0.0000       |
| 39         | J          | 4           | 120          | 43.9765      | 56.0235      | 0.0000       |
| 40         | J          | 4           | 150          | 48.8513      | 50.1716      | 0.9770       |
| 41         | K          | 1           | 30           | 10.1010      | 7.5758       | 82.3232      |
| 42         | K          | 1           | 60           | 12.5408      | 27.5897      | 59.8696      |
| 43         | K          | 1           | 90           | 30.0183      | 60.0365      | 9.9452       |
| 44         | K          | 1           | 120          | 27.0619      | 59.2784      | 13.6598      |
| 45         | K          | 1           | 150          | 27.2374      | 59.6628      | 13.0999      |
| 46         | K          | 2           | 30           | 15.1362      | 42.8860      | 41.9778      |
| 47         | K          | 2           | 60           | 33.8014      | 59.8024      | 6.3963       |

(Continued)

(Sheet 1 of 7)

Table B4 (Continued)

| Obs | Row | Grid | Depth | %Clay   | %Silt   | %Sand   |
|-----|-----|------|-------|---------|---------|---------|
| 48  | K   | 2    | 90    | 37.9879 | 62.0121 | 0.0000  |
| 49  | K   | 2    | 120   | 35.2021 | 64.7979 | 0.0000  |
| 50  | K   | 2    | 150   | 35.0285 | 62.2730 | 2.6985  |
| 51  | K   | 3    | 30    | 33.9958 | 66.0042 | 0.0000  |
| 52  | K   | 3    | 60    | 38.0677 | 61.9323 | 0.0000  |
| 53  | K   | 3    | 90    | 24.5415 | 74.9160 | 0.5425  |
| 54  | K   | 3    | 120   | 52.6458 | 47.3542 | 0.0000  |
| 55  | K   | 3    | 150   | 52.6458 | 45.8963 | 1.4579  |
| 56  | K   | 4    | 30    | 33.5917 | 64.5995 | 1.8088  |
| 57  | K   | 4    | 60    | 35.4052 | 64.5948 | 0.0000  |
| 58  | K   | 4    | 90    | 35.0649 | 64.9351 | 0.0000  |
| 59  | K   | 4    | 120   | 35.3403 | 64.6597 | 0.0000  |
| 60  | K   | 4    | 150   | 49.7446 | 48.4001 | 1.8553  |
| 61  | L   | 1    | 60    | 35.3311 | 57.5766 | 7.0924  |
| 62  | L   | 1    | 90    | 30.0811 | 60.1622 | 9.7567  |
| 63  | L   | 1    | 120   | 29.8391 | 64.8677 | 5.2932  |
| 64  | L   | 1    | 150   | 24.4153 | 51.4007 | 24.1840 |
| 65  | L   | 2    | 30    | 17.8389 | 68.8073 | 13.3537 |
| 66  | L   | 2    | 60    | 32.2165 | 67.0103 | 0.7732  |
| 67  | L   | 2    | 90    | 29.6239 | 69.5518 | 0.8243  |
| 68  | L   | 2    | 120   | 27.3794 | 72.6206 | 0.0000  |
| 69  | L   | 2    | 150   | 21.7725 | 74.2828 | 3.9447  |
| 70  | L   | 3    | 30    | 28.6235 | 70.2576 | 1.1189  |
| 71  | L   | 3    | 60    | 41.0487 | 58.9513 | 0.0000  |
| 72  | L   | 3    | 90    | 29.9401 | 70.0599 | 0.0000  |
| 73  | L   | 3    | 120   | 40.8217 | 59.1783 | 0.0000  |
| 74  | L   | 3    | 150   | 58.4716 | 41.5284 | 0.0000  |
| 75  | L   | 4    | 30    | 17.9257 | 71.7029 | 10.3713 |
| 76  | L   | 4    | 60    | 26.9923 | 71.9794 | 1.0283  |
| 77  | L   | 4    | 90    | 24.3091 | 74.2068 | 1.4841  |
| 78  | L   | 4    | 120   | 40.4700 | 59.5300 | 0.0000  |
| 79  | L   | 4    | 150   | 49.6245 | 50.3755 | 0.0000  |
| 80  | L   | I    | 30    | 25.7003 | 64.2508 | 10.0488 |
| 81  | M   | 1    | 30    | 36.4868 | 63.5132 | 0.0000  |
| 82  | M   | 1    | 60    | 24.5415 | 74.9160 | 0.5425  |
| 83  | M   | 1    | 90    | 32.6883 | 60.1464 | 7.1653  |
| 84  | M   | 1    | 120   | 29.9323 | 62.4675 | 7.6002  |
| 85  | M   | 1    | 150   | 27.2515 | 59.6937 | 13.0548 |
| 86  | M   | 2    | 30    | 33.6091 | 59.4623 | 6.9286  |
| 87  | M   | 2    | 60    | 24.4530 | 72.0721 | 3.4749  |
| 88  | M   | 2    | 90    | 29.3293 | 70.6707 | 0.0000  |
| 89  | M   | 2    | 120   | 21.8678 | 77.1803 | 0.9519  |
| 90  | M   | 2    | 150   | 21.8621 | 77.1605 | 0.9774  |
| 91  | M   | 3    | 30    | 25.4582 | 66.1914 | 8.3503  |
| 92  | M   | 3    | 60    | 24.7203 | 75.2797 | 0.0000  |
| 93  | M   | 3    | 120   | 21.8565 | 77.1407 | 1.0028  |
| 94  | M   | 3    | 150   | 46.2718 | 53.7282 | 0.0000  |
| 95  | M   | 4    | 30    | 25.9134 | 72.5577 | 1.5289  |

(Continued)

(Sheet 2 of 7)

Table B4 (Continued)

| Obs | Rpw | Grid | Depth | %Clay   | %Silt   | %Sand   |
|-----|-----|------|-------|---------|---------|---------|
| 96  | M   | 4    | 60    | 24.2656 | 74.0741 | 1.6603  |
| 97  | M   | 4    | 90    | 27.0062 | 72.9938 | 0.0000  |
| 98  | M   | 4    | 120   | 16.5100 | 83.4900 | 0.0000  |
| 99  | M   | 4    | 150   | 37.3808 | 61.8716 | 0.7476  |
| 100 | N   | 1    | 30    | 10.5988 | 34.4462 | 54.9550 |
| 101 | N   | 1    | 60    | 29.7234 | 70.2766 | 0.0000  |
| 102 | N   | 1    | 90    | 48.1771 | 51.8229 | 0.0000  |
| 103 | N   | 1    | 120   | 27.1599 | 62.0797 | 10.7605 |
| 104 | N   | 1    | 150   | 28.3213 | 61.7920 | 9.8867  |
| 105 | N   | 2    | 30    | 44.6650 | 52.1092 | 3.2258  |
| 106 | N   | 2    | 60    | 11.4040 | 60.8211 | 27.7750 |
| 107 | N   | 2    | 90    | 19.1424 | 79.1220 | 1.7356  |
| 108 | N   | 2    | 120   | 20.4971 | 76.8640 | 2.6390  |
| 109 | N   | 2    | 150   | 21.5027 | 78.4215 | 0.0759  |
| 110 | N   | 3    | 30    | 23.0120 | 71.5929 | 5.3950  |
| 111 | N   | 3    | 60    | 19.1718 | 79.2434 | 1.5849  |
| 112 | N   | 3    | 90    | 27.2021 | 72.7979 | 0.0000  |
| 113 | N   | 3    | 120   | 27.2232 | 72.5953 | 0.1815  |
| 114 | N   | 3    | 150   | 55.3157 | 44.6843 | 0.0000  |
| 115 | N   | 4    | 30    | 21.8285 | 77.0416 | 1.1299  |
| 116 | N   | 4    | 60    | 24.3777 | 75.6223 | 0.0000  |
| 117 | N   | 4    | 90    | 19.3299 | 80.6701 | 0.0000  |
| 118 | N   | 4    | 120   | 16.5352 | 81.4042 | 2.0605  |
| 119 | N   | 4    | 120   | 21.3568 | 78.6432 | 0.0000  |
| 120 | N   | 4    | 150   | 32.4929 | 67.5071 | 0.0000  |
| 121 | O   | 1    | 30    | 16.5647 | 79.0010 | 4.4343  |
| 122 | O   | 1    | 60    | 13.7983 | 82.7898 | 3.4119  |
| 123 | O   | 1    | 90    | 22.8021 | 77.1979 | 0.0000  |
| 124 | O   | 1    | 120   | 35.4238 | 62.9756 | 1.6006  |
| 125 | O   | 1    | 150   | 27.0688 | 59.2936 | 13.6375 |
| 126 | O   | 2    | 30    | 13.8854 | 60.5908 | 25.5239 |
| 127 | O   | 2    | 60    | 21.4918 | 73.3249 | 5.1833  |
| 128 | O   | 2    | 90    | 18.9970 | 75.9878 | 5.0152  |
| 129 | O   | 2    | 120   | 11.3852 | 80.3213 | 8.3835  |
| 130 | O   | 2    | 150   | 16.2378 | 79.9400 | 3.8221  |
| 131 | O   | 3    | 30    | 6.3468  | 55.8517 | 37.8015 |
| 132 | O   | 3    | 60    | 8.7456  | 69.9650 | 21.2894 |
| 133 | O   | 3    | 90    | 12.6263 | 75.7576 | 11.6162 |
| 134 | O   | 3    | 150   | 12.5094 | 85.0638 | 2.4268  |
| 135 | O   | 3    | 150   | 13.9736 | 81.3008 | 4.7256  |
| 136 | O   | 4    | 30    | 7.8839  | 22.0751 | 70.0410 |
| 137 | O   | 4    | 60    | 8.8563  | 20.2429 | 70.9008 |
| 138 | O   | 4    | 90    | 10.0075 | 50.0375 | 39.9550 |
| 139 | O   | 4    | 120   | 8.7653  | 55.0964 | 36.1382 |
| 140 | O   | 4    | 150   | 11.3464 | 52.9501 | 35.7035 |
| 141 | P   | 1    | 30    | 13.8644 | 80.6655 | 5.4701  |
| 142 | P   | 1    | 60    | 13.9665 | 81.2595 | 4.7740  |
| 143 | P   | 1    | 90    | 21.4809 | 78.3422 | 0.1769  |

(Continued)

(Sheet 3 of 7)

Table B4 (Continued)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>Depth</u> | <u>%Clay</u> | <u>%Silt</u> | <u>%Sand</u> |
|------------|------------|-------------|--------------|--------------|--------------|--------------|
| 144        | P          | 1           | 120          | 35.0376      | 38.9307      | 26.0317      |
| 145        | P          | 1           | 150          | 39.0625      | 60.9375      | 0.0000       |
| 146        | P          | 2           | 30           | 6.3131       | 45.4545      | 48.2323      |
| 147        | P          | 2           | 60           | 13.9029      | 78.3620      | 7.7351       |
| 148        | P          | 2           | 90           | 8.8473       | 83.4176      | 7.7351       |
| 149        | P          | 2           | 120          | 11.3407      | 83.1653      | 5.4940       |
| 150        | P          | 2           | 150          | 12.4969      | 82.4794      | 5.0237       |
| 151        | P          | 3           | 30           | 6.2081       | 37.2486      | 56.5433      |
| 152        | P          | 3           | 60           | 10.0629      | 55.3459      | 34.5912      |
| 153        | P          | 3           | 90           | 10.0528      | 50.2639      | 39.6833      |
| 154        | P          | 3           | 120          | 6.2500       | 27.5000      | 66.2500      |
| 155        | P          | 3           | 150          | 12.5723      | 42.7458      | 44.6819      |
| 156        | P          | 4           | 30           | 8.8496       | 20.2276      | 70.9229      |
| 157        | P          | 4           | 60           | 9.9676       | 27.4109      | 62.6215      |
| 158        | P          | 4           | 90           | 7.5719       | 47.9556      | 44.4725      |
| 159        | P          | 4           | 120          | 6.2438       | 39.9600      | 53.7962      |
| 160        | P          | 4           | 150          | 12.4782      | 47.4170      | 40.1048      |
| 161        | Q          | 1           | 30           | 8.7873       | 82.8521      | 8.3605       |
| 162        | Q          | 1           | 60           | 10.0654      | 83.0398      | 6.8948       |
| 163        | Q          | 1           | 90           | 12.6550      | 87.3450      | 0.0000       |
| 164        | Q          | 1           | 120          | 19.0018      | 80.9982      | 0.0000       |
| 165        | Q          | 1           | 150          | 41.8629      | 58.1371      | 0.0000       |
| 166        | Q          | 2           | 30           | 8.7719       | 32.5815      | 58.6466      |
| 167        | Q          | 2           | 60           | 11.2108      | 22.4215      | 66.3677      |
| 168        | Q          | 2           | 90           | 9.9133       | 49.5663      | 40.5204      |
| 169        | Q          | 2           | 120          | 6.2531       | 57.5288      | 36.2181      |
| 170        | Q          | 2           | 150          | 7.4832       | 59.8653      | 32.6515      |
| 171        | Q          | 3           | 30           | 8.7173       | 52.3039      | 38.9788      |
| 172        | Q          | 3           | 60           | 11.3236      | 45.2944      | 43.3820      |
| 173        | Q          | 3           | 90           | 15.3257      | 45.9770      | 38.6973      |
| 174        | Q          | 3           | 120          | 6.3420       | 63.4196      | 30.2385      |
| 175        | Q          | 3           | 150          | 17.8072      | 45.7899      | 36.4030      |
| 176        | Q          | 4           | 30           | 11.3436      | 45.3743      | 43.2821      |
| 177        | Q          | 4           | 60           | 12.8074      | 48.6680      | 38.5246      |
| 178        | Q          | 4           | 90           | 10.0150      | 60.0901      | 29.8948      |
| 179        | Q          | 4           | 120          | 11.4562      | 58.5540      | 29.9898      |
| 180        | Q          | 4           | 150          | 10.0528      | 57.8035      | 32.1438      |
| 181        | R          | 1           | 30           | 8.8161       | 57.9345      | 33.2494      |
| 182        | R          | 1           | 60           | 10.9436      | 68.0934      | 20.9630      |
| 183        | R          | 1           | 90           | 10.0326      | 80.2608      | 9.7065       |
| 184        | R          | 1           | 120          | 12.6422      | 75.8534      | 11.5044      |
| 185        | R          | 1           | 150          | 25.5558      | 51.1117      | 23.3325      |
| 186        | R          | 2           | 30           | 18.9012      | 25.2016      | 55.8972      |
| 187        | R          | 2           | 60           | 22.0093      | 54.3760      | 23.6147      |
| 188        | R          | 2           | 90           | 33.9603      | 54.8589      | 11.1808      |
| 189        | R          | 2           | 120          | 30.6513      | 56.1941      | 13.1545      |
| 190        | R          | 2           | 150          | 10.4493      | 83.5946      | 5.9561       |
| 191        | R          | 3           | 30           | 6.1214       | 53.8688      | 40.0098      |

(Continued)

(Sheet 4 of 7)

Table B4 (Continued)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>Depth</u> | <u>%Clay</u> | <u>%Silt</u> | <u>%Sand</u> |
|------------|------------|-------------|--------------|--------------|--------------|--------------|
| 192        | R          | 3           | 60           | 11.3350      | 45.3401      | 43.3249      |
| 193        | R          | 3           | 90           | 7.4914       | 38.5274      | 53.9812      |
| 194        | R          | 3           | 120          | 15.1592      | 42.9510      | 41.8898      |
| 195        | R          | 3           | 150          | 10.1549      | 40.6194      | 49.2257      |
| 196        | R          | 4           | 30           | 16.5479      | 45.8248      | 37.6273      |
| 197        | R          | 4           | 60           | 16.5017      | 40.6194      | 42.8789      |
| 198        | R          | 4           | 90           | 14.1753      | 51.5464      | 34.2784      |
| 199        | R          | 4           | 150          | 10.1755      | 53.4215      | 36.4030      |
| 200        | R          | 4           | 150          | 23.0888      | 61.5700      | 15.3412      |
| 201        | S          | 1           | 30           | 6.2877       | 60.3622      | 33.3501      |
| 202        | S          | 1           | 60           | 8.8161       | 52.8967      | 38.2872      |
| 203        | S          | 1           | 90           | 10.0908      | 63.0676      | 26.8416      |
| 204        | S          | 1           | 120          | 7.5700       | 47.9435      | 44.4865      |
| 205        | S          | 1           | 150          | 5.0239       | 55.2625      | 39.7136      |
| 206        | S          | 2           | 30           | 13.8994      | 48.0162      | 38.0844      |
| 207        | S          | 2           | 60           | 24.6178      | 51.8269      | 23.5553      |
| 208        | S          | 2           | 90           | 18.1441      | 36.2882      | 45.5677      |
| 209        | S          | 2           | 120          | 25.8665      | 46.5598      | 27.5737      |
| 210        | S          | 2           | 150          | 10.1626      | 40.6504      | 49.1870      |
| 211        | S          | 3           | 30           | 6.2814       | 57.7889      | 35.9296      |
| 212        | S          | 3           | 60           | 7.5586       | 75.5858      | 16.8556      |
| 213        | S          | 3           | 90           | 8.3913       | 21.5776      | 70.0312      |
| 214        | S          | 3           | 120          | 7.5019       | 37.5094      | 54.9887      |
| 215        | S          | 3           | 150          | 4.9826       | 29.8954      | 65.1221      |
| 216        | S          | 4           | 30           | 8.8697       | 70.9579      | 20.1723      |
| 217        | S          | 4           | 60           | 11.2528      | 35.0088      | 53.7384      |
| 218        | S          | 4           | 90           | 7.4590       | 27.3496      | 65.1914      |
| 219        | S          | 4           | 120          | 2.5013       | 15.0075      | 82.4912      |
| 220        | S          | 4           | 150          | 7.5113       | 42.5638      | 49.9249      |
| 221        | T          | 1           | 30           | 29.8159      | 46.6684      | 23.5157      |
| 222        | T          | 1           | 60           | 38.4717      | 47.7580      | 13.7702      |
| 223        | T          | 1           | 90           | 41.6089      | 32.3625      | 26.0287      |
| 224        | T          | 1           | 150          | 12.6968      | 48.2478      | 39.0554      |
| 225        | T          | 2           | 30           | 6.3052       | 45.3972      | 48.2976      |
| 226        | T          | 2           | 60           | 11.3179      | 35.2113      | 53.4708      |
| 227        | T          | 2           | 90           | 20.3200      | 22.8600      | 56.8199      |
| 228        | T          | 2           | 120          | 13.7226      | 12.4750      | 73.8024      |
| 229        | T          | 2           | 150          | 9.9552       | 19.9104      | 70.1344      |
| 230        | T          | 3           | 30           | 19.2604      | 64.2013      | 16.5383      |
| 231        | T          | 3           | 60           | 11.2641      | 77.5970      | 11.1389      |
| 232        | T          | 3           | 90           | 7.6084       | 50.7228      | 41.6688      |
| 233        | T          | 3           | 120          | 6.2893       | 42.7673      | 50.9434      |
| 234        | T          | 3           | 150          | 10.0326      | 57.6875      | 32.2799      |
| 235        | U          | 1           | 30           | 11.5296      | 58.9290      | 29.5414      |
| 236        | U          | 1           | 60           | 10.0985      | 47.9677      | 41.9339      |
| 237        | U          | 1           | 90           | 5.0454       | 63.0676      | 31.8870      |
| 238        | U          | 1           | 120          | 8.7478       | 62.4844      | 28.7678      |
| 239        | U          | 1           | 150          | 8.6207       | 54.1872      | 37.1921      |

(Continued)

(Sheet 5 of 7)

Table B4 (Continued)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>Depth</u> | <u>%Clay</u> | <u>%Silt</u> | <u>%Sand</u> |
|------------|------------|-------------|--------------|--------------|--------------|--------------|
| 240        | U          | 1           | 150          | 11.2080      | 59.7758      | 29.0162      |
| 241        | U          | 2           | 30           | 16.3934      | 27.7427      | 55.8638      |
| 242        | U          | 2           | 60           | 13.9276      | 48.1134      | 37.9590      |
| 243        | U          | 2           | 90           | 6.2861       | 42.7458      | 50.9681      |
| 244        | U          | 2           | 120          | 8.8206       | 35.2823      | 55.8972      |
| 245        | U          | 2           | 150          | 6.2205       | 7.4645       | 86.3150      |
| 246        | U          | 3           | 30           | 11.3550      | 12.6167      | 76.0283      |
| 247        | U          | 3           | 60           | 2.5272       | 20.2173      | 77.2555      |
| 248        | U          | 3           | 60           | 2.4963       | 22.4663      | 75.0374      |
| 249        | U          | 3           | 90           | 3.7764       | 7.5529       | 88.6707      |
| 250        | U          | 3           | 120          | 8.4931       | 19.4128      | 72.0942      |
| 251        | V          | 1           | 30           | 11.3065      | 27.6382      | 61.0553      |
| 252        | V          | 1           | 60           | 5.0289       | 27.6590      | 67.3120      |
| 253        | V          | 1           | 90           | 3.7641       | 27.6035      | 68.6324      |
| 254        | V          | 1           | 120          | 5.9298       | 28.4630      | 65.6072      |
| 255        | V          | 1           | 150          | 6.2578       | 27.5344      | 66.2078      |
| 256        | V          | 1           | 150          | 6.1973       | 93.8027      | 0.0000       |
| 257        | V          | 2           | 30           | 13.8087      | 35.1494      | 51.0419      |
| 258        | V          | 2           | 60           | 21.0240      | 24.7341      | 54.2419      |
| 259        | V          | 2           | 90           | 25.7400      | 51.4801      | 22.7799      |
| 260        | V          | 2           | 120          | 24.6305      | 49.2611      | 26.1084      |
| 261        | V          | 2           | 150          | 13.9100      | 27.8199      | 58.2701      |
| 262        | V          | 3           | 30           | 5.0607       | 20.2429      | 74.6964      |
| 263        | V          | 3           | 30           | 15.8924      | 53.7897      | 30.3178      |
| 264        | V          | 3           | 30           | 11.3407      | 57.9637      | 30.6956      |
| 265        | V          | 3           | 60           | 11.1940      | 14.9254      | 73.8806      |
| 266        | V          | 3           | 90           | 8.7984       | 30.1659      | 61.0357      |
| 267        | V          | 3           | 120          | 6.2267       | 39.8506      | 53.9228      |
| 268        | V          | 3           | 150          | 6.3243       | 40.4756      | 53.2001      |
| 269        | V          | 3           | 150          | 3.7566       | 96.2434      | 0.0000       |
| 270        | W          | 1           | 30           | 16.5690      | 43.3342      | 40.0969      |
| 271        | W          | 1           | 60           | 34.4740      | 38.3044      | 27.2217      |
| 272        | W          | 1           | 90           | 28.3600      | 49.3218      | 22.3181      |
| 273        | W          | 1           | 120          | 16.7655      | 64.4828      | 18.7516      |
| 274        | W          | 1           | 150          | 3.7509       | 96.2491      | 0.0000       |
| 275        | W          | 2           | 30           | 18.4957      | 24.6609      | 56.8434      |
| 276        | W          | 2           | 60           | 6.2925       | 17.6189      | 76.0886      |
| 277        | W          | 2           | 90           | 3.7323       | 12.4409      | 83.8268      |
| 278        | W          | 2           | 120          | 8.5262       | 17.0524      | 74.4214      |
| 279        | W          | 2           | 150          | 3.7129       | 96.2871      | 0.0000       |
| 280        | W          | 3           | 30           | 4.9975       | 22.4888      | 72.5137      |
| 281        | W          | 3           | 60           | 2.5151       | 10.0604      | 87.4245      |
| 282        | W          | 3           | 90           | 6.2235       | 27.3836      | 66.3928      |
| 283        | W          | 3           | 90           | 8.7829       | 20.0753      | 71.1418      |
| 284        | W          | 3           | 120          | 26.9093      | 48.6930      | 24.3977      |
| 285        | W          | 3           | 150          | 8.7719       | 25.0627      | 66.1654      |
| 286        | X          | 1           | 30           | 16.0217      | 44.3678      | 39.6105      |
| 287        | X          | 1           | 60           | 24.5415      | 46.4996      | 28.9589      |

(Continued)

(Sheet 6 of 7)

Table B4 (Concluded)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>Depth</u> | <u>%Clay</u> | <u>%Silt</u> | <u>%Sand</u> |
|------------|------------|-------------|--------------|--------------|--------------|--------------|
| 288        | X          | 1           | 90           | 23.2558      | 48.9596      | 27.7846      |
| 289        | X          | 1           | 120          | 11.3493      | 22.6986      | 65.9521      |
| 290        | X          | 1           | 150          | 6.3084       | 20.1867      | 73.5049      |
| 291        | X          | 1           | 150          | 6.2578       | 93.7422      | 0.0000       |
| 292        | X          | 2           | 30           | 13.4245      | 51.2570      | 35.3185      |
| 293        | X          | 2           | 60           | 11.3436      | 27.7288      | 60.9277      |
| 294        | X          | 2           | 90           | 8.7282       | 37.4065      | 53.8653      |
| 295        | X          | 2           | 120          | 5.0531       | 22.7388      | 72.2082      |
| 296        | X          | 2           | 150          | 3.7594       | 96.2406      | 0.0000       |
| 297        | X          | 3           | 30           | 10.1600      | 38.1001      | 51.7399      |
| 298        | X          | 3           | 60           | 15.8382      | 70.6628      | 13.4990      |
| 299        | X          | 3           | 90           | 5.0251       | 17.5879      | 77.3869      |
| 300        | X          | 3           | 120          | 18.1378      | 9.6735       | 72.1886      |
| 301        | X          | 3           | 150          | 3.7230       | 96.2770      | 0.0000       |
| 302        | Y          | 1           | 60           | 10.1574      | 43.1691      | 46.6734      |
| 303        | Y          | 1           | 90           | 5.7991       | 44.0733      | 50.1276      |
| 304        | Y          | 1           | 120          | 8.0552       | 43.7284      | 48.2163      |
| 305        | Y          | 1           | 120          | 6.2877       | 40.2414      | 53.4708      |
| 306        | Y          | 1           | 150          | 6.1989       | 34.7136      | 59.0875      |
| 307        | Y          | 2           | 30           | 7.4386       | 34.7136      | 57.8478      |
| 308        | Y          | 2           | 60           | 13.8018      | 20.0753      | 66.1230      |
| 309        | Y          | 2           | 90           | 5.9751       | 26.2906      | 67.7342      |
| 310        | Y          | 2           | 120          | 8.4623       | 29.0135      | 62.5242      |
| 311        | Y          | 2           | 150          | 6.2735       | 93.7265      | 0.0000       |
| 312        | Y          | 3           | 60           | 11.3780      | 32.8698      | 55.7522      |
| 313        | Y          | 3           | 90           | 6.2909       | 25.1636      | 68.5455      |
| 314        | Y          | 3           | 120          | 6.3243       | 30.3567      | 63.3190      |
| 315        | Y          | 3           | 120          | 11.4011      | 38.0035      | 50.5954      |
| 316        | Y          | 3           | 150          | 3.7566       | 96.2434      | 0.0000       |
| 317        | Y          | I           | 30           | 10.2599      | 31.9197      | 57.8203      |
| 318        | Z          | 1           | 30           | 18.8537      | 75.4148      | 5.7315       |
| 319        | Z          | 1           | 60           | 11.3751      | 63.1951      | 25.4297      |
| 320        | Z          | 1           | 90           | 12.7033      | 71.1382      | 16.1585      |
| 321        | Z          | 1           | 120          | 11.3751      | 73.3064      | 15.3185      |
| 322        | Z          | 1           | 150          | 8.8630       | 83.5655      | 7.5715       |

(Sheet 7 of 7)

Table B5  
WES pH Data for I-Z Grids, 1989  
(0- to 30-cm depth)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>pH</u> |
|------------|------------|-------------|-----------|
| 1          | I          | 1           | 4.16      |
| 2          | I          | 2           | 4.16      |
| 3          | I          | 3           | 4.12      |
| 4          | I          | 4           | 4.76      |
| 5          | J          | 1           | 3.89      |
| 6          | J          | 2           | 4.12      |
| 7          | J          | 3           | 3.87      |
| 8          | J          | 4           | 3.85      |
| 9          | K          | 1           | 4.54      |
| 10         | K          | 2           | 4.42      |
| 11         | K          | 3           | 4.25      |
| 12         | K          | 4           | 4.25      |
| 13         | L          | 1           | 4.71      |
| 14         | L          | 2           | 5.54      |
| 15         | L          | 3           | 5.54      |
| 16         | L          | 4           | 3.98      |
| 17         | M          | 1           | 4.60      |
| 18         | M          | 2           | 4.98      |
| 19         | M          | 3           | 4.80      |
| 20         | M          | 4           | 4.89      |
| 21         | N          | 1           | 4.87      |
| 22         | N          | 2           | 4.54      |
| 23         | N          | 3           | 4.96      |
| 24         | N          | 4           | 4.74      |
| 25         | O          | 1           | 4.79      |
| 26         | O          | 2           | 4.92      |
| 27         | O          | 3           | 4.72      |
| 28         | O          | 4           | 5.18      |
| 29         | P          | 1           | 4.73      |
| 30         | P          | 2           | 4.69      |
| 31         | P          | 3           | 5.00      |
| 32         | P          | 4           | 4.62      |
| 33         | Q          | 1           | 5.56      |
| 34         | Q          | 2           | 4.54      |
| 35         | Q          | 3           | 4.98      |
| 36         | Q          | 4           | 4.92      |
| 37         | R          | 1           | 6.15      |
| 38         | R          | 2           | 5.10      |
| 39         | R          | 3           | 5.05      |
| 40         | R          | 4           | 4.82      |
| 41         | S          | 1           | 4.86      |
| 42         | S          | 2           | 4.72      |
| 43         | S          | 3           | 5.93      |
| 44         | S          | 4           | 5.51      |
| 45         | T          | 1           | 4.93      |
| 46         | T          | 2           | 5.23      |
| 47         | T          | 3           | 5.42      |

(Continued)

Table B5 (Concluded)

| <u>Obs</u> | <u>Row</u> | <u>Grid</u> | <u>pH</u> |
|------------|------------|-------------|-----------|
| 48         | U          | 1           | 5.09      |
| 49         | U          | 2           | 5.80      |
| 50         | U          | 3           | 4.73      |
| 51         | V          | 1           | 4.54      |
| 52         | V          | 2           | 4.95      |
| 53         | V          | 3           | 4.94      |
| 54         | W          | 1           | 4.84      |
| 55         | W          | 2           | 4.61      |
| 56         | W          | 3           | 5.18      |
| 57         | X          | 1           | 4.76      |
| 58         | X          | 2           | 4.81      |
| 59         | X          | 3           | 5.64      |
| 60         | Y          | 1           | 4.73      |
| 61         | Y          | 2           | 4.86      |
| 62         | Z          | 1           | 4.88      |

# **Appendix C**

## **Growth and Yield Data for Cotton Bioassay**

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Table C1  
Average Seedling Height, centimeters/pot

| <u>Obs</u> | <u>Treat</u> | <u>Grid</u> | <u>Height</u> |            |
|------------|--------------|-------------|---------------|------------|
|            |              |             | <u>Feb</u>    | <u>Apr</u> |
| 1          | POKON0       | IM          | 39.25         | 50.40      |
| 2          | POKON0       | IM          | 40.85         | 52.25      |
| 3          | POKON0       | IM          | 41.20         | 56.25      |
| 4          | POKON0       | IM          | 39.20         | 51.30      |
| 5          | POKON0       | NZ          | 25.90         | 35.85      |
| 6          | POKON0       | NZ          | 23.50         | 35.20      |
| 7          | POKON0       | NZ          | 28.75         | 33.90      |
| 8          | POKON0       | NZ          | 30.90         | 36.25      |
| 9          | POKON1       | IM          | 30.75         | 51.20      |
| 10         | POKON1       | IM          | 46.05         | 63.35      |
| 11         | POKON1       | IM          | 40.85         | 69.35      |
| 12         | POKON1       | IM          | 33.05         | 57.10      |
| 13         | POKON1       | NZ          | 36.35         | 52.10      |
| 14         | POKON1       | NZ          | 34.95         | 54.90      |
| 15         | POKON1       | NZ          | 27.75         | 49.45      |
| 16         | POKON1       | NZ          | 32.30         | 59.05      |
| 17         | POKON2       | IM          | 42.05         | 67.65      |
| 18         | POKON2       | IM          | 38.00         | 61.10      |
| 19         | POKON2       | IM          | 47.85         | 64.05      |
| 20         | POKON2       | IM          | 38.00         | 57.00      |
| 21         | POKON2       | NZ          | 34.50         | 56.80      |
| 22         | POKON2       | NZ          | 39.20         | 48.35      |
| 23         | POKON2       | NZ          | 31.00         | 42.20      |
| 24         | POKON2       | NZ          | 30.45         | 50.75      |
| 25         | POK1N1       | IM          | 30.30         | 71.65      |
| 26         | POK1N1       | IM          | 43.75         | 59.00      |
| 27         | POK1N1       | IM          | 41.95         | 55.90      |
| 28         | POK1N1       | IM          | 42.20         | 56.95      |
| 29         | POK1N1       | NZ          | 36.75         | 53.95      |
| 30         | POK1N1       | NZ          | 38.10         | 49.40      |
| 31         | POK1N1       | NZ          | 39.60         | 51.50      |
| 32         | POK1N1       | NZ          | 34.25         | 54.00      |
| 33         | POK1N2       | IM          | 45.50         | 65.65      |
| 34         | POK1N2       | IM          | 45.20         | 73.30      |
| 35         | POK1N2       | IM          | 40.65         | 60.25      |
| 36         | POK1N2       | IM          | 30.05         | 79.95      |
| 37         | POK1N2       | NZ          | 35.60         | 59.35      |
| 38         | POK1N2       | NZ          | 39.95         | 52.35      |
| 39         | POK1N2       | NZ          | 36.95         | 48.70      |
| 40         | POK1N2       | NZ          | 35.95         | 46.75      |
| 41         | P1K0N1       | IM          | 44.90         | 66.25      |
| 42         | P1K0N1       | IM          | 40.35         | 52.45      |
| 43         | P1K0N1       | IM          | 44.70         | 60.35      |
| 44         | P1K0N1       | IM          | 44.05         | 73.35      |
| 45         | P1K0N1       | NZ          | 34.90         | 50.30      |
| 46         | P1K0N1       | NZ          | 39.45         | 70.80      |

(Continued)

Table C1 (Concluded)

| <u>Obs</u> | <u>Treat</u> | <u>Grid</u> | <u>Height</u> |            |
|------------|--------------|-------------|---------------|------------|
|            |              |             | <u>Feb</u>    | <u>Apr</u> |
| 47         | P1K0N1       | NZ          | 41.40         | 54.25      |
| 48         | P1K0N1       | NZ          | 35.35         | 51.55      |
| 49         | P1K0N2       | IM          | 43.65         | 66.85      |
| 50         | P1K0N2       | IM          | 38.30         | 60.30      |
| 51         | P1K0N2       | IM          | 39.60         | 71.30      |
| 52         | P1K0N2       | IM          | 47.15         | 71.65      |
| 53         | P1K0N2       | NZ          | 24.85         | 51.45      |
| 54         | P1K0N2       | NZ          | 45.30         | 57.45      |
| 55         | P1K0N2       | NZ          | 37.65         | 50.00      |
| 56         | P1K0N2       | NZ          | 39.15         | 55.80      |
| 57         | P1K1N1       | IM          | 47.35         | 58.50      |
| 58         | P1K1N1       | IM          | 44.90         | 61.65      |
| 59         | P1K1N1       | IM          | 40.50         | 54.55      |
| 60         | P1K1N1       | IM          | 36.75         | 54.90      |
| 61         | P1K1N1       | NZ          | 41.85         | 48.70      |
| 62         | P1K1N1       | NZ          | 43.65         | 56.55      |
| 63         | P1K1N1       | NZ          | 37.95         | 49.40      |
| 64         | P1K1N1       | NZ          | 45.20         | 63.95      |
| 65         | P1K1N2       | IM          | 42.45         | 71.15      |
| 66         | P1K1N2       | IM          | 31.75         | 54.60      |
| 67         | P1K1N2       | IM          | 50.10         | 74.50      |
| 68         | P1K1N2       | IM          | 43.20         | 64.75      |
| 69         | P1K1N2       | NZ          | 38.80         | 47.70      |
| 70         | P1K1N2       | NZ          | 36.50         | 48.35      |
| 71         | P1K1N2       | NZ          | 33.00         | 43.95      |
| 72         | P1K1N2       | NZ          | 31.30         | 53.00      |
| 73         | P2K2N3       | IM          | 32.65         | 61.90      |
| 74         | P2K2N3       | IM          | 43.00         | 69.35      |
| 75         | P2K2N3       | IM          | 45.20         | 85.80      |
| 76         | P2K2N3       | IM          | 44.30         | 75.90      |
| 77         | P2K2N3       | NZ          | 22.50         | 66.15      |
| 78         | P2K2N3       | NZ          | 24.35         | 59.20      |
| 79         | P2K2N3       | NZ          | 25.50         | 50.05      |
| 80         | P2K2N3       | NZ          | 16.30         | 49.10      |

Table C2  
Greenhouse Seed Lint Yield

| <u>Obs</u> | <u>Treatmt</u> | <u>Grid</u> | <u>Yield</u> |              |
|------------|----------------|-------------|--------------|--------------|
|            |                |             | <u>g/pot</u> | <u>kg/ha</u> |
| 1          | CONTROL        | IM          | 15.55        | 401.19       |
| 2          | CONTROL        | IM          | 13.35        | 344.43       |
| 3          | CONTROL        | IM          | 12.75        | 328.95       |
| 4          | CONTROL        | IM          | 12.85        | 331.53       |
| 5          | CONTROL        | NZ          | 0.00         | 0.00         |
| 6          | CONTROL        | NZ          | 1.75         | 45.15        |
| 7          | CONTROL        | NZ          | 1.35         | 34.83        |
| 8          | CONTROL        | NZ          | 0.00         | 0.00         |
| 9          | P0K0N1         | IM          | 16.05        | 414.09       |
| 10         | P0K0N1         | IM          | 34.65        | 893.97       |
| 11         | P0K0N1         | IM          | 17.65        | 455.37       |
| 12         | P0K0N1         | IM          | 24.05        | 620.49       |
| 13         | P0K0N1         | NZ          | 11.15        | 287.67       |
| 14         | P0K0N1         | NZ          | 15.45        | 398.61       |
| 15         | P0K0N1         | NZ          | 14.95        | 385.71       |
| 16         | P0K0N1         | NZ          | 17.85        | 460.53       |
| 17         | P0K0N2         | IM          | 24.45        | 630.81       |
| 18         | P0K0N2         | IM          | 26.75        | 690.15       |
| 19         | P0K0N2         | IM          | 39.35        | 1015.23      |
| 20         | P0K0N2         | IM          | 29.65        | 764.97       |
| 21         | P0K0N2         | NZ          | 17.95        | 463.11       |
| 22         | P0K0N2         | NZ          | 18.05        | 465.69       |
| 23         | P0K0N2         | NZ          | 11.95        | 308.31       |
| 24         | P0K0N2         | NZ          | 19.05        | 491.49       |
| 25         | P0K1N1         | IM          | 34.35        | 886.23       |
| 26         | P0K1N1         | IM          | 26.65        | 687.57       |
| 27         | P0K1N1         | IM          | 17.55        | 452.79       |
| 28         | P0K1N1         | IM          | 13.95        | 359.91       |
| 29         | P0K1N1         | NZ          | 9.05         | 233.49       |
| 30         | P0K1N1         | NZ          | 16.55        | 426.99       |
| 31         | P0K1N1         | NZ          | 15.15        | 390.87       |
| 32         | P0K1N1         | NZ          | 16.05        | 414.09       |
| 33         | P0K1N2         | IM          | 25.85        | 666.93       |
| 34         | P0K1N2         | IM          | 28.15        | 726.27       |
| 35         | P0K1N2         | IM          | 20.95        | 540.51       |
| 36         | P0K1N2         | IM          | 23.75        | 612.75       |
| 37         | P0K1N2         | NZ          | 17.25        | 445.05       |
| 38         | P0K1N2         | NZ          | 10.45        | 269.61       |
| 39         | P0K1N2         | NZ          | 16.65        | 429.57       |
| 40         | P0K1N2         | NZ          | 14.95        | 385.71       |
| 41         | P1K0N1         | IM          | 26.95        | 695.31       |
| 42         | P1K0N1         | IM          | 19.25        | 496.65       |
| 43         | P1K0N1         | IM          | 23.55        | 607.59       |
| 44         | P1K0N1         | IM          | 24.45        | 630.81       |
| 45         | P1K0N1         | NZ          | 10.85        | 279.93       |
| 46         | P1K0N1         | NZ          | 12.35        | 318.63       |
| 47         | P1K0N1         | NZ          | 13.25        | 341.85       |
| 48         | P1K0N1         | NZ          | 10.25        | 264.45       |

(Continued)

Table C2 (Concluded)

| <u>Obs</u> | <u>Treatmt</u> | <u>Grid</u> | <u>Yield</u> |              |
|------------|----------------|-------------|--------------|--------------|
|            |                |             | <u>g/pot</u> | <u>kg/ha</u> |
| 49         | P1K0N2         | IM          | 26.05        | 672.09       |
| 50         | P1K0N2         | IM          | 26.65        | 687.57       |
| 51         | P1K0N2         | IM          | 26.65        | 687.57       |
| 52         | P1K0N2         | IM          | 23.55        | 607.59       |
| 53         | P1K0N2         | NZ          | 21.75        | 561.15       |
| 54         | P1K0N2         | NZ          | 19.25        | 496.65       |
| 55         | P1K0N2         | NZ          | 18.35        | 473.43       |
| 56         | P1K0N2         | NZ          | 21.65        | 558.57       |
| 57         | P1K1N1         | IM          | 18.55        | 478.59       |
| 58         | P1K1N1         | IM          | 15.95        | 411.51       |
| 59         | P1K1N1         | IM          | 20.55        | 530.19       |
| 60         | P1K1N1         | IM          | 15.65        | 403.77       |
| 61         | P1K1N1         | NZ          | 18.95        | 488.91       |
| 62         | P1K1N1         | NZ          | 17.85        | 460.53       |
| 63         | P1K1N1         | NZ          | 15.65        | 403.77       |
| 64         | P1K1N1         | NZ          | 17.05        | 439.89       |
| 65         | P1K1N2         | IM          | 32.75        | 844.95       |
| 66         | P1K1N2         | IM          | 25.05        | 646.29       |
| 67         | P1K1N2         | IM          | 30.35        | 783.03       |
| 68         | P1K1N2         | IM          | 32.35        | 834.63       |
| 69         | P1K1N2         | NZ          | 16.85        | 434.73       |
| 70         | P1K1N2         | NZ          | 17.05        | 439.89       |
| 71         | P1K1N2         | NZ          | 15.65        | 403.77       |
| 72         | P1K1N2         | NZ          | 16.55        | 426.99       |
| 73         | P2K2N3         | IM          | 46.65        | 1203.57      |
| 74         | P2K2N3         | IM          | 50.15        | 1293.87      |
| 75         | P2K2N3         | IM          | 57.55        | 1484.79      |
| 76         | P2K2N3         | IM          | 49.25        | 1270.65      |
| 77         | P2K2N3         | NZ          | 14.75        | 380.55       |
| 78         | P2K2N3         | NZ          | 19.55        | 504.39       |
| 79         | P2K2N3         | NZ          | 16.15        | 416.67       |
| 80         | P2K2N3         | NZ          | 18.65        | 481.17       |

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| 13. ABSTRACT (Maximum 200 words)<br><br><p>The use of Yazoo River dredged material for improving farmland considered marginal for cotton (<i>Gossypium hirsutum</i> L.) production was studied as an alternative to thick-layer confinement methods. The thick-layer confinement methods were not well received by landowners along the Yazoo River because of the loss of productive farmland by placement of confined disposal facilities (CDF) and lack of agricultural benefit. Disposal of Yazoo River dredged material in a shallow layer on marginal farmland not only provides for a means of dredged material disposal, but also improves marginal farmland making it more conducive to cotton production. Before the shallow-layer disposal concept was attempted, cotton response to Yazoo River dredged material was first studied on an existing thick-layer CDF.</p> <p>Dredged material was collected from an existing thick-layer CDF, and the entire CDF was characterized physically and chemically. Based on particle size analysis, the CDF was divided into three sections characterized as clay, silty clay loam, and loam. The clay section, which made up one third of the CDF, was not suitable for cotton production due to high moisture-holding capacity of the excess clay. Cotton</p> <p style="text-align: right;">(Continued)</p> |                                                             |                                            |                                                                             |                                                          |
| 14. SUBJECT TERMS<br>Agriculture<br>Cotton<br>Dredged material<br>Thick-layer disposal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                             |                                            | 15. NUMBER OF PAGES<br>60                                                   |                                                          |
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13. (Concluded).

was grown in an environmentally controlled greenhouse on dredged material collected from the silty clay loam and loam sections under various fertilizer treatments. Lint yields were equivalent to 351.5 and 20.0 kg ha<sup>-1</sup> with no fertilizer added to the silty clay loam and loam, respectively. Yields of 775.3 and 432.2 kg ha<sup>-1</sup> on the silty clay loam and loam, respectively, were obtained with an N rate of 168 kg ha<sup>-1</sup>. Lint yields were generally higher in the silty clay loam than the loam. Response to phosphorus and potassium additions was not as evident as response to additions of nitrogen and varied between the two test materials and nitrogen rates. Only nitrogen additions were determined necessary for substantial cotton production on Yazoo River dredged material, as tested.

Cotton was then planted on the CDF using normal agricultural practices, and nitrogen fertilizer was applied at 78 kg ha<sup>-1</sup> preplant and 78 kg ha<sup>-1</sup> sidedress actual nitrogen. A 0.4-ha (1-acre) test strip was harvested by normal mechanical means to determine the total lint yield. The deep-layer CDF produced an average yield of 870 kg ha<sup>-1</sup> of ginned lint or about 1.6 bales per acre. This yield was considered equivalent to average yields obtained in the area for that growing season. This indicates Yazoo River dredged material can provide a beneficial medium for cotton production.