MONITORING PLAN

PROJECT NO. PO-20 Red Mud Demonstration Project

ORIGINAL DATE: June 19, 1995
REVISED DATE: July 23, 1998

Preface

Pursuant to a CWPPRA Task Force decision on April 14, 1998, the original monitoring plan was reviewed for potential reduction in scope. Specifically, there were no reductions in scope, only changes to the format of the document.

Project Description

The Red Mud Demonstration Project is located in St. James Parish, Louisiana, about 14 mi east of Sorrento at 30º 03' 50" N and 90º 45' 35" W (figure 1). This demonstration project is to establish the suitability of red mud amended material for coastal wetland restoration. The main objectives of the project are to evaluate red mud amended material treatments to determine their suitability for creating and substaining marsh, and to determine what the potential environmental consequences are of the various marsh restoration options tested.

The red mud amended material sediment is a very fine grained material similar to fine clays. It is produced as a byproduct of extracting alumina from bauxite. The red mud amended material will be mixed with compost and dredged material sediment to produce a 50%/50% mixture in slurry form. The dredged material sediment from the Bonnet Carre Spillway will serve as a treatment control sediment for the red mud amended material mixture treatments. Plots will be filled with the red mud amended material mixtures and dredged material and allowed to dewater until they reach a consistency which will allow planting. After dewatering the depth of the treatment sediments should be approximately two feet, overlying agricultural soil which will be utilized as a base material.

The demonstration site is approximately 230 ft x 362 ft (figure 2). The site is divided into three treatments, which include red mud amended material with compost, red mud amended material with dredged material, and dredged material (used as a reference material). Each treatment is replicated three times for a total of nine plots, each plot being the same basic design. Before laying the plots, the entire area will be excavated by approximately 5 ft and an impermeable layer will be laid to prevent soil or groundwater contamination (figure 3). The plots will then be constructed on the impermeable layer. Treatment plots will be constructed at the proper elevation to simulate a typical brackish marsh flooding scenario. The brackish water master reservoir will be produced by proportionally mixing saline water with fresh water from the freshwater master reservoir simulating the salinity regime of Grand Bayou located at the Bully Camp (figure 4). Water from the brackish water master reservoir is pumped into the tidal reservoirs and tidal action is simulated similar to the Grand Bayou area. A recycle reservoir may be used to recycle brackish water after each tidal event. Any water to be recycled will be closely monitored and replaced as necessary.

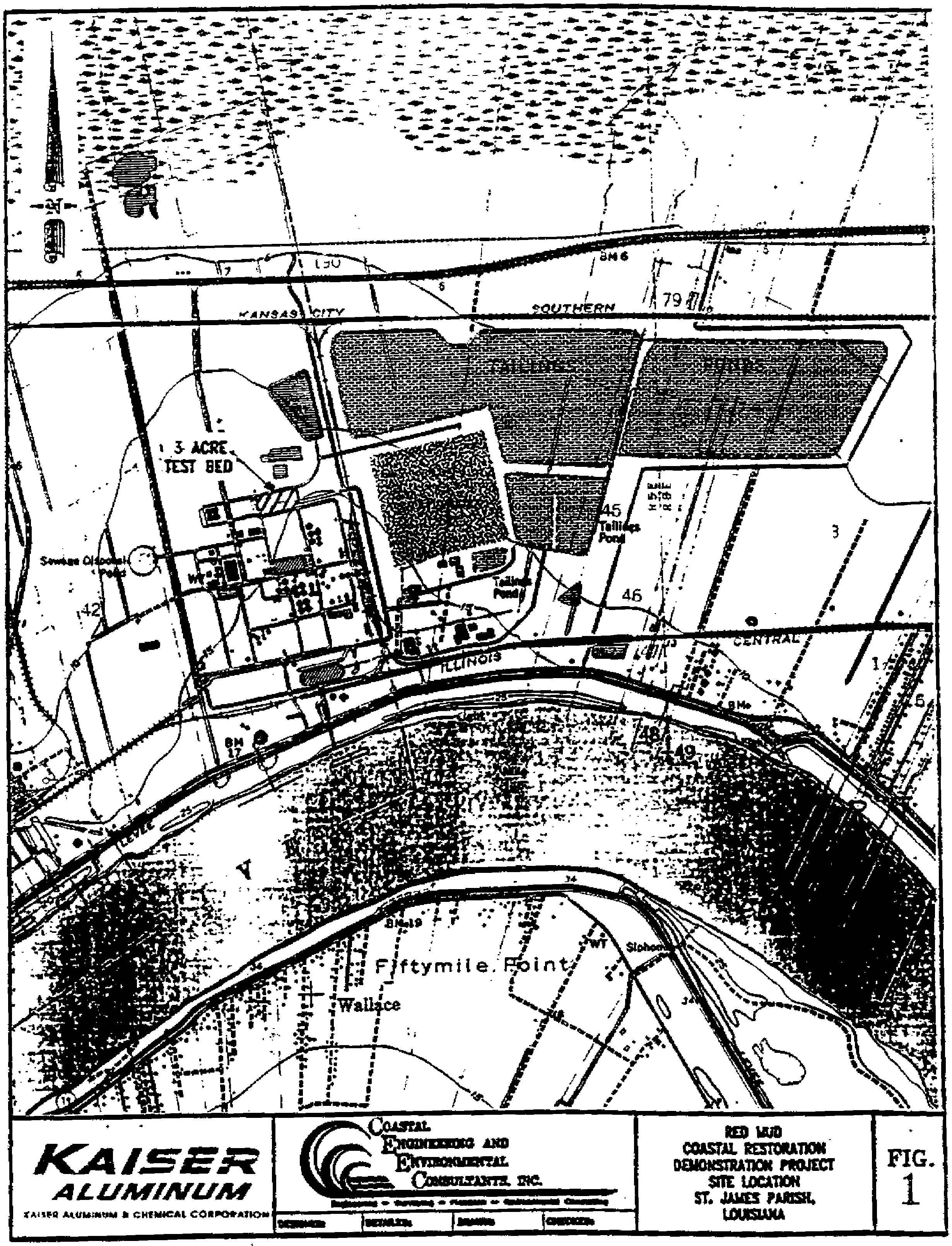

Figure 1 . Location of Red Mud Demonstration Project (PO-20).

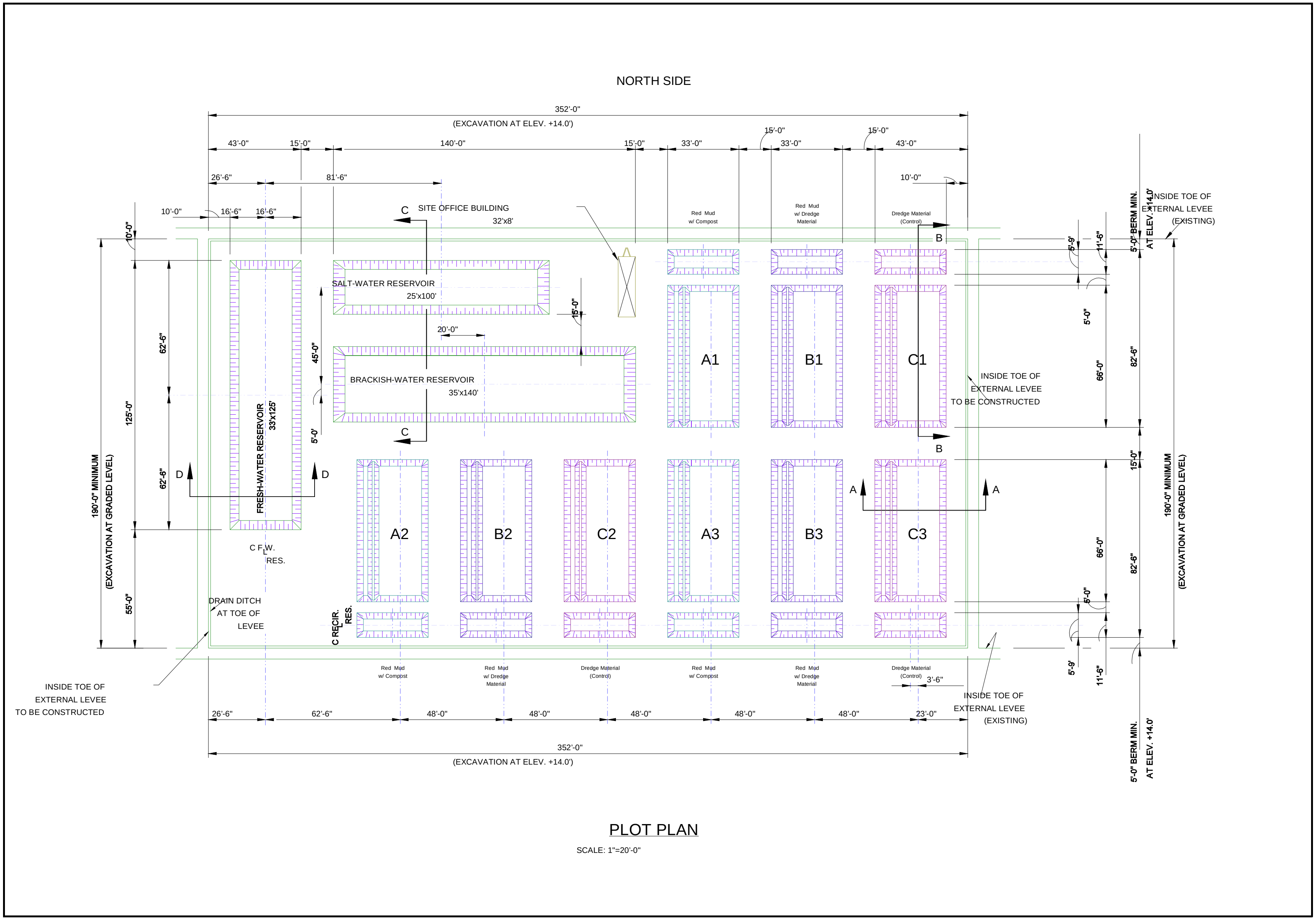

Figure 2. Layout of the reservoirs and treatment plots.

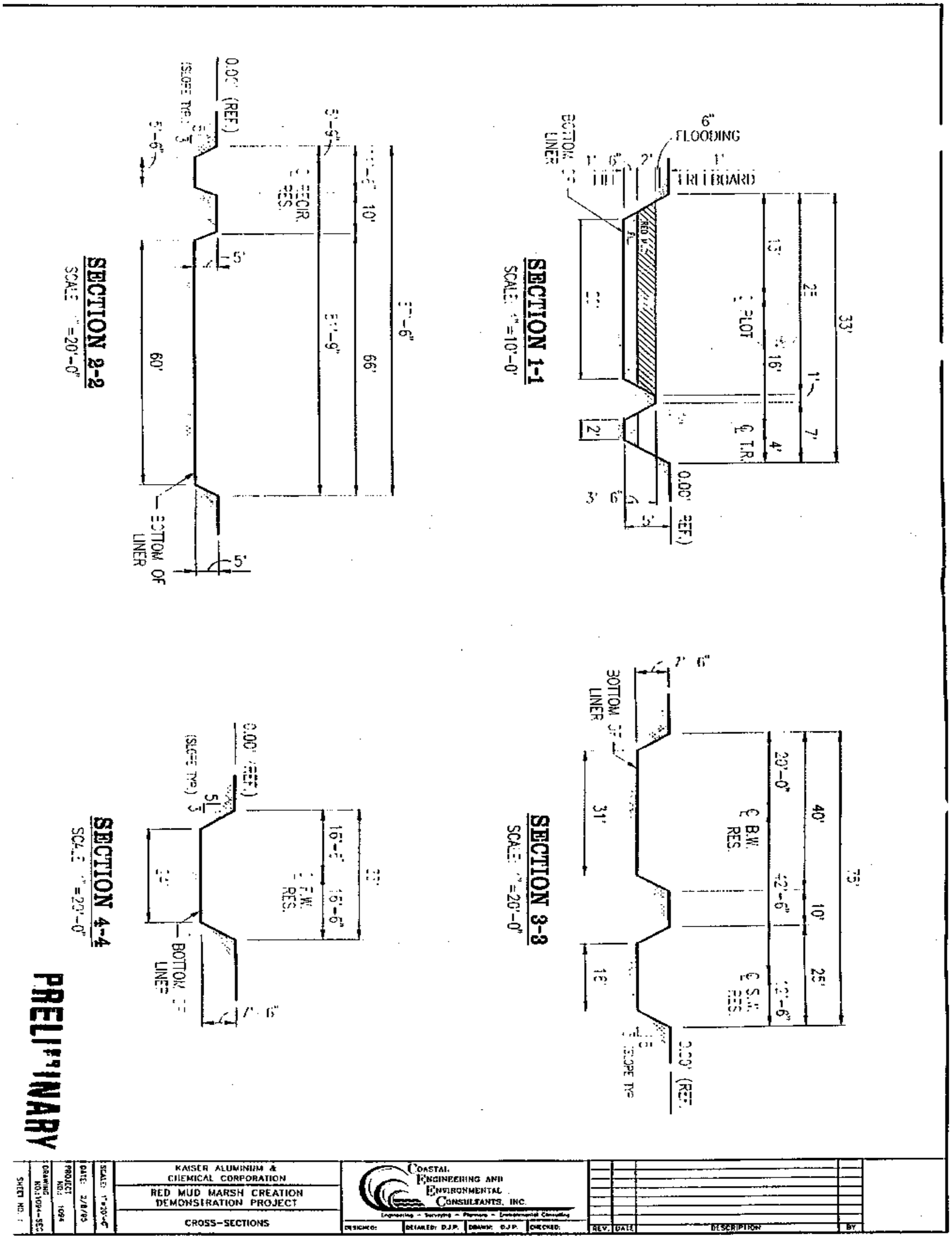

Figure 3 . Red Mud Demonstration Project (PO-20) treatment unit cross section.

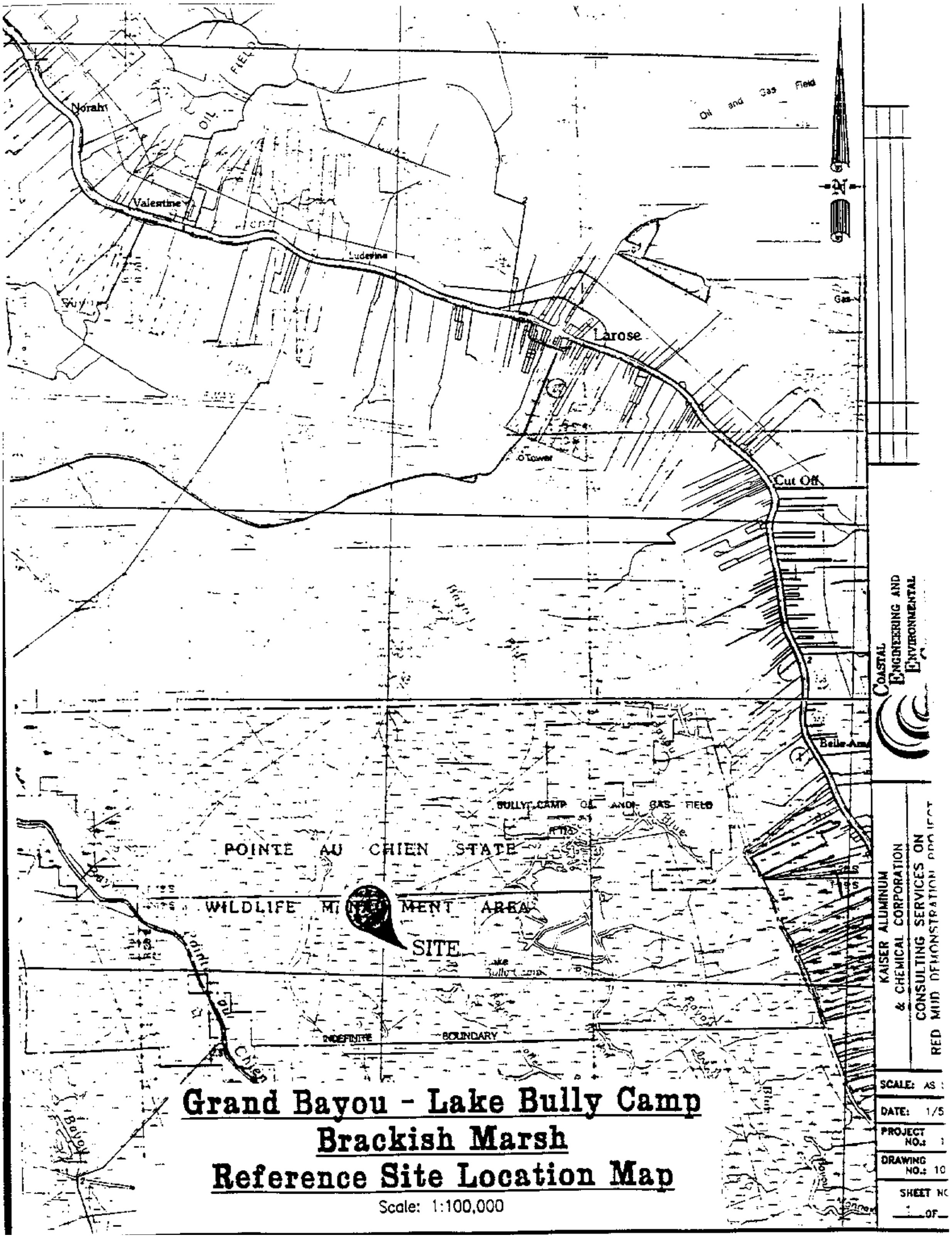

Figure 4 . Red Mud Demonstration Project (PO-20) brackish marsh reference site location.

In order to assess marsh plant growth and development on the demonstration treatments, two typical brackish marsh species *Spartina alterniflora* (saltmarsh cordgrass) and *Spartina patens* (saltmeadow cordgrass) will be planted. The planted portions of the plots will be approximately 20 ft x 60 ft and will be planted with half *S. alterniflora* and half *S. patens*. Plants will be planted on 2-ft centers, with a total of 300 plants per plot. Planting will be done once the sediments have consolidated enough to ensure that the plants will remain upright after planting.

<u>Plan Objectives</u>

1. Evaluate red mud amended material treatments to determine their suitability for creating and sustaining marsh.

2. Determine what the environmental consequences are of the various marsh restoration options tested.

<u>Specific Goals</u>

1. Will a red mud amended material-based marsh substrate support marsh plant growth, and will marsh plant survival and growth in red mud amended material sediment be comparable to that in a dredged material sediment?

2. Which red mud amended material treatment (red mud amended material + compost, red mud amended material + dredged material) provides the best plant growth?

3. Will red mud amended material and associated constituents stay where they are placed?

4. Is red mud amended material toxic to exposed organisms (e.g., benthic macroinvertebrates) that live in or on the marsh?

5. Will red mud amended material release contaminants (metals) to the water column in amounts toxic to aquatic organisms?

6. Will metals in red mud amended material bioaccumulate in plants and/or invertebrates to levels of concern to higher trophic levels?

<u>Reference Area</u>

The reference sediments will be tested and evaluated for benthic toxicity in a similar fashion to the project sediments to provide a means to achieve statistically valid comparisons. Brackish marsh reference sediment will be collected from the Grand Bayou marsh and from South Falgout Canal (figure 4). This will provide a measurement of the project's success. Statistical analyses will be set up to compare all treatments and the natural marsh sediment reference.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Settlement — As the red mud amended material dewaters, settlement will be monitored. Survey rods will be placed in all plots to measure settlement. Settlement will be measured once every 15 days for 3 mos, or until changes are no longer measurable, and then quarterly thereafter.

2. Vegetation — Vegetation characteristics will be measured that reflect successful establishment and health of marsh plants, including plant or stem density by species; percent cover of vegetation; stem height; nondestructive sampling for biomass (by statistically relating stem height and density to biomass) also by species; species composition; and percent survival. The final sampling date will include destructive sampling for aboveground biomass. Nondestructive sampling would be conducted three times per year, once in the middle of the growing season (May/June), once in the summer (July/August), and once late in the growing season (September/October). Vegetation sampling would continue over the 2-yr life of the project to assess trends over time.

3. Soils and Pore Water — Soil pH and redox (reduction-oxidation potential) will be measured in each experimental plot near the surface (approximately 3 cm), in the root zone (25 cm), and below the root zone in the underlying experimental sediment (80 cm). Triplicate measurements will be made in each experimental cell. Three soil samples per cell will also be taken at 25 cm to measure soil bulk density, particle size distribution, soil organic content, acid volatile sulfides (AVS), and simultaneously extractable nutrients and extracted metals using the appropriate pH test method or equivalent methodology. The metals to be analyzed will be cadmium, chromium, copper, lead, manganese, nickel, zinc, aluminum, and mercury. These metals, except for mercury, will be analyzed across all monitoring elements. These were identified as the metals of potential concern based on results of previous greenhouse and laboratory studies that showed in at least one sediment or water sample these metals could occur in

concentrations that exceeded either sediment (NOAA 1990; EPA 1994) or water quality (EPA 1986) standards or action levels. These standards will be applied to all water and sediment samples taken.

Triplicate pore water samples will be collected and composited from each experimental cell at 3, 25, and 80 cm. The deeper samples will represent collections of leachate. Samples will be collected from permanently installed, small diameter plastic tubes inserted into the substrate. The lowest 2 cm of the tubes are perforated and covered with cheesecloth, and upper ends are sealed to prevent oxygen diffusion. Pore water samples will be filtered through a 0.45 micron filter and analyzed for salinity, pH, dissolved oxygen, soluble nutrients, and soluble metals.

The amount of nutrients and metals released by the red mud amended material during the project, and thereby available to adjacent habitats in field placement, will be estimated. The total amount of nutrients and metals in the red mud amended material treatments will be estimated on a square meter basis from soil bulk density, thickness of red mud amended material, and the concentration of extractable nutrients and metals in the red mud amended material treatments. Estimates based on initial conditions and final conditions will be made and compared to estimate the amount of nutrients and metals released by the red mud amended material treatments during the project. Similar estimates will be made for the dredged material treatment control plots. These data will allow us to predict how much metals and nutrients will be released into a watershed by red mud amended material projects based on the number of acres of marsh to be created and the thickness of the created marsh.

Soil pH and redox will be measured once a month for the first 6 mos, at 1 yr and 2 yrs. Particle size distribution and soil bulk density will be measured at the beginning and end of the demonstration. Samples for soil organic content, AVS, simultaneously extractable nutrients and extracted metals, and pore water will be measured at 3 mo, 6 mo, 1 yr, 1.5 yrs, 2 yrs and at one low water time period during the demonstration, except for mercury which will be analyzed in the bulk sediment once at 14 days and once on the final sampling date. All testing in this demonstration will be synchronous, if applicable.

4. Surface Water and Suspended Sediment

Surface water samples will be collected from the lower edge of the cells during the simulated tidal drawdown, from the recirculation reservoirs and from the brackish reservior. Representative samples allowing for temporal variations will be taken over the ebb tidal event (early, mid, and late in the event) for the first month to account for short-term changes that may occur in surface water concentrations of constituents of interest; and subsequently will be taken at the time of the previously determined highest concentrations of constituents of interest. Surface water samples will be analyzed for pH, salinity, dissolved oxygen, soluble and total nutrients, soluble and total metals (to account for metals associated with suspended sediments) and total suspended solids.

Surface water samples will be collected frequently at the beginning of the demonstration project, because it is expected that the greatest changes in chemistry and mobility of constituents would take place right after the sediments are placed in the experimental plots. If feasible, the sampling will coincide with a major rainfall event. The proposed frequency of collection is twice per week for the first month, daily during the ebb tide for the second month, and will then probably be decreased to once per month or once every two months for the duration of the project. When sampling frequency is reduced, the final sampling frequency will be based on the degree of variation observed during the inital two months of sampling.

5. Plant Bioaccumulation

Within each experimental cell, duplicate 30-cm^2 areas will be randomly selected, and all aboveground plant biomass in that area will be harvested for metals and nutrients analyses. The locations of sampled areas will be recorded so that the same area is not sampled again during the project. The metals to be measured will be the same metals measured in water and soils (cadmium, chromium, copper, lead, manganese, nickel, zinc, and aluminum). Fresh weight and dry weight of the plant material, and nutrient content of the plants will also be measured. Bioaccumulation will be measured in below-ground biomass at the end of the demonstration if an adequate, uncontaminated subsample exists.

Plants will be sampled for metals and nutrient analyses twice each year; once in the beginning of the growing season (May/June), and once close to the end of the growing season (September/October) but before the plants become senescent and turn brown.

6. Benthic Toxicity

Sediment samples from one replicate of each test cell will be collected to conduct laboratory sediment bioassays. In addition to the dredged material from demonstration test plots, natural marsh sediment will be collected and serve as the reference and clean sediment with the same grain size as red mud amended material will serve as the control in accordance with the Inland Testing Manual (EPA and DOA 1994). Brackish marsh sediment will be collected from the Grand Bayou marshes, as well as from South Falgout Canal (figure 4). Two benthic species will be used for each test. The testing will consist of a 28-day chronic sediment test with *Hyalella azteca* and a 28-day chronic reproductive toxicity test with *Leptocheirus plumosus* using growth, reproduction, and survival as end points (species from Draft Inland Testing Manual, Environmental Protection Agency (EPA) and Department of the Army (DOA) 1994). The animals will be fed throughout the test. A second test will be a pore water test (Carr and Chapman 1995) and will involve a minimum of two species to be mutually agreed upon. Results of the pore water testing will provide life-cycle toxicity testing. These tests fall under Tier IV, and are not generally considered to be routine. Therefore, this testing will include a rigorous assessment of the performance of the test including a wide range of controls. A Scientific Analytical Committee will be established by the TAG to assist in the evaluation of benthic toxicity and bioaccumulation testing.

To account for the possibility that over time in a marsh situation, pH and redox characteristics of red mud amended material may gradually change in a manner that may affect the bioavailability of metals, chronic bioassays will be conducted three times over the course of the demonstration project. The proposed frequency of testing is 14 days after initiation of the project; at year one, and year two.

7. Benthic Bioaccumulation of Metals

Benthic bioaccumulation of metals will be assessed with the 28-day laboratory bioaccumulation tests in the laboratory. The same combination of sediment types will be tested as for benthic toxicity. Two benthic invertebrates species will be tested, based on species selection guidance in the Inland Testing Manual, provided that they include a surface polychaete and a bivalve (e.g., *Nereis virens* and *Macoma nasuta*), they have adequate biomass for chemical analysis, and that they survive in treatment and reference sediments. At the end of the exposures, all live test organisms will be analyzed for metals content, assaying for the same metals measured in water and soils (cadmium, chromium, copper, lead, manganese, nickel, zinc, mercury and aluminum) with endpoints, procedures and species from the Inland Testing Manual (EPA and DOA 1994). Testing frequency will be three times during the course of the demonstration project. The proposed frequency of testing is 14 days after the initiation of the project; at year one, and year two.

Anticipated Statistical Tests and Hypotheses

Descriptive and summary statistics will be conducted on data collected during project implementation (and post-project implementation) to examine the treatment effects (red mud amended material + compost, red mud amended material + dredged material). Parametric (analysis of variance [ANOVA], Fisher's Least Significant Difference), and nonparametric tests will be used to compare various characteristics (e.g., health of marsh plants, aboveground biomass, soil pH and redox, soil bulk density, particle size distribution, organic matter content, acid volatile sulphides, concentration of the metals of potential concern (cadmium, chromium, copper, lead, manganese, mercury, nickel, zinc, and aluminum), plant bioaccumulation, benthic organism bioaccumulation, and benthic toxicity) of the treatments. The model assumptions will be tested to check the validity of the statistical models. For the three treatments considered in this project, comparisons of metal concentrations will be done with action (standard) levels (derived from EPA and DOA 1994; EPA 1986; National Oceanic and Atmospheric Administration (NOAA) 1990; and EPA 1994). For bioaccumulation, simple kinetic models will be used with data collected over 2 yrs to project tissue concentrations of metals at the steady state. Statistical analyses of benthic toxicity and benthic bioaccumulation will conform with the methods listed in the Inland Testing Manual (USEPA and DOA 1994).

The following hypotheses correspond with the monitoring elements (above) and will be used to evaluate the accomplishment of the project goals (above).

1. *Hypothesis:*

H_0: Mean vertical settling for red mud amended material + compost treatment = mean vertical settling for red mud amended material + dredged material treatment = mean vertical settling for dredged material treatment (i.e., control).

H_a: Mean vertical settling is not the same for all treatments.

then if: H_0 is rejected then we test:

a) H_{01}: Mean vertical settling for red mud amended material + compost treatment = mean vertical settling for dredged material treatment.

H_{a1}: Mean vertical settling is not the same for both treatments.

and b) H_{02}: Mean vertical settling for red mud amended material + dredged material treatment = mean vertical settling for dredged material treatment.

H_{a2}: Mean vertical settling is not the same for both treatments.

In each case (a and b), if the null hypothesis is rejected then we test further against one- sided alternatives.

If we fail to reject the null hypothesis, we will investigate for negative effects.

2. *Hypothesis:*

H_0: Mean vegetation characteristic (plant or stem density by species, percent cover, stem height, above- and below-ground biomass by species, species composition and percent survival by species) for red mud amended material + compost treatment = mean vegetation characteristic (plant or stem density by species, percent cover, stem height, above- and below-ground biomass by species, species composition and percent survival by species) for red mud amended material + dredged material treatment = mean vegetation characteristic (plant or stem density by species, percent cover, stem height, above- and below-ground biomass by species, species composition and percent survival by species) for dredged material treatment (i.e., control).

H_a: Mean vegetation characteristics are not the same for all treatments.

then if: H_0 is rejected then we test:

a) H_{01}: Mean vegetation characteristics for red mud amended material + compost treatment = mean vegetation characteristics for dredged material treatment (i.e., control).

H_{a1}: Mean vegetation characteristics are not the same for both treatments.

and b) H_{02}: Mean vegetation characteristics for red mud amended material + dredged material treatment = mean vegetation characteristics for dredged material treatment (i.e., control).

H_{a2}: Mean vegetation characteristics are not the same for both treatments.

In each case (a and b), if the null hypothesis is rejected then we test further against one- sided alternatives.

If we fail to reject the null hypothesis, we will investigate for negative effects.

3A. *Hypothesis:*

H_0: Mean soil characteristics (pH, redox, particle bulk density, particle size distribution, organic matter content, acid volatile sulfides (AVS), and simultaneously extractable nutrients and extracted metals (cadmium, chromium, copper, lead, manganese, mercury, nickel, zinc, and aluminum)) for red mud amended material + compost treatment = mean soil characteristics for red mud amended material + dredged material treatment = mean soil characteristics (pH, redox, particle bulk density, particle size distribution, organic matter content, acid volatile sulfides (AVS), and simultaneously extractable nutrients and extracted metals (cadmium, chromium, copper, lead, manganese, mercury, nickel, zinc, and aluminum) for dredged material treatment (i.e., control).

H_a: Mean soil characteristics are not the same for all treatments.

then if: H_0 is rejected then we test:

a) H_{01}: Mean soil characteristics for red mud amended material + compost treatment = mean soil characteristic for dredged material treatment (i.e., control).

H_{a1}: Mean soil characteristics are not the same for both treatments.

and b) H_{02}: Mean soil characteristics for red mud amended material + dredged material treatment = mean soil characteristic for dredged material treatment (i.e., control).

H_{a2}: Mean soil characteristics are not the same for both treatments.

In each case (a and b), if the null hypothesis is rejected then we test further against one- sided alternatives.

Also, we can test SC_{R+C}, SC_{R+D}, and SC_D against some fixed action level, say, SC_o.

Test: (i) H^*_{01}: $SC_{R+C} \leq SC_o$ vs. H^*_{a1}: $SC_{R+C} > SC_o$.

(ii) H^*_{02}: $SC_{R+D} \leq SC_o$ vs. H^*_{a2}: $SC_{R+D} > SC_o$..

(iii) H^*_{03}: $SC_D \leq SC_o$ vs. H^*_{a3}: $SC_D > SC_o$.

If we fail to reject the null hypothesis, we will investigate for negative effects.

3B. *Hypothesis:*

H_0: $PW_{R+C} = PW_{R+D} = PW_D$

H_a: "=" does not hold at least in one place

where: PW_{R+C}= mean pore water characteristics (salinity, pH, dissolved oxygen, soluble nutrients, and soluble metals (cadmium, chromium, copper, lead, manganese, mercury, nickel, zinc, and aluminum)) for red mud amended material + compost treatment.

PW_{R+D}= mean pore water characteristics (salinity, pH, dissolved oxygen, soluble nutrients, and soluble metals (cadmium, chromium, copper, lead, manganese, mercury, nickel, zinc, and aluminum)) for red mud amended material + dredged material treatment.

PW_D= mean pore water characteristics (salinity, pH, dissolved oxygen, soluble nutrients, and soluble metals (cadmium, chromium, copper, lead, manganese, mercury, nickel, zinc, and aluminum)) for dredged material treatment (i.e., control).

then if: H_0 is rejected then we test:

a) H_{01}: $PW_{R+C} = PW_D$ vs. H_{a1}: $PW_{R+C} \neq PW_D$

and b) H_{02}: $PW_{R+D} = PW_D$ vs. H_{a2}: $PW_{R+D} \neq PW_D$

In each case (a and b), if the null hypothesis is rejected then we test further against one- sided alternatives.

Also, we can test PW_{R+C}, PW_{R+D}, and PW_D against some fixed action level, say, PW_o.

Test: (i) H^*_{01}: $PW_{R+C} \leq$ Pwo vs. H^*_{a1}: $PW_{R+C} > PW_o$.

(ii) H^*_{02}: $PW_{R+D} \leq PW_o$ vs. H^*_{a2}: $PW_{R+D} > PW_o$.

(iii) H^*_{03}: $PW_D \leq PW_o$ vs. H^*_{a3}: $PW_D > PW_o$.

If we fail to reject the null hypothesis, we will investigate for negative effects.

4. *Hypothesis:*

H_0: $SFW_{R+C} = SFW_{R+D} = SFW_D$

H_a: "=" does not hold at least in one place

where: SFW_{R+C}= mean surface water characteristics (pH, salinity, dissolved oxygen, soluble and total nutrients, soluble and total metals (cadmium, chromium, copper, lead, manganese, nickel, zinc, and aluminum)), and total suspended sediments for red mud amended material + compost treatment.

SFW_{R+D}= mean surface water characteristics (pH, salinity, dissolved oxygen, soluble and total nutrients, soluble and total metals (cadmium, chromium, copper, lead, manganese, nickel, zinc, and aluminum)), and total suspended sediments for red mud amended material + dredged material treatment.

SFW_D= mean surface water characteristics (pH, salinity, dissolved oxygen, soluble and total nutrients, soluble and total metals (cadmium, chromium, copper, lead, manganese, nickel, zinc, and aluminum)), and total suspended sediments for dredged material treatment (i.e., control).

then if: H_0 is rejected then we test:

a) H_{01}: $SFW_{R+C} = SFW_D$ vs. H_{a1}: $SFW_{R+C} \neq SFW_D$

and b) H_{02}: $SFW_{R+D} = SFW_D$ vs. H_{a2}: $SFW_{R+D} \neq SFW_D$

In each case (a and b), if the null hypothesis is rejected then we test further against one- sided alternatives.

Also, we can test SFW_{R+C}, SFW_{R+D}, and SFW_D against some fixed action level, say, SFW_o.

Test: (i) H^*_{01}: $SFW_{R+C} \leq SFW_o$ vs. H^*_{a1}: $SFW_{R+C} > SFW_o$.

(ii) H^*_{02}: $SFW_{R+D} \leq SFW_o$ vs. H^*_{a2}: $SFW_{R+D} > SFW_o$.

(iii) H^*_{03}: $SFW_D \leq SFW_o$ vs. H^*_{a3}: $SFW_D > SFW_o$.

If we fail to reject the null hypothesis, we will investigate for negative effects.

5. *Hypothesis:*

H_0: $PB_{R+C} = PB_{R+D} = PB_D$

H_a: "=" does not hold at least in one place

where:

PB_{R+C}= mean plant bioaccumulation (cadmium, chromium, copper, lead, manganese, nickel, zinc, aluminum, nutrients) for red mud amended material + compost treatment.

PB_{R+D}= mean plant bioaccumulation (cadmium, chromium, copper, lead, manganese, nickel, zinc, aluminum, nutrients) for red mud amended material + dredged material treatment.

PB_D= mean plant bioaccumulation (cadmium, chromium, copper, lead, manganese, nickel, zinc, aluminum, nutrients) for dredged material treatment (i.e., control).

then if: H_0 is rejected then we test:

a) H_{01}: $PB_{R+C} = PB_D$ vs. H_{a1}: $PB_{R+C} \neq PB_D$

and b) H_{02}: $PB_{R+D} = PB_D$ vs. H_{a2}: $PB_{R+D} \neq PB_D$

In each case (a and b), if the null hypothesis is rejected then we test further against one- sided alternatives.

Also, we can test PB_{R+C}, PB_{R+D}, and PB_D against some fixed action level, say, PB_o.

Test: (i) H^*_{01}: $PB_{R+C} \leq PB_o$ vs. H^*_{a1}: $PB_{R+C} > PB_o$.

(ii) H^*_{02}: $PB_{R+D} \leq PB_o$ vs. H^*_{a2}: $PB_{R+D} > PB_o$.

(iii) H^*_{03}: $PB_D \leq PB_o$ vs. H^*_{a3}: $PB_D > PB_o$.

If we fail to reject the null hypothesis, we will investigate for negative effects.

6. *Hypothesis:*

H_0: $BTL_{R+C} = BTL_{R+D} = BTL_D$

H_a: "=" does not hold at least in one place

where:

BTL_{R+C}= mean benthic toxicity using the *Leptocheirus* test for red mud amended material + compost treatment.

BTL_{R+D}= mean benthic toxicity using the *Leptocheirus* test for red mud amended material + dredged material treatment.

BTL_D= mean benthic toxicity using the *Leptocheirus* test for dredged material treatment (i.e., control).

then if: H_o is rejected then we test:

a) H_{01}: $BTL_{R+C} = BTL_D$ vs. H_{a1}: $BTL_{R+C} \neq BTL_D$

and b) H_{02}: $BTL_{R+D} = BTL_D$ vs. H_{a2}: $BTL_{R+D} \neq BTL_D$

In each case (a and b), if the null hypothesis is rejected then we test further against one- sided alternatives.

Also, we can test BTL_{R+C}, BTL_{R+D}, and BTL_D against some fixed action level, say, BTL_o and against reference sediments (BTL_R).

Test: (i) H^*_{01}: $BTL_{R+C} \leq BTL_o$ vs. H^*_{a1}: $BTL_{R+C} > BTL_o$.

H^*_{01}: $BTL_{R+C} \leq BTL_R$ vs. H^*_{a1}: $BTL_{R+C} > BTL_{R.}$

(ii) H^*_{02}: $BTL_{R+D} \leq BTL_o$ vs. H^*_{a2}: $BTL_{R+D} > BTL_o$.

H^*_{02}: $BTL_{R+D} \leq BTL_R$ vs. H^*_{a2}: $BTL_{R+D} > BTL_R$.

(iii) H^*_{03}: $BTL_D \leq BTL_o$ vs. H^*_{a3}: $BTL_D > BTL_o$.

H^*_{03}: $BTL_{R+D} \leq BTL_R$ vs. H^*_{a3}: $BTL_{R+D} > BTL_{R.}$

Identical hypothesis testing will be conducted with *Hyalella azteca*.
If we fail to reject the null hypothesis, we will investigate for negative effects.

7. *Hypothesis:*

H_0: $BB_{R+C} = BB_{R+D} = BB_D$

H_a: "=" does not hold at least in one place

where: BB_{R+C}= mean benthic accumulation of metals (cadmium, chromium, copper, lead, manganese, nickel, zinc, and aluminum) for red mud amended material + compost treatment.

BB_{R+D}= mean benthic accumulation of metals (cadmium, chromium, copper, lead, manganese, nickel, zinc, and aluminum) for red mud amended material + dredged material treatment

BB_D= mean benthic accumulation of metals (cadmium, chromium, copper, lead, manganese, nickel, zinc, and aluminum) for dredged material treatment (i.e., control).

then if: H_o is rejected then we test:

a) H_{01}: $BB_{R+C} = BB_D$ vs. H_{a1}: $BB_{R+C} \neq BB_D$

and b) H_{02}: $BB_{R+D} = BB_D$ vs. H_{a2}: $BB_{R+D} \neq BB_D$

In each case (a and b), if the null hypothesis is rejected then we test further against one- sided alternatives.

Also, we can test BB_{R+C}, BB_{R+D}, and BB_D against some fixed action level, say, BB_o.

Test: (i) H^*_{01}: $BB_{R+C} \leq Bbo$ vs. H^*_{a1}: $BB_{R+C} > BB_o$.

H^*_{01}: $BB_{R+C} \leq BB_R$ vs. H^*_{a1}: $BB_{R+C} > BB_{R.}$

(ii) H^*_{02}: $BB_{R+D} \leq Bbo$ vs. H^*_{a2}: $BB_{R+D} > BB_o$.

H^*_{02}: $BB_{R+D} \leq BB_R$ vs. H^*_{a2}: $BB_{R+D} > BB_R$.

(iii) H^*_{03}: $BB_D \leq BB_o$ vs. H^*_{a3}: $BB_D > BB_o$.

H^*_{03}: $BB_{R+D} \leq BB_R$ vs. H^*_{a3}: $BB_{R+D} > BB_{R.}$

Test: (i) H^*_{01}: $BB_{R+C} \leq Bbo$ vs. H^*_{a1}: $BB_{R+C} > BB_o$.

(ii) H^*_{02}: $BB_{R+D} \leq Bbo$ vs. H^*_{a2}: $BB_{R+D} > BB_o$..

(iii) H^*_{03}: $BB_D \leq BB_o$ vs. H^*_{a3}: $BB_D > BB_o$.

If we fail to reject the null hypothesis, we will investigate for negative effects.

Note: Available ecological data, both descriptive and quantitative, will be evaluated in concert with statistical analyses to determine overall project success.

Notes

1.	Implementation:	Start cell construction End cell construction	June 1995 August 1995
		Start planting End Planting	April 1999 May1999
2.	EPA Point of Contact:	Jeanene Peckham	(214) 665-8330.
3.	DNR Project Manager: DNR Monitoring Manager:	Brian Kendrick John Troutman	(504) 449-5057 (504) 342-1952

4. The three year monitoring plan development and implementation budget for this project is $387,364. A comprehensive report will be available in May 2002. This report will describe the status and effectiveness of the project.

5. Kaiser Aluminum will be responsible for project operation and maintenance.

6. References:

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