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FIELD STUDIES OF BEACH CONES AS COASTAL EROSION CONTROL/REVERSAL DEVICES FOR AREAS WITH SIGNIFICANT OIL AND GAS ACTIVITIES

CONTRACT DE-AC22-92MT920002

Chemical Engineering Department
Tulane University

March 15, 1993

Contract Date: February 24, 1992

Anticipated Completion Date: February 23, 1994

Government Award: $175,979 for first year

Program Manager: Dr. Victor J. Law

Principal Investigator: Dr. Victor J. Law

Technical Project Officer (COR): Dr. Brent W. Smith

Reporting Period: February 24, 1992 - February 23, 1993

This draft report has not been reviewed by the U. S. Department of Energy, nor has it been approved for application. Approval, when given, does not signify that the contents necessarily reflect the views and policies constitute endorsement of recommendation for use.

US/DOE Patent Clearance is not required prior to publication of this document

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Abstract

The primary objective of this project is to evaluate the utility of a device called the "beach cone" in combating coastal erosion. Seven initial sites were selected for testing beach cones in a variety of geometric configurations. Permits were obtained from the State of Louisiana and the U. S. Army Corps of Engineers to perform the work associated with this study. Six hundred beach cones were actually installed at six of the sites in late July and early August, 1992. One of the initial sites was abandoned because it was found to be unsuitable for beach cone placement. The test sites have been observed for six months and preliminary findings indicate that beach cones accreted significant amounts of materials along the beach of a barrier island. At other test sites, accretion rates have been less dramatic but importantly, no significant additional erosion has occurred, which is a positive result. It is too soon to state the categorical success of the beach cones, but results to date are encouraging.

Executive Summary

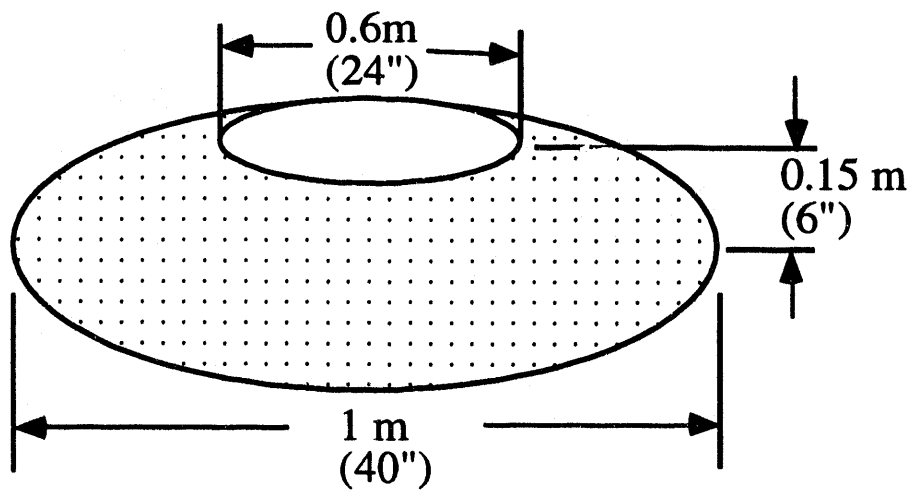
Beach cones are hollow truncated conical structures made of lightweight concrete with a larger diameter of about 1 m and a smaller diameter of about 0.6 m and a thickness of about 3 cm. Each cone weighs approximately 40 kg. Beach cones are typically deployed in a pyramid of two or three layers with a typical arrangement of two rows of six cones on the bottom and a single row of five cones on the top layer. Pairs of cones are connected by an interstitial "wave block" which is molded of the same concrete material to fit the contours of the cones. Each wave block weighs about 35 kg and has a two inch vertical hole through it so that PVC pipe can be driven through the wave block and into the underlying media. The geometry of a pyramid of cones is such that layers of wave blocks align so that the PVC pipe stabilizes the entire structure.

The main objective of the present study is to deploy 600 beach cones and associated wave blocks in areas where coastal erosion has been a serious problem and to assess the utility of these devices in combating the problem of coastal erosion. Seven potential sites were selected and cones were installed at six of these sites; one site was abandoned since its shoreline had no slope at all, which was found to be a requirement for effective beach cone installation. The six experimental sites included an eroded marsh area between two bays, the shoreline of a bayou, the shoreline of a bay, the entrance to a pipeline canal, a second eroded marsh between two bays (the second of these was an area where more sediment was thought to be available than for the first one), and an eroded shoreline of a barrier island. All cones were deployed in late July and early August, 1992.

The test sites have been observed for six months and preliminary findings indicate that beach cones accreted significant amounts of materials along the beach of the barrier island site. At other test sites, accretion rates have been less dramatic but importantly, no significant additional erosion has occurred. It is too soon to state the categorical success of the beach cones, but results to date are encouraging. It is of interest to note that all of the cones survived Hurricane Andrew intact. A portion of the barrier island adjacent to the test site was destroyed by the hurricane. Unfortunately, the portion of the island that was lost was the primary "control" area for the project and thus it will be difficult to judge the ultimate success or failure of the beach cones in absolute terms since the basis for direct measurement was lost. Other landmarks such as nearby pilings are now being used to evaluate changes in the elevations of the test site over time.

Introduction

Coastal Louisiana has become the focus of an intense national debate concerning the control of coastal erosion. Although there are many causes of erosion in this area, the rate of beach and marsh retrogradation has been accelerated by man's activities. The goals of the current project are to test and evaluate the effectiveness of a particular device call the "beach cone" with regard to arresting erosion and possibly reversing the process by accreting sediments. A description of a beach cone appears in Figure 1.



Weight : 40 kg (88 lb) Weight in Water: 20kg (44 lb)
Material of Construction: Lightweight Concrete

Figure 1: Schematic drawing of one beach cone.

Most often, beach cones are deployed in pyramids of two or three layers. An example of such a configuration is shown in Figure 2. In that figure, the pyramid is three-high with the bottom layer consisting of 15 cones with interstitial "wave blocks" that interlock adjacent cones. The second layer has 8 cones and the top layer consists of three cones and two wave blocks, so the entire pyramid contains 26 cones. Although not shown in the figure, each wave block is cast with a nominal two-inch vertical hole through which PVC pipe is driven. The geometry of the pyramid is such that the holes in the wave blocks align vertically so that the PVC pipe can be driven directly through the pyramid and into the sediment beneath. This gives the pyramid great stability but does not render it entirely rigid.

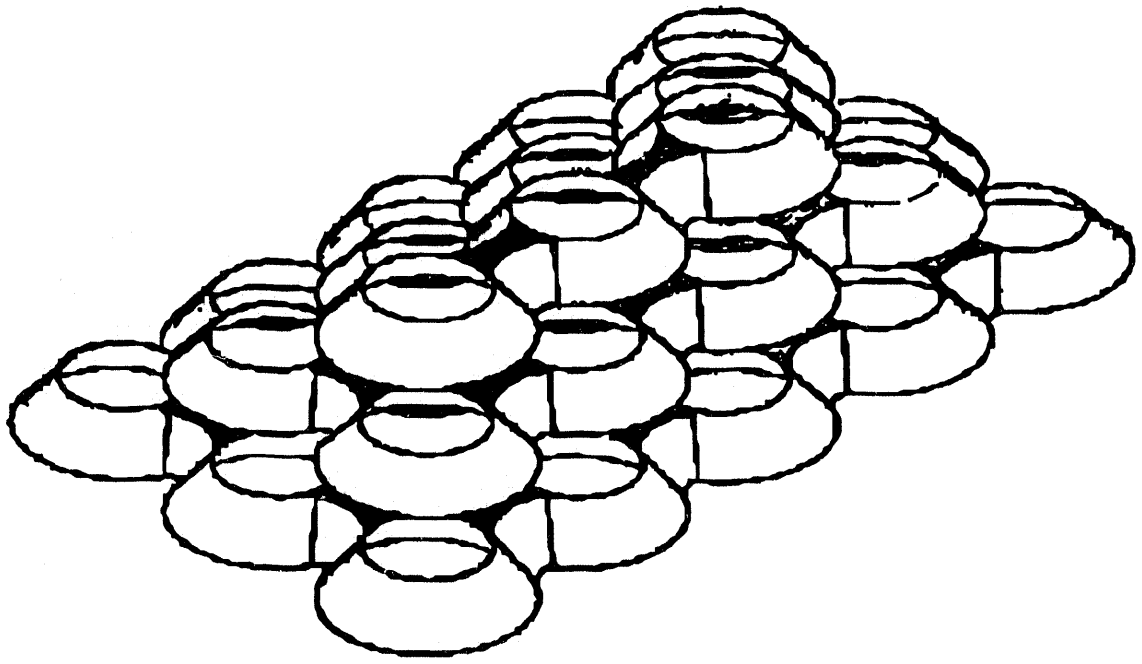


Figure 2: A 3-high pyramid of 26 cones with wave blocks.

Approximately 600 beach cones, with the associated wave blocks, have been installed at six locations within a typical barrier island/marsh ecosystem located south of Empire, LA in Plaquemines Parish. The map of Figure 3 identifies the approximate locations of the test sites. Note that there is no Site 5 since it was abandoned having been judged not suitable for this study. The installed beach cones were monitored for a six month period. This report gives details about the installation process and the results of the monitoring through the end of February, 1993.

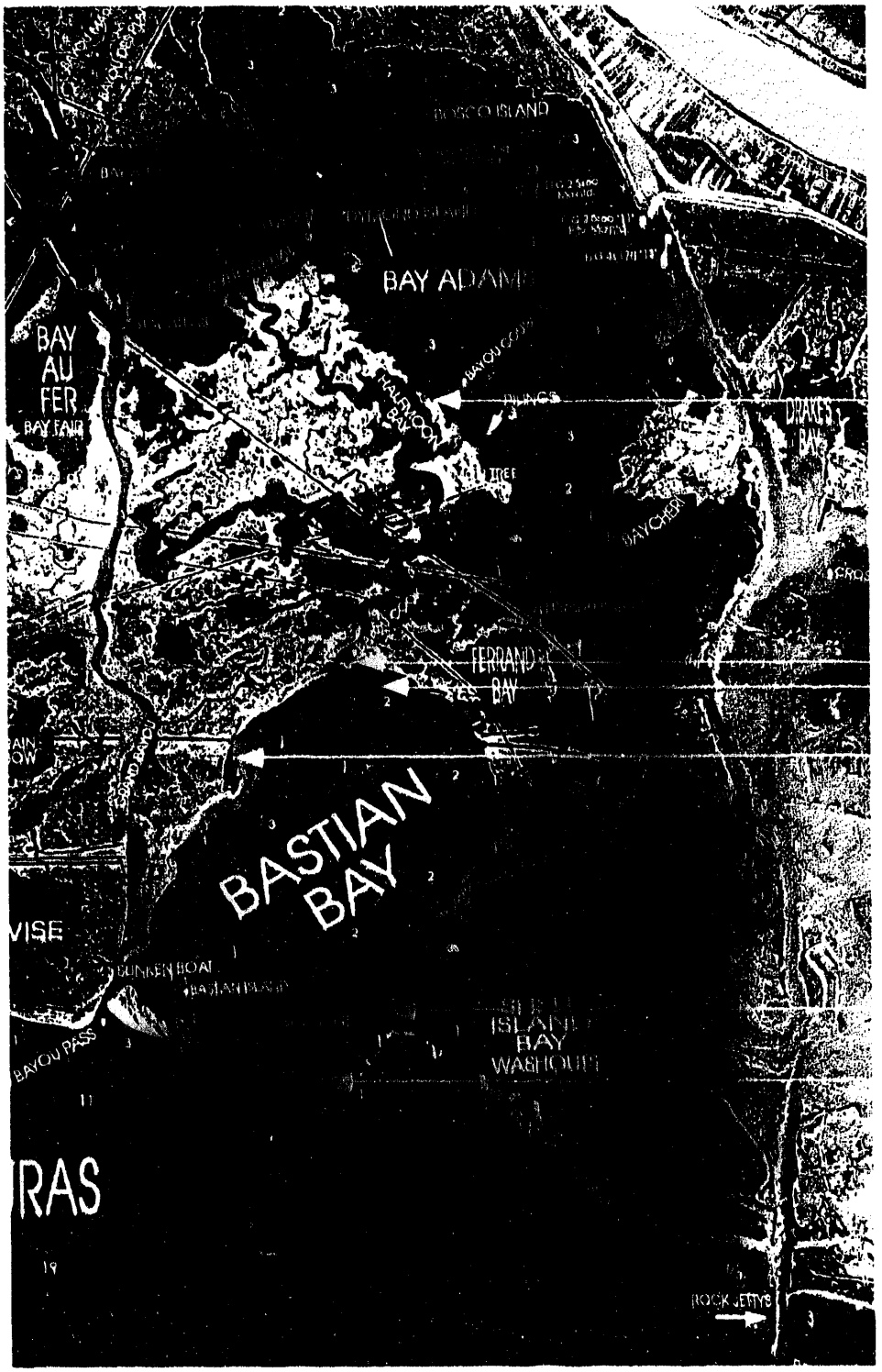


Figure 3: Map of the Empire to Shell Island estuary.

Project Description

The plan calls for six months of preliminary work, sixteen months of actual study at the selected experimental sites and two months for preparation of the final report and for dismantling of the experimental sites (if necessary). The primary objective of the study are to assess the viability of beach cones as a coastal erosion control/reversal device.

Task 1: Preliminary studies that include the following sub-tasks:

Sub-Task 1.1: Planning and Site Selection

Involves the detailed planning and selection of specific experimental sites. These tasks were scheduled for the first six months of the project.

Sub-Task 1.2: Permits

Involves obtaining of permits to install the beach cones at the selected sites. Permits from the U.S. Army Corps of Engineers and the State of Louisiana were to be obtained. A subcontractor Environmental Professionals Limited, Inc. will assist with the obtaining of permits.

Sub -Task 1.3: Initial Ecological Survey

To be performed by subcontracting groups from Xavier University and Louisiana State University. Purpose is to establish existing conditions of sediments and biota at the proposed experimental sites.

Sub-Task 1.4: Environmental Report

Involves the preparation of an Environmental Report as soon as possible after initiation of the contract.

Sub-Task 1.5: Beach Cone Installation

By the end of the first six month period, all 600 beach cones with their constituent wave blocks will be in place at the chosen experimental sites. Several different geometric combinations of cone installations will be used, including the placement of single cones along bay shorelines and the banks of bayous and marshy inlets.

Task 2: Monitoring of the Beach Cones:
After installation of the cones, they will be observed on a frequent basis over a sixteen month period. Physical measurements will be supplemented with both photographic and video taped evidence of their progress toward shoreline stabilization and/or sediment accretion. As sediments accrete, varieties of *Spartina alterniflora* will be planted within the newly accreted area to further assist in the stabilization of the reclaimed marshland.

Task 3: Ecological Surveys including the following sub-tasks:

Sub-Task 3.1: Mapping of Beach Biota and Assessment of Physical-Chemical Conditions:
Involves reconnaissance mapping of beach biota and assessment of the beach/ shoreline substrate. Core samples will be taken and analyzed. This sub-task will be performed by subcontractors from the Louisiana State University Laboratory for Wetlands Soils and Sediments.

Sub-Task 3.2: Evaluation of Beach Biota Changes:
Involves the evaluation of beach biota changes under various field conditions that are associated with the presence or absence of beach cones. This sub-task will be performed by subcontractors from Xavier University.

Sub-Task 3.3: Field Testing and Selection of Alternative Biota
Involves field testing and examination of selected alternative beach/marsh biota with the goal of finding more erosion and saline resistant strains.

Task 4: Geographic Information System:
Numerical data involving elevation changes, biota alterations, and changes in sediment characteristics will be maintained in a geographical information system (GIS).

Task 5: Final Report:
At the conclusion of the sixteen month study, a final report will be prepared. Also, in any areas where it is not desirable to leave the beach cones permanently placed, they will be removed.

Project Status

The status of the project is summarized in the chart of Figure 4.

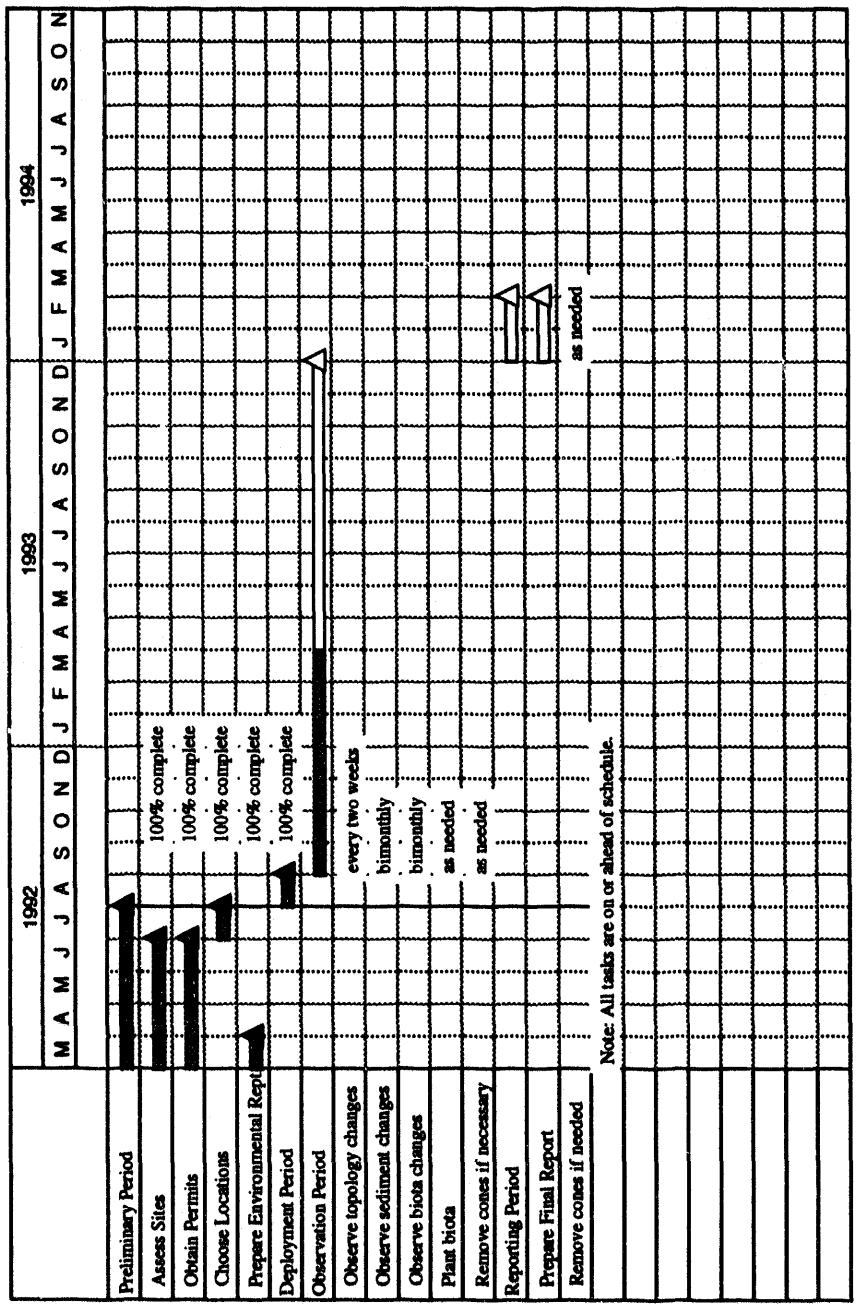


Figure 4: Project status summary.

A detailed account of work performed toward achieving the present status of the project is given in the following paragraphs:

1. On January 15, 1992, the P.I. and Mr. William Mouton were piloted to the experimental sites in a small plane. Over 40 color photographs were taken of a variety of potential study areas. These photographs were needed prior to filing for federal and state permits.

2. On February 11, 1992, permit application was made to the Louisiana Department of Natural Resources (DNR). This application was filed in anticipation of a contract starting date in early March. By filing the application prior to formal contract signing, several weeks of valuable experimental time might be gained. A copy of the permit application is attached to this report.

3. On February 25, 1992, executives of Freeport McMoRan, Inc. (FMI) were shown the experimental sites by the P.I. and Mr. Edward Davis (Research Assistant on the project). Recall that FMI is a cosponsor of this work. The group spent the prior evening at FMI's lodge in Port Sulphur, LA and proceeded to Empire, LA at 7 a.m. where the P.I.'s boat was launched. By 7:45 a.m. the group was observing Site 1 and the tour concluded at Site 7 at approximately 12 p.m.

4. On March 6 - 8, a reconnaissance trip to the sites was made with the P.I., Mr. Edward Davis (Research Assistant on the project), and Mr. Noel Brodtmann of EPL (one of the subcontractors on the project). Preliminary LORAN coordinates were taken at each of the experimental sites. It was subsequently concluded that the LORAN unit, which belongs to EPL, was not sufficiently accurate for the purposes of this project and a Global Positioning System (GPS) was purchased (for $1,287) from funds earmarked as "Cone Installation and Field Travel." This instrument is essential to proper mapping of the experimental sites prior to cone installation and for monitoring progress of sediment accretion after cone deployment.

5. On March 20, 1992, a 21 foot flat boat with trailer was leased for the duration of the project for $5,640. This boat will be the primary work vessel for ferrying personnel to the sites and for cone deployment. On March 24, this vessel was

moved from New Orleans, LA to a boat shed in Empire, LA. At that time the boat was taken on a shakedown cruise where it performed flawlessly. The availability of this vessel at an extremely attractive lease rate will allow all field work to be performed within the specified budget.

6. On April 3, another reconnaissance trip was made with Mr. Brodtmann to observe the oyster populations at the various sites since the DNR had indicated that a full "Oyster Assessment" was likely to be required prior to obtaining permits. Subsequently, DNR did inform us that an Oyster Assessment was needed and EPL has initiated this study.

7. On April 10, coworkers from Louisiana State University (LSU) were taken to the experimental sites by the P.I. and Mr. Davis. Below water soil core samples were taken at all sites along with samples of vegetation and above water soils. A summary paragraph submitted by the LSU personnel is attached to this report.

8. On April 13, the Management Plan was submitted to DOE. This report was prepared by the P.I. during the period from April 1 through the time of submission.

9. On April 24, the P.I. and Mr. Davis accompanied Mr. Brodtmann where oyster assessment was performed at Site 1, Half Moon Bay. See the attached permit application for a more detailed description of all seven experimental sites.

10. Staring in December, 1991, forms were built by Beach Cones Research, Inc. for making the beach cones and connecting wave blocks. By the end of April, 1992, the required 600 cones for this project had been manufactured and are in storage awaiting deployment.

11. The P.I. worked with a DOE support contractor in the preparation of an Environmental Report.

12. On May 1, 1992, the PI took the Xavier University coinvestigators to the test sites where they sampled the flora and above water soils. A copy of their summary paragraphs pertaining to their activities is attached to this report.

13. On May 4, 1992, a permit was obtained from the U. S. Army Corps of Engineers. A copy of that permit is attached to this report.

14. On May 5, the PI met with representatives of C. L. Dill Construction Company. Freeport McMoRan has agreed to hire Dill Construction to transport the beach cones from their dock in Empire, LA to the study sites by barge.

15. A letter of "no objection" was received from the State of Louisiana, Department of Health and Hospitals. This letter is dated April 15, 1992 but was not received by the PI until May 6. A copy of this letter is attached to this report.

16. On May 22 - 24, a reconnaissance trip to the sites was made by the PI and Mr. Edward Davis (Research Assistant on the project). GPS readings and depth sounding data were recorded at Sites 6 and 7. Mr. Davis subsequently entered these data into a geographic information system (GIS). Similar data will be obtained for all seven sites and will constitute the baseline information prior to beach cone deployment.

17. On June 3, 1992, Mr. Brodtmann of EPL submitted the finalized Oyster Assessment, a copy of which is attached to this report.

18. On June 9, 1992, a permit to proceed with field installation of beach cones at the proposed sites was obtained from the Coastal Management Division of the State of Louisiana Department of Natural Resources. This was the culmination of several month's effort. A copy of the permit is attached to this report.

19. On June 7 - 9, work on the initial survey of all experimental sites was completed. These data are being entered into a geographical database.

20. Further discussions were held at various times with C. L. Dill Contractors about transporting the beachcones by truck from New Orleans, LA to Empire, LA and then by barge to the experimental sites.

21. On July 3 and 10, the PI and Research Associate (RA) visited the proposed test sites to finalize cone placement where possible.

22. On July 17, the first shipment of approximately 84 beach cones and 96 wave blocks were trucked from the beach cone plant in New Orleans, LA to the yard of C. L. Dill construction company in Empire, LA. The cones and blocks were loaded onto a 120' x 40' spud barge.

23. On July 20, the spud barge was moved by tug boat to Site 1 (see permit documents) and two pyramids of 19 beach cones were installed in a gap that was created by erosion of the marsh land.

24. On July 21, the spud barge was moved by tug to Shell Island, Site 7 (see permit documents), and two pyramids of 19 cones were installed in a gap in the island that was created originally by Hurricane Juan.

25. On July 22 a shipment of approximately 132 beach cones and wave blocks were shipped by truck to the Dill yard in Empire.

26. One July 22 and 23, the PI and RA assisted Freeport McMoRan personnel with the filming of the proposed experimental sites and other subjects to be used in a television commercial. Freeport McMoRan is a joint sponsor of this project and their involvement was based on their ability to use project activities in their commercials.

27. On July 24 and 25, seven pyramids of 19 cones were constructed in Bayou Cook, Site 2 (see permit documents). Five pyramids were placed in front of a lagoon that has grown by a factor of 10 in the past five years due to marsh erosion. The other two pyramids were built in front of a gap in the marsh created originally by a marsh buggy (associated with oil and gas exploration) and which has enlarged considerably within the last 10 years.

28. On July 27 a shipment of approximately 132 beach cones and wave blocks were shipped by truck to the Dill yard in Empire.

29. On July 28 approximately 30 beach cones and wave blocks were laid single file around a rapidly eroding marsh area at Site 2.

30. On July 29, the remainder of the cones and wave blocks on the spud barge were unloaded at Site 3, North Shore of Bastian Bay (see permit documents) and at Site 7, Shell Island.

31. On July 30, one pyramid of 19 cones was constructed at Site 3 and a single file zig-zag arrangement was started at Site 7. On this same day, a shipment of approximately 84 cones were shipped to the Dill yard and loaded onto the spud barge.

32. One July 31, the 84 cones were unloaded on the shore at Site 7 and the zig-zag was completed.

33. On August 3, the remaining 252 beach cones were loaded onto trucks, delivered to the Dill yard and loaded onto the spud barge.

34. On August 4, cones were off-loaded at Site 7 where an additional pyramid of 19 cones was constructed along with a "triple" of 38 cones.

35. On August 5, two pyramids of 19 cones were installed at Site 6, North Shore of Shell Island Bay (see permit documents).

36. On August 6, approximately 20 cones were installed in a single file manner along the shoreline of a cove at Site 4, Single Pipeline Canal (see permit documents).

37. On August 7, the remainder of the cones were off loaded and installed single file along the shoreline of Site 2.

38. Reconnaissance trips were made to the sites on August 11 - 12, August 19.

39. A reconnaissance trip was made to the sites on August 29, just after Hurricane Andrew. It was encouraging that all cones were still in place except for a very few at Site 7 (Shell Island), which had simply moved a few yards. On the other hand, an entire segment of Shell Island just to the East of the test site had disappeared. This was most distressing since that piece of the island represented our control area for elevations, it will now be impossible to precisely measure the changes in elevation at Site 7. However, suitable approximations can be made

from other reference points, such as pilings, that were not disturbed by the Hurricane.

40. Reconnaissance excursions were made to the sites on September 8, 15, and 25. The September 25 trip was after a strong Northeasterly storm and showed a significant buildup of shell and sediment at the Easternmost end of the Shell Island test site. The shell and sediment appear to have come from that which washed away during Hurricane Andrew from a portion of the island where no beach cones were deployed.

41. On October 16, a reconnaissance trip was made to the experimental sites. Since the tide was high, we could only wade in several inches of water to try to observe the state of the beach cones. All cones appeared to be in their proper place. It was not possible to observe any accretion but clearly no erosive effects had taken place.

42. On October 30, another reconnaissance trip was made to the experimental sites. Weather conditions similar to those of October 16 existed and prevented any detailed observation of progress or lack thereof.

43. On November 6, a reconnaissance trip was made to the experimental sites. Since the tide was high and the temperature was low, we could only visually observe the state of the beach cones. It was not possible to observe any accretion but clearly no erosive effects had taken place.

44. On November 13, a reconnaissance trip was made to the experimental sites. Once again the tide was high and it was very cold, so we could only visually observe the state of the beach cones. The water was murky and it was impossible to draw any conclusion about the status of the project.

45. On November 27, a reconnaissance trip was made to the experimental sites. Finally conditions were such that we could observe that status of each site. No noticeable changes were observed at Sites 3, 4, and 6. There was a noticeable buildup of shells on the South side of the pyramids at Site 1 (Half Moon Bay) and on the shore side of some of the pyramids at Site 2 (Bayou Cook). At Site 7 (Shell Island) there was an impressive buildup of primarily shell on the North

side of the experimental area (on the bay side rather than the sea side). We attribute this to strong Northerly winds that would normally push this material to the sea side. The beach cone installation prevented this movement and trapped the shells, which is the desired effect.

46. On December 4, a reconnaissance trip was made to the experimental sites. Tide and wind conditions were not highly conducive to observation of the beach cones but there appeared to be no noticeable change since the November 27 trip.

47. On December 10, a cursory survey of the Shell Island site was made. Based on the level of the PVC pipes driven to hold down the beach cone pyramids and on notes made during the installation period of late July and early August, 1992, a rectangular area behind the cones (on the Bastian Bay side) measuring approximately 25 feet by 40 feet has accreted to a height approximately 16 inches above its original level.

48. On December 26, a reconnaissance trip was made to the experimental sites. Crude surveys at the Half Moon Bay site indicated a buildup behind the two pyramids of an area approximately 5 feet by 20 feet to a height about six inches above the original. At the Bayou Cook site, there was a noticeable accretion behind two of the seven pyramids similar in dimensions to the Half Moon Bay site. Tide conditions did not allow measurements near the other five pyramids in Bayou Cook.

49. On January 9, a reconnaissance trip was made to the experimental sites. The tide and wind was high and the temperature was low. The beach cones were not very visible at Shell Island but were easy to see but under water at the other sites. No major changes could be observed at any of the locations.

50. On January 18, a reconnaissance trip was made to the experimental sites. Once again the tide and was high and the temperature was low, so we could only visually observe the state of the beach cones. The water was murky and it was impossible to draw any conclusion about the status of the project.

51. On January 25, a reconnaissance trip was made to the experimental sites. Conditions still were not conducive to quality observations. However, no major changes could be observed.

52. On February 2, a reconnaissance trip was made to the experimental sites. The tide and wind was high and the temperature was low. The beach cones were not very visible at Shell Island but were easy to see under the water at other sites. No major changes could be observed at any of the locations.

53. On February 19, a reconnaissance trip was made to the experimental sites. The tide and temperature were low. Additionally, the water was not very clear, so careful observations were not possible.

54. On February 26, a reconnaissance trip was made to the experimental sites with the express purpose of performing a survey at Shell Island with a surveyor's level. Our crew of the P.I. and four graduate assistants went to the site at 8 a.m. and began to set up for the survey. When the P.I. checked the water temperature and realized that at least one person would have to get into the water, and considering a very strong northwesterly wind, the survey was canceled and rescheduled for April when weather conditions should improve.

Planned Activities

As indicted in Figure 4, the primary activity of the project over the next ten months is to continue to monitor the experimental sites. We will continue to occasionally take samples of sediments and flora to have them analyzed by the LSU and Xavier subcontractors. Beginning in January of 1994, the final report will be prepared.

Summary

The primary objective of this project is to evaluate the utility of a device called the "beach cone" in combating coastal erosion. Seven initial sites were selected for testing beach cones in a variety of geometric configurations. Permits were obtained from the State of Louisiana and the U. S. Army Corps of Engineers to perform the work associated with this study. Six hundred beach cones were actually installed at six of the sites in late July and early August, 1992. One of the initial sites was abandoned because it was found to be unsuitable for beach cone placement.

The test sites have been observed for six months and preliminary findings indicate that beach cones accreted significant amounts of materials along the beach of a barrier island. At other test sites, accretion rates have been less dramatic but importantly, no significant additional erosion has occurred, which is a positive result. It is too soon to conclude the categorical success of the beach cones, but results to date are encouraging.

Appendices

A. Permit Documents
B. Oyster Assessment from EPL, Inc.
C. Annual Report from LSU
D. Annual Report from Xavier

Appendix A

Permit Documents

STATE OF LOUISIANA

STATE LAND OFFICE

NOTICE OF AUTHORIZATION

A PERMIT TO Place beach cone pyramids under high waterline Sept. 30, 1992

AT See attached application

HAS BEEN ISSUED TO Tulane University

ADDRESS OF PERMITTEE Chemical Eng. Dept.
Tulane University
New Orleans, Louisiana

ON Sept. 30, 19 92
EXPIRES Sept. 30, 1994

H. Glen Kent, Jr.
H.GLEN KENT

PERMIT NUMBER B-12 (P920100)

THIS PERMIT MUST BE CONSPICUOUSLY DISPLAYED AT THE SITE OF WORK

DA 5729
(3/92)

CLASS B PERMIT NO. B-12

CONSTRUCT AND/OR MAINTAIN BULKHEADS AND FLOOD PROTECTION STRUCTURES

UNITED STATES OF AMERICA

BETWEEN Tulane University

STATE OF LOUISIANA

~~Plaquemines Parish Government~~

PARISH OF Plaquemines

AND STATE OF LOUISIANA

BODY OF WATER Gulf of Mexico/Shell Island Bay/Bay Bastian/Bayou Cook

BE IT KNOWN AND REMEMBERED, that on the dates and before the several Notaries Public or other authorities named below, there personally came and appeared the undersigned parties who declared and acknowledged separately to each of said Notaries, as follows:

A permit contract is entered into on this the 29th day of July, 1992, by and between the State of Louisiana, represented by H. Glen Kent and

Tulane University (Victor J. Law, Principal Investigator),
(print or type full name)

a resident of Chemical Engineering Dept., New Orleans, LA 70118, (504) 865-5773
(street and city) (telephone)

Orleans, Parish, Louisiana, hereinafter referred as PERMITTEE:

By virtue of R. S. 41:1131, et seq., and upon the terms and conditions of the Rules and Regulations adopted thereunder and this contract, a permit is granted to PERMITTEE for the construction of a bulkhead or other type structure in the manner, place, and to the extent specified in the plans attached hereto and described briefly as follows:

Place beach cone pyramids under high water line at locations indicated on the attached map. The objective is to study the effectiveness of beach cones with regard to curtailing coastal erosion.

In consideration for this permit to construct a bulkhead or other type structure PERMITTEE hereby agrees:

A. To comply with all applicable laws, R. S. 41:1131, et seq., and the Rules and Regulations adopted thereunder;

B. That this permit shall be effective for a period of two years from the 29th day of July, 1992 to the same day, 1994;

C. That upon termination of the permit, no further reclamation shall be done except by issuance of a new permit in accordance with law;

D. That this permit in no way vests any right, title or interest in PERMITTEE, which can be accomplished only in accordance with law;

E. That within sixty (60) days of the completion of the reclamation or termination of the permit (if only partial reclamation has been effected) PERMITTEE shall prove the extent of reclamation as provided by the Regulations;

F. That PERMITTEE shall hold the State of Louisiana and her agencies and subdivisions harmless for all acts or omissions in reclaiming and maintaining eroded lands and constructing or maintaining any structures and bulkheads though the permit for the same subsequently expires or is revoked; PERMITTEE assumes responsibility for all development and construction and for the condition and operation of the premises, and agrees to indemnify the State and all of its agents, servants and employees against and from any and all claims, demands, causes of action, costs and expenses on account of or in any way arising out of this permit or the negligence or act or acts of omission of commission of PERMITTEE in furtherance of this permit or otherwise;

G. That activities by PERMITTEE shall not create a hazard or obstruction to navigation or impose undue or unreasonable restraints on State or public right;

H. And the failure to substantially comply with the Rules and Regulations or

applicable law shall result in revocation of this permit and all rights granted hereunder.

THUS EXECUTED AND SIGNED, in triplicate, at 821 Baronne Street, New Orleans Parish of Orleans, Louisiana, on the 29th day of July, 19 92, by Victor J. Law, before me, W. Lloyd Bowers, a Notary Public duly commissioned and qualified in and for the Parish of Orleans, Louisiana and in the presence of Gail Howard and Judy Ward, competent witnesses, after due reading of the whole.

WITNESSES:

Gail Howard

Judy Ward

BY: _____

PERMITTEE (Owner)

_____

Notary Public

THUS EXECUTED AND SIGNED, in triplicate, at Baton Rouge, Parish of East Baton Rouge, Louisiana, on the 6th day of August, 19 92, by STATE OF LOUISIANA, represented by H. GLEN KENT (STATE LAND OFFICE), all before me, Gerald P. Theriot, a Notary Public duly commissioned and qualified in and for the Parish of East Baton Rouge, Louisiana, and in the presence of Cheryl A. Hebert and Marcie Suacier, competent witnesses, after due reading of the whole.

WITNESSES:

Cheryl A. Hebert

Marcie Saucier

STATE OF LOUISIANA

BY: H. Glen Kent Jr.

H. Glen Kent

State Land Office

Gerald P. Theriot

Notary Public

APPROVED AS TO FORM AND LEGALITY:

_____

Attorney General

State of Louisiana

THUS EXECUTED AND SIGNED, in triplicate, at New Orleans, Louisiana, Parish of Orleans, Louisiana, on the 29th day of July, 1992, by Luke A. Petrovich, Parish President for the Parish of Plaquemines, before me, W. Lloyd Bowers, a Notary Public duly commissioned and qualified in and for the Parish of Orleans, Louisiana and in the presence of Judy Ward and Gail Howard, competent witnesses, after due reading of the whole.

WITNESSES:

Judy Ward

Judy Ward

Gail Howard

Gail Howard

PLAQUEMINES PARISH GOVERNMENT

BY: _____
Luke A. Petrovich
Parish President

_____
NOTARY PUBLIC

DEPARTMENT OF NATURAL RESOURCES
COASTAL MANAGEMENT DIVISION
P. O. BOX 44487
BATON ROUGE, LOUISIANA 70804-4487
(504) 342-7591

D23

COASTAL USE PERMIT/CONSISTENCY DETERMINATION

C.U.P. No. P920100

C.O.E. No. NOD-22

NAME AND ADDRESS: DR. VICTOR LAW, Ph.D.: Attn: Bud Brodtmann, c/o EPL, Inc., 4813 W. Napoleon Ave., Metairie, LA 70001

LOCATION: SEE NEXT PAGE

PROJECT DESCRIPTION: SEE NEXT PAGE

In accordance with the rules and regulations of the Louisiana Coastal Resources Program and Louisiana R.S. 49, Sections 213.1 to 213.21, the State and Local Coastal Resources Management Act of 1978, as amended, the permittee agrees to:

1. Carry out or perform the use in accordance with the plans and specifications approved by Department of Natural Resources.
2. Comply with any permit conditions imposed by the Department of Natural Resources.
3. Adjust, alter, or remove any structure or other physical evidence of the permitted use if, in the opinion of the Department of Natural Resources, it proves to be beyond the scope of the use as approved or is abandoned.
4. Provide, if required by the Department of Natural Resources, an acceptable surety bond in an appropriate amount to ensure adjustment, alteration, or removal should the Department of Natural Resources determine it necessary.
5. Hold and save the State of Louisiana, the local government, the department, and their officers and employees harmless from any damage to persons or property which might result from the use, including the work, activity, or structure permitted.
6. Certify that the use has been completed in an acceptable and satisfactory manner and in accordance with the plans and specifications approved by the Department of Natural Resources. The Department of Natural Resources may, when appropriate, require such certification be given by a registered professional engineer.
7. All terms of the permit shall be subject to all applicable federal and state laws and regulations.
8. This permit, or a copy thereof, shall be available for inspection at the site of work at all times during operations.
9. The applicant will notify the Coastal Management Division of the date on which initiation of the permitted activity described under the "Coastal Use Description" began. The applicant shall notify the Coastal Management Division by mailing the enclosed green initiation card on the date of initiation of the coastal use.
10. Unless specified elsewhere in this permit, this permit authorizes the initiation of the coastal use described under "Coastal Use Description" for two years from the date of the signature of the Secretary or his designee. If the coastal use is not initiated within this two year period, then this permit will expire and the applicant will be required to submit a new application. Initiation of the coastal use, for purposes of this permit, means the actual physical beginning of the use or activity for which the permit is required. Initation does not include preparatory activities, such as movement of equipment onto the coastal use site, expenditure of funds, contracting out of work, or performing activities which by themselves do not require a permit. In addition, the permittee must, in good faith and with due diligence, reasonably progress toward completion of the project once the coastal use has been initiated.
11. This Coastal Use Permit authorizes periodic maintenance, but such maintenance activities must be conducted pursuant to the specifications and conditions of this permit.
12. The following special conditions must also be met in order for the use to meet the guidelines of the Coastal Resources Program:

C.U.P. No. P920100

C.O.E. No. NOD-22

LOCATION: **PLAQUEMINES PARISH, LA:** Sec. 41, T20S-R28E, northeast shoreline of Halfmoon Bay between Lat. 29°21'28"N, Long. 89°37'48"W and Lat. 29°21'14"W, Long. 89°37'44"W (Site No. 1); Secs. 4, 5, 8, and 9, T21S-R28E, east bankline of Bayou Cook between Lat. 29°20'00"N, Long. 89°38'28"W and Lat. 29°19'45"W, Long. 89°38'32"W (Site No. 2), and north shoreline of Bastian Bay between Lat. 29°19'45"N, Long. 89°38'42"W and Lat. 29°19'34"W, Long. 89°38'20"W (Site No. 3); Secs. 7 and 8, T21S-R21E, west shoreline of Bastian Bay at Lat. 29°19'19"N, Long. 89°39'34"W (Site No. 4), and between Lat. 29°18'34"N, Long. 89°40'05"W and Lat. 29°18'33"W, Long. 89°40'05"W (Site No. 5); Sec. 21, T21S-R28E, north shoreline of Shell Island Bay between Lat. 29°17'14"N, Long. 89°38'30"W and Lat. 29°17'22"W, Long. 89°37'50"W (Site No. 6); and Secs. 19, 20, 28, 29, 33, 34, and 35, T21S-R28E, south (Gulf of Mexico) shoreline of remnants of Lanaux Island (Shell Island) between Lat. 29°17'16"N, Long. 89°40'12"W and Lat. 29°15'15"N, Long. 89°36'30"W (Site No. 7); approx. 6 mi. southwest of Empire, LA, oyster lease area.

PROJECT DESCRIPTION:
Proposal to install glass fiber-reinforced concrete "beach cone" erosion control modules along different types of shorelines at seven study sites in the vicinity of Bastian Bay. The objectives of the proposed study are to determine the effectiveness of the "beach cone" erosion control modules in providing protection from shoreline erosion and inducing the accretion of water-borne sediments to rebuild shorelines, as well as to assess their effect on adjacent shorelines, and to define the hydrodynamics of the modules by in-the-field monitoring. All study sites will be located in shallow water between 2.0 ft. and 3.0 ft. MSL. All study sites will be approx. 15 ft. wide and have the following approx. lengths: Site No. 1, 1500 ft.; Site No. 2, 2500 ft.; Site No. 3, 2500 ft.; Site No. 4, 500 ft.; Site No. 5, 600 ft.; Site No. 6, 5000 ft.; and Site No. 7, 27000 ft. Spacing of the "beach cone" erosion control modules within Site Nos. 1 through 6 will be no less than 100 ft. apart, and within Site No. 7 the spacing will be no less than 1000 ft. apart. Precise locations for deployment of the modules within each of the study areas will be determined on the basis of field surveys, including soil borings and identification of water bottom conditions. Each array of modules will be marked with 2 in. diameter white PVC pipe fitted with reflective tape and an 11 in. x 17 in. reflective sign to identify their locations and to alert boaters of their presence. Monitoring and evaluation of the study sites shall be conducted frequently for a period of at least two years after deployment to evaluate the effectiveness of the modules at the points of deployment and on adjoining and/or adjacent shorelines, and the effectiveness of differing orientations and/or geometric patterns of placement of the modules at the study sites. Any modules found to be ineffective or to be exacerbating shoreline erosion at any study site and/or adjoining shorelines will be promptly removed and properly disposed of. There are oyster leases in the vicinity of the proposed work.

LOUISIANA DEPARTMENT OF NATURAL RESOURCES
COASTAL MANAGEMENT DIVISION

a. That the applicant shall insure that all sanitary sewage and/or related domestic wastes generated during the subject project activity and at the site, thereafter, as may become necessary shall receive the equivalent of secondary treatment (30 mg/l BOD_5; 30 mg/l TSS) with disinfection prior to discharge into any of the streams or adjacent waters of the area or, in the case of total containment, shall be disposed of in approved sewerage and sewage treatment facilities, as is required by the State Sanitary Code. Such opinion as may be served by those comments offered herein shall not be construed to suffice as any more formal approval(s) which may be required of possible sanitary details (i.e. provisions) scheduled to be associated with the subject activity. Such shall generally require that appropriate plans and specifications be submitted to the Department of Health and Hospitals for purpose of review and approval prior to any utilization of such provisions.

b. Shorelines that become increasingly eroded as a result of deployment of these beach cone modules shall be stabilized by methods other than bulkheading (i.e. rip-rap, matting material, or natural vegetation). This condition does not preclude the necessity of obtaining a separate Coastal Use Permit, should one be required, for such shoreline stabilization activities.

c. Applicant shall remove and promptly dispose of any modules found to be ineffective or to be exacerbating shoreline erosion at any study site and/or on adjoining shorelines.

d. That a permit is received from the Division of State Lands prior to the initiation of construction and that a lease is obtained from the State Land Office at the completion of construction.

e. All beach cone modules and study site markers shall be removed within 120 days of abandonment of the facilities for the herein permitted use unless prior written approval to leave such structures in place is received from the Coastal Management Division. This condition does not preclude the necessity for revising the current permit or obtaining a separate Coastal Use Permit, should one be required, for such removal activities.

f. The following provisions are required by the Louisiana Department of Wildlife and Fisheries (LDWF) to protect the oyster resources of Bastian Bay. Dr. Victor Law, Ph.D. shall adhere to these provisions:

   1) The permittee shall provide notification of the proposed activity to any oyster lease holder who may be affected by it prior to commencement of the activity. Copies of notification letters sent to the oyster lease holder(s) shall be provided to the Coastal Management Division prior to commencement of the activity.

2) Applicant is subject to all applicable state laws related to damages which are demonstrated to have been caused by this action.

3) Applicant shall make every possible effort to avoid crossing current oyster leases.

4) Applicant shall, to the maximum extent possible, avoid crossing both living and non-living reefs on state owned water bottoms when choosing a route to and from the proposed locations.

g. (i) This permit authorizes the initiation of the Coastal Use described under "Coastal Use Description" for two years from the date of the signature of the Secretary or his designee. Initiation of the Coastal Use, for purposes of this permit, means the actual physical beginning of the use or activity for which the permit is required. Initiation does not include preparatory activities, such as movement of equipment onto the Coastal Use site, expenditure of funds, contracting out of work, or performing activities which by themselves do not require a permit. In addition, the permittee must, in good faith and with due diligence, reasonably progress toward completion of the project once the Coastal Use has been initiated. If the Coastal Use is not initiated within this two year period, an extension may be granted pursuant to the requirements contained in the Rules and Procedures for Coastal Use Permits (Title 43:I.723.D.). Please note that a request for permit extension MUST be made no sooner than 180 days and no later than 60 days prior to the expiration of the permit.

(ii) The expiration date of this permit is five (5) years from the date of the signature of the Secretary or his designee.

(iii) Upon expiration of this permit, a new Coastal Use Permit will be required for completion of any unfinished or uncommenced work items and for any maintenance activities involving dredging or fill that may become necessary. Other types of maintenance activities may also require a new Coastal Use Permit.

h. The permittee shall allow representatives of the Coastal Management Division or authorized agents to make periodic, unannounced inspections to assure the activity being performed is in accordance with the conditions of this permit.

C.U.P. No. P920100

C.O.E. No. NOD-22

i. In order to ensure the safety of all parties, the permittee shall contact the Louisiana DOTTIE System (1-800-272-3020) a minimum of 48 hours prior to the commencement of any excavation (digging, dredging, jetting, etc.) or demolition activity.

j. It is requested that the applicant provide a copy of any progress and final reports on this study effort, as well as a reprint of any scientific paper published on the study, to Mr. Rocky Hinds, Department of Natural Resources, Coastal Management Division, P.O. Box 44487, Baton Rouge, LA 70804-4487 and Mr. Fred Dunham, Department of Wildlife and Fisheries, Ecological Studies, P.O. Box 98000, Baton Rouge, LA 70898-9800.

By accepting this permit the applicant agrees to its terms and conditions.

I affix my signature and issue this permit this 9th day of June, 19 92.

DEPARTMENT OF NATURAL RESOURCES

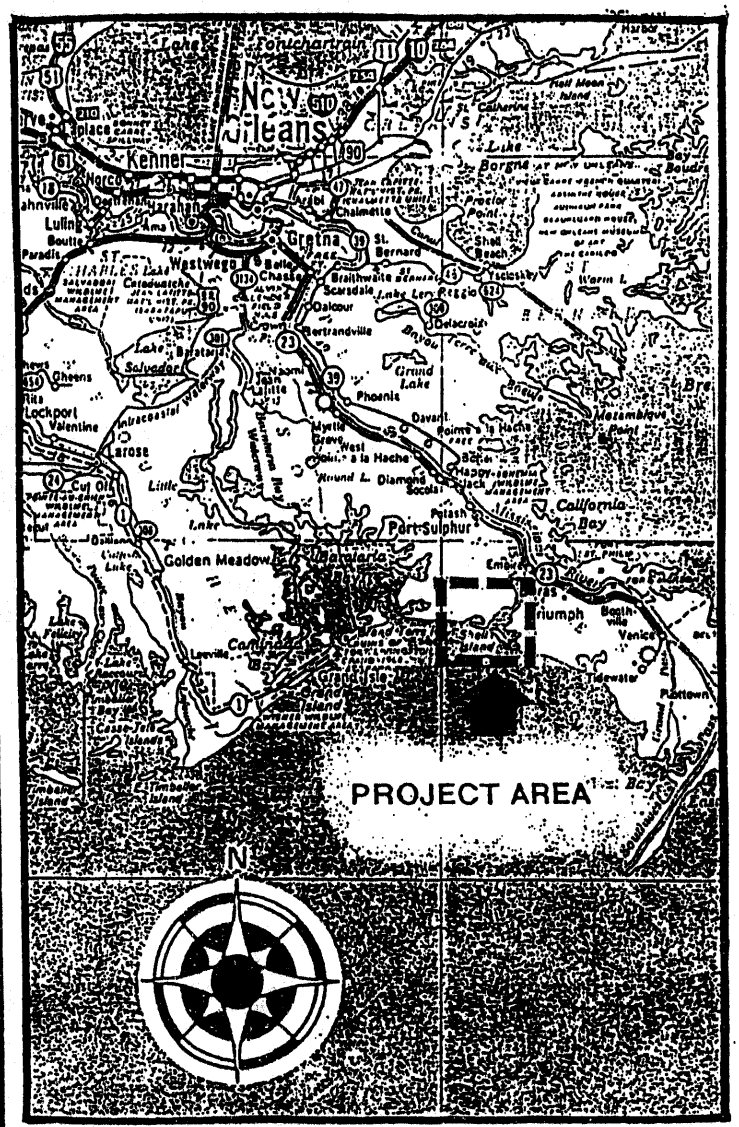
Terry W Howey

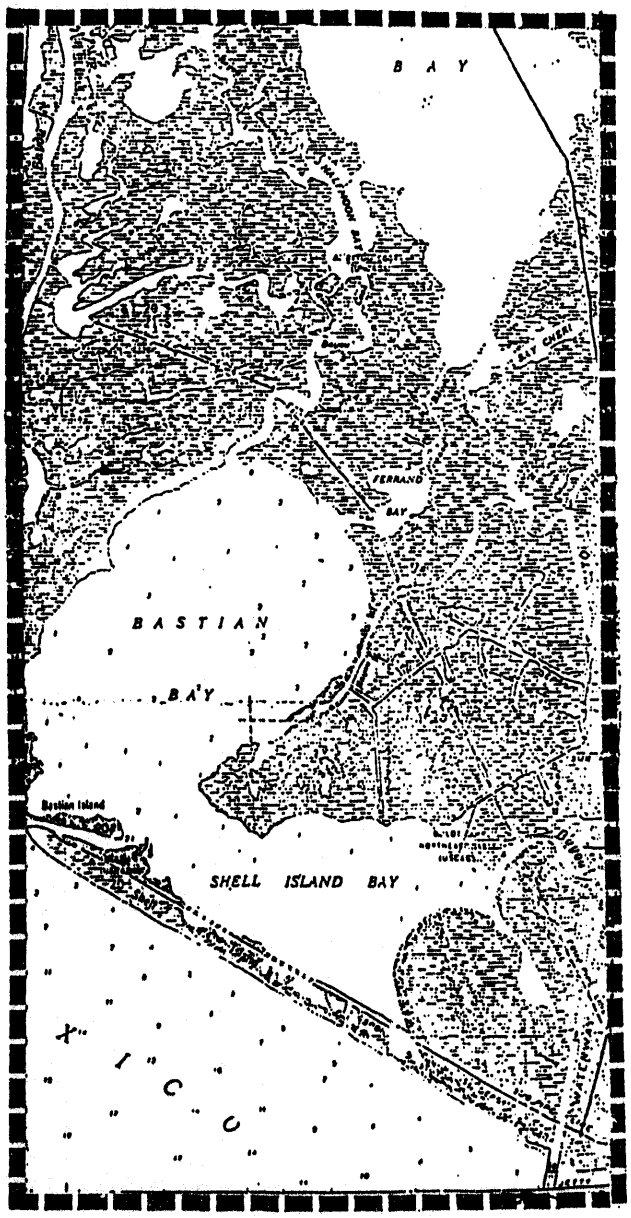
TERRY W. HOWEY, DIRECTOR
Coastal Management Division

This agreement becomes binding when signed by the Director of the Coastal Management Division, Department of Natural Resources.

Final Plat
P920100
1 June 1992
KAV

VICINITY MAP

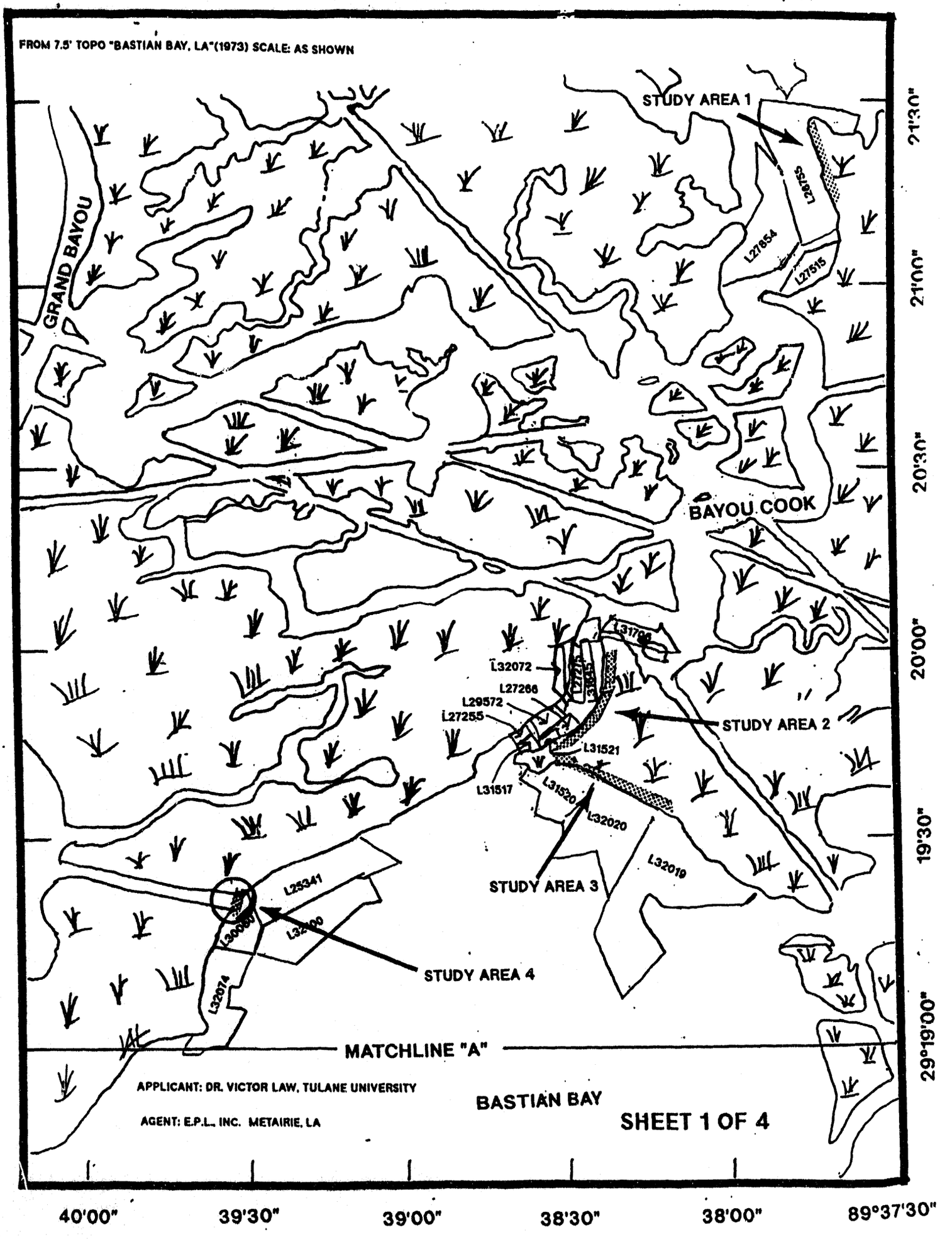




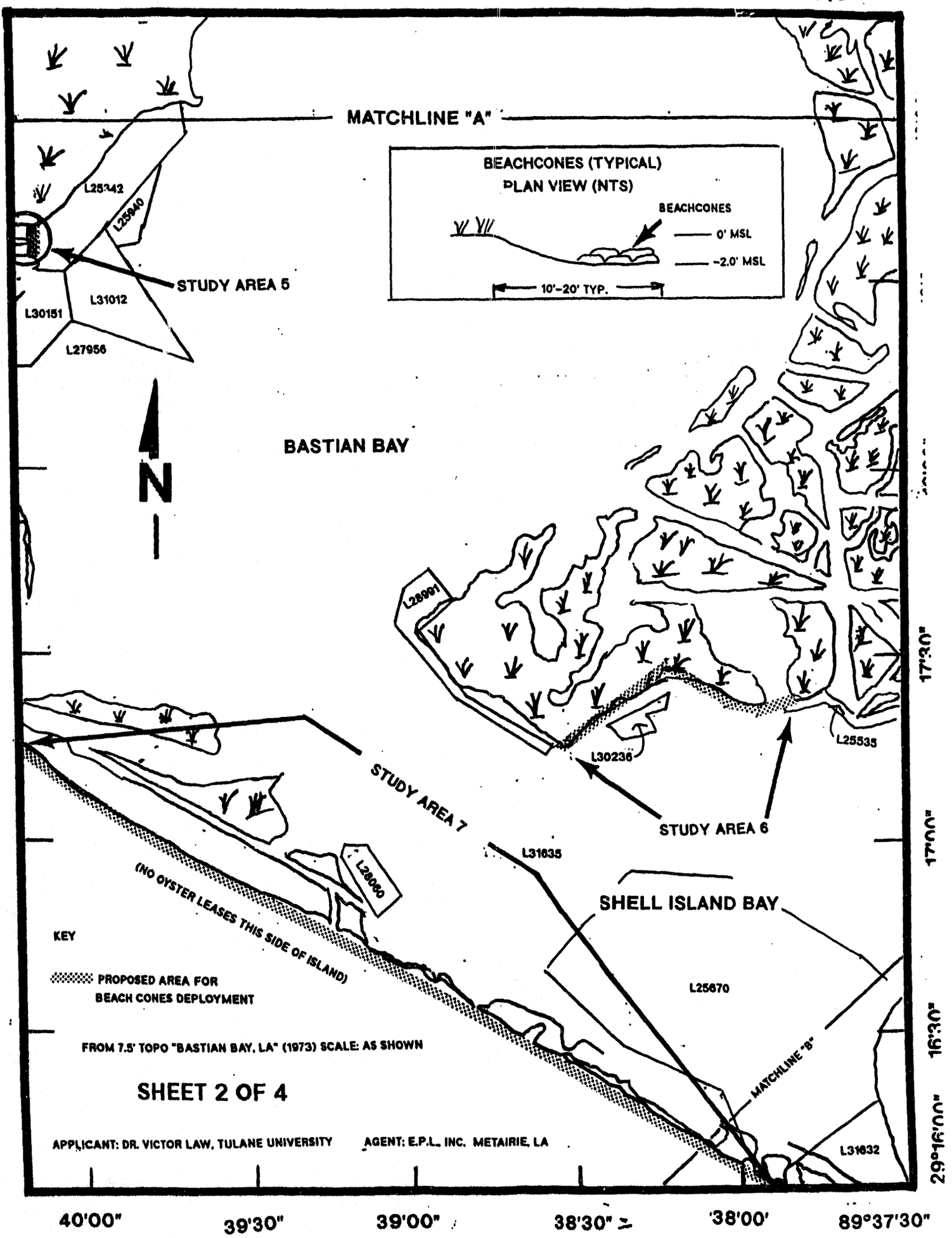
PROJECT AREA ENLARGED

ENVIRONMENTAL PROFESSIONALS LTD. 4813 W. NAPOLEON AVENUE METAIRIE, LOUISIANA 70001	
Scale: NONE	Date: 1/27/92
Drawn By: Ant	Approved By: MB

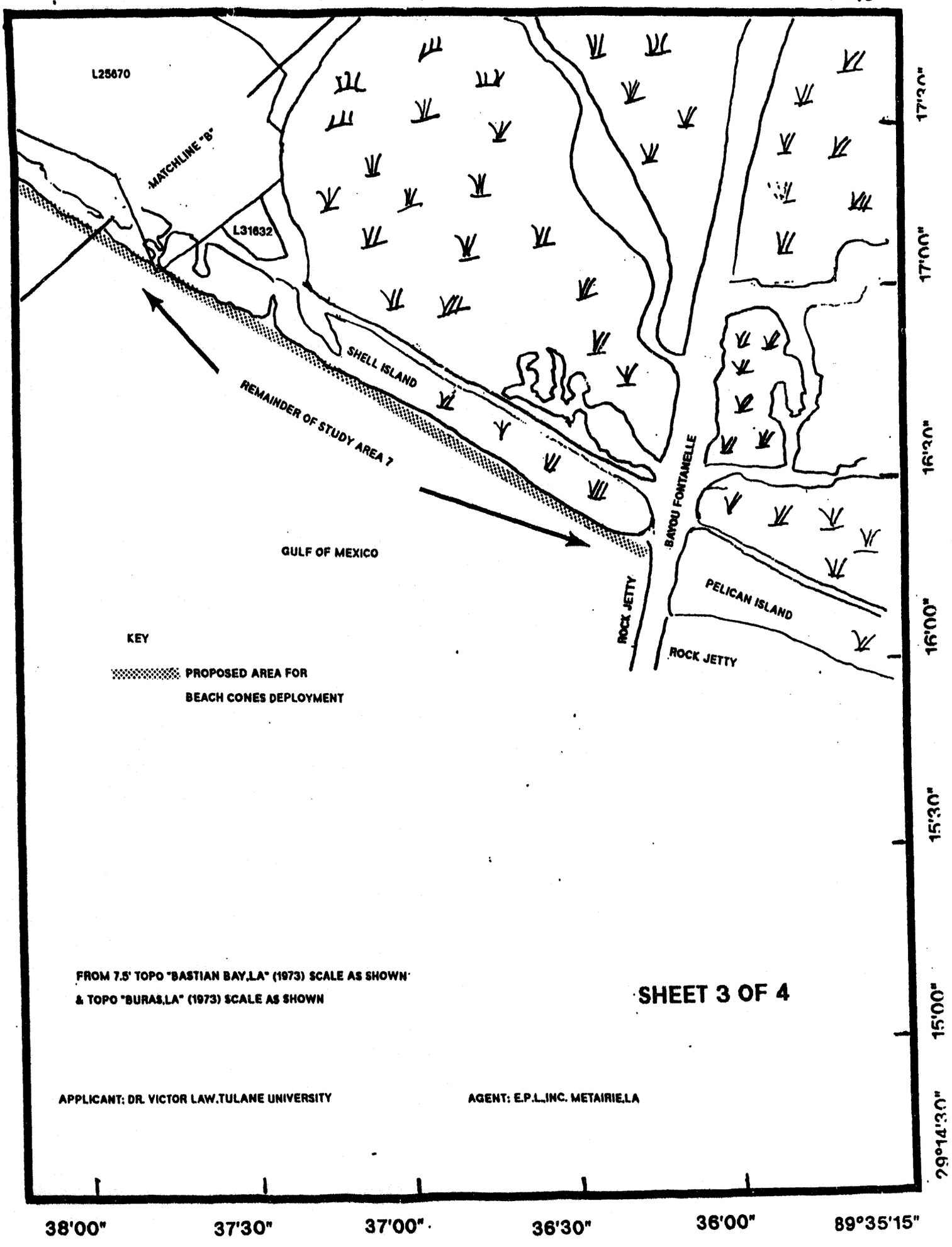
P120100
1 June 1992
KAV



1 June 1992
KAC



F120100
1 June 1992
KAV



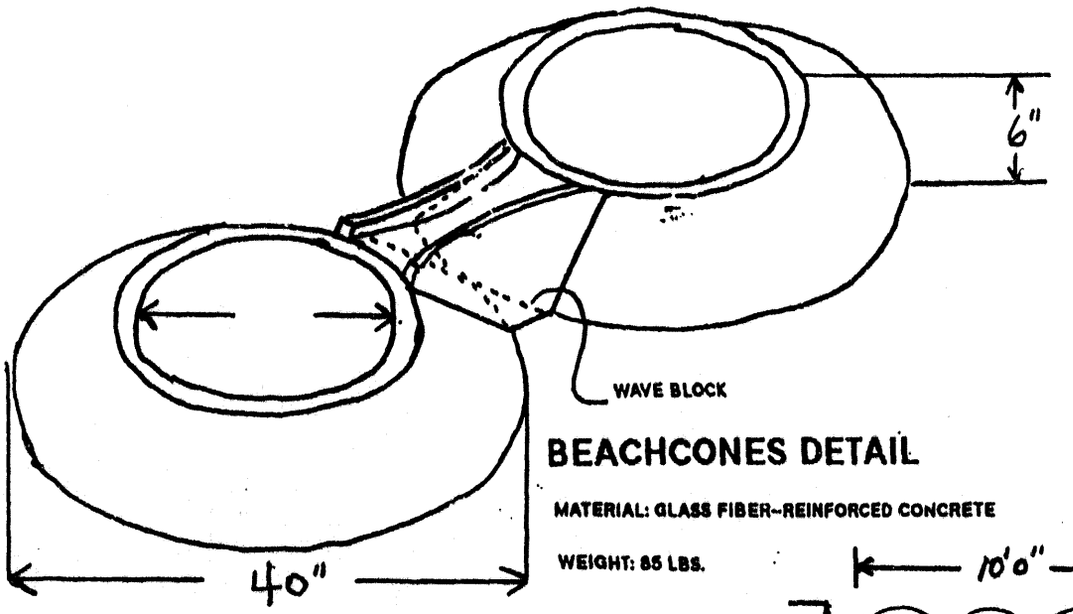
FROM 7.5' TOPO "BASTIAN BAY,LA" (1973) SCALE AS SHOWN
& TOPO "BURAS,LA" (1973) SCALE AS SHOWN

SHEET 3 OF 4

APPLICANT: DR. VICTOR LAW,TULANE UNIVERSITY

AGENT: E.P.L.,INC. METAIRIE,LA

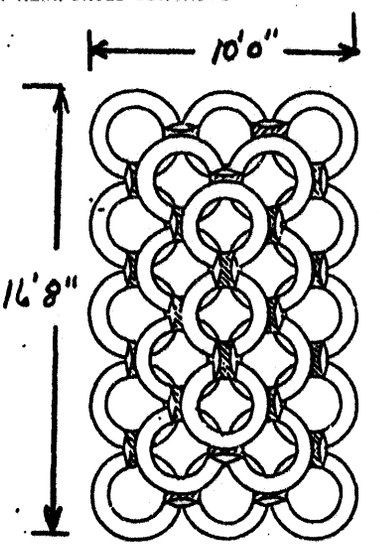
1 June 1992
KAV



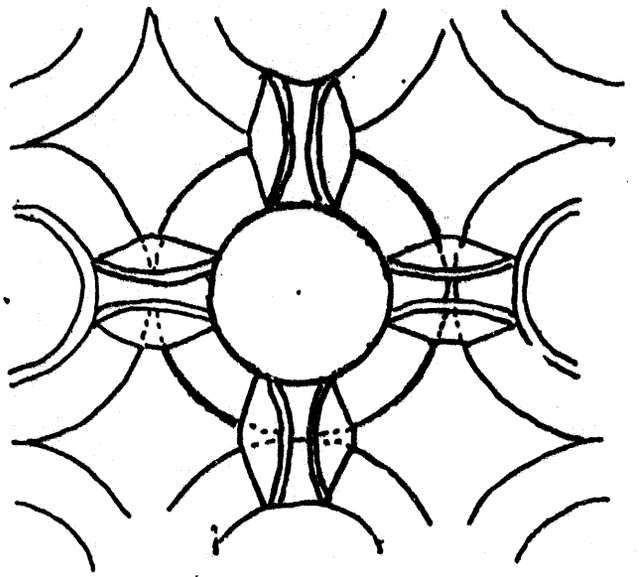
BEACHCONES DETAIL

MATERIAL: GLASS FIBER-REINFORCED CONCRETE

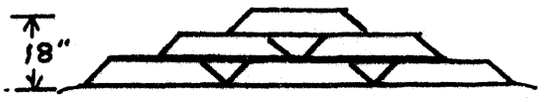
WEIGHT: 85 LBS.



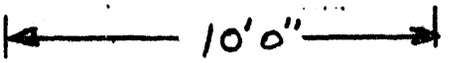
PLAN VIEW OF 3-2-1 PYRAMIDAL INSTALLATION

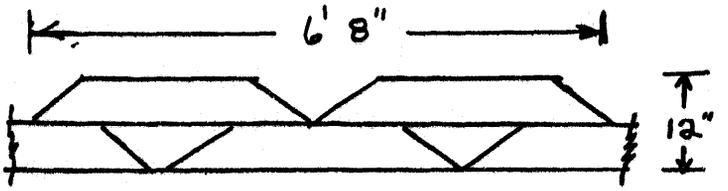


TYP. BEACHCONES ARRAY (PLAN)



ELEVATION OF 3-2-1 ARRAY





TYP BEACHCONES 2-LEVEL ARRAY (ELEV.)

SHEET 4 OF 4

APPLICANT: DR. VICTOR LAW, TULANE UNIVERSITY

AGENT: E.P.L., INC. METAIRIE, LA

F7L0100
1 June 1992
KAV

NOTE 1. "Beach Cone" erosion control modules will be evaluated in 7 study areas. Within each study area one or more arrays of the beach cones will be installed to study the effect of differing orientations and/or geometric patterns.

NOTE 2. Spacing of beach cone arrays within study areas 1 though 6 will be no less than about 100 feet apart.

NOTE 3. Spacing of cones along the Gulf shore of Shell Island remnants (study area 7) will be no less than about 1000 feet apart.

NOTE 4. Effectiveness of the beach cones will be monitored frequently; during the two-year study. Applications deemed to be exacerbating shoreline loss will be removed properly and promptly.

NOTE 5. White, 2" diameter PVC pipes fitted with reflective tape will be used to mark the installations of beach cones. Each array's locations will also be protected with an 11" x 17" reflective sign identifying the array's location and warning boaters of the installation.

NOTE 6. Precise locations for deployment of beach cones within each of the seven study areas will be determined based on detailed field surveys including soil borings and identification of water bottom conditions.

NOTE 7. Please note on sheet 2 of 4 typical plan view of beach cone deployment relative to distance from shoreline and relationship to MHW and MLW levels.

NOTE 8. The approximate length and width of each study area is as follows:

Site 1: 1,500 ft. x 15 ft.
Site 2: 2,500 ft. x 15 ft.
Site 3: 2,500 ft. x 15 ft.
Site 4: 500 ft. x 15 ft.
Site 5: 600 ft. x 15 ft.
Site 6: 5,000 ft. x 15 ft.
Site 7: 27,000 ft. x 15 ft.

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

REPLY TO
ATTENTION OF:

May 4, 1992

Operations and Readiness Division
Eastern Evaluation Section

SUBJECT: Final Determination of Eligibility Under NOD-22

Dr. Victor Law, Ph.D.
School of Engineering, Chem. Eng. Department
332 Lindy Boggs Building, Tulane University
New Orleans, Louisiana 70118-5674

Dear Dr. Law:

This letter constitutes a Final Determination of Eligibility.

The final determination is as follows:

a. The proposed work, shown on the attached drawings, is authorized under NOD-22 provided that all conditions of the permit are met.

b. Prior to commencing work on your project, you must obtain approvals from state and local agencies as required by law and by terms of this permit. These approvals include, but are not limited to, a permit or waiver from the Coastal Management Division of the Louisiana Department of Natural Resources, a water quality certification from the Department of Environmental Quality of the State of Louisiana, and approval from the State Land Office.

c. If the permitted project requires additional structures or facilities not expressly permitted herein, you must obtain a separate approval from this office for any additional structures or facilities not shown on the attached drawings.

d. No work may be performed between May 1 and July 15 of any year at site number 7, to protect the bird rookeries in the area.

e. Your use of the permitted activity must not interfere with the public's right to free navigation on all navigable waters of the United States.

f. You must install and maintain, at your expense, safety lights, signs, and/or markers identifying the beach cone locations.

g. If the beach cones are found to be ineffective or to be exacerbating shoreline erosion at any study site or on adjoining shorelines, they will be removed and properly disposed of.

h. Your Department of the Army permit authorization number for this project is GP920100.

Sincerely,

Ronald J. Ventola
Chief, Regulatory Functions Branch

Attachment

Copies furnished: w/attachment

U.S. Fish & Wildlife Service
825 Kaliste Saloom Road
Brandywine II, Suite 102
Lafayette, LA 70508

National Marine Fisheries Service
c/o LSU Center of Wetland Resources
Baton Rouge, LA 70803-7535

U.S. Environmental Protection Agency
Federal Activities Branch (6E-FT)
1445 Ross Avenue
Dallas, TX 75202-2733

LA Dept. of Natural Resources
Coastal Management Section
P. O. Box 44487
Baton Rouge, LA 70804-4487

Dept. of Environmental Quality
Office of Water Resources
P. O. Box 82215
Baton Rouge, LA 70804-2215

Division of Historic Preservation
P. O. Box 44247
Baton Rouge, LA 70804-4247

LA Dept. of Wildlife & Fisheries
Ecological Studies Section
P. O. Box 98000
Baton Rouge, LA 70808-8000

U.S. Coast Guard
8th Coast Guard District (OAN)
Hale Boggs Building
500 Camp Street
New Orleans, LA 70130

Appendix B

Annual Report from Louisiana State University

CONE PROJECT

Year 1 Progress Report

Submitted by

R.D. DeLaune, C.W. Lindau, and S.R. Pezeshki

Wetland Biogeochemistry Institute
Center for Coastal, Energy and Environmental Resources
Louisiana State University
Baton Rouge, LA 70803

SITE CHARACTERIZATION

The first year effort was directed at providing background data on chemical and physical characteristics of sediment prior to cone placement. Sediment (cores and surface) and plant materials collected near cone sites located in Plaquemine Parish, Louisiana were characterized for elemental content and sedimentation rates. The samples were collected several weeks prior to cone placement.

Ten cm diameter cores taken from selected sites in Spring of 92 were sectioned into 3 cm increment, dried and ^{137}Cs activity quantified using a Germanium detector and multi-channel analysis profile distribution of ^{137}Cs and used to estimate sedimentation rates (DeLaune et al. 1978). Surface sediment was collected with the aid of a Peterson dodge. Vegetation samples were collected randomly from marsh sites in vicinity of the sites in which the cone were subsequently installed. Total element content in surface sediment and in marsh vegetation near the cone displaced site were determined by acid digested and ICP analysis (Plumb 1981).

Results from ^{137}Cs profiled distribution indicated rapid rates of sedimentation at the two marsh sites sampled (Fig. 1a & 1b). At site 2, the rate was greater than 1 cm/year. This actual sedimentation rate could not be calculated because the 63 horizon (years of maximum ^{137}Cs fall-out) was not reached. The marsh at site 3 (which the 63 marsh horizon was evident) indicated a sedimentation rate of 1.3 cm/year. The sedimentation obtained from the 2 core rates would not compensate for reported subsidence or submergence rates reported for this area of the Mississippi River deltaic plain. Compared to submergence, the sedimentation rate support the rapid rate of marsh deterioration in this particular area of coastal Louisiana.

Sedimentation rate was difficult to determine in the core collected from the bay-bottom (Figs. 1c - 1f). The sediment physical characteristics (sand and shell fragment) at sites 2, 3, and 6 did not retain sufficient ^{137}Cs to estimate sedimentation rates. Site 5 was the only core in which we are able to obtain an adequate ^{137}Cs profile distribution. Using the 63 marker we estimate sedimentation to be approximately 0.70 cm/year at site 5, a rate also considerably less than subsidence in the area.

Elemental content of plant tissue were determined at five marsh sites (Table 1). These concentrations will be compared to the elemental contents of tissue of any marsh vegetation colonizing each site if sufficient sediment is trapped by the cones to support vegetation.

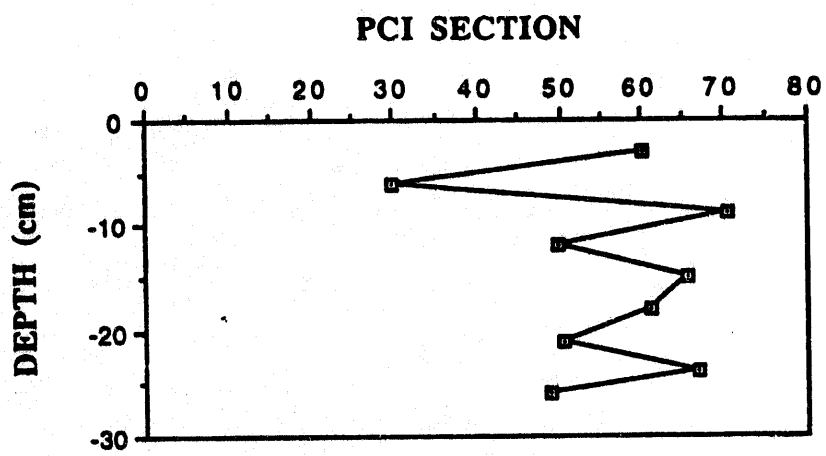
Elemental content of bottom sediment of the sites (3 locations at each site) was characteristic for the sediments in the area (Table 2). The chemical and physical properties of the sediment retained by the cones will be compared to these baseline sediment analysis. The collected sediment are currently being analyzed for particle size distribution (sand, salt, and clay) which will be compared to distribution of sediment trapped by the cones.

The present data will provide the baseline information on plant-sediment on each site which will be used to compare sediment-vegetation relationships on these site as affected by cone placement. The potential changes in soil characteristics and vegetation structural/compositional changes will be further preserved as the research project continues. A second trip is being planned (Spring 93) for collecting and analyzing sediment trapped in the cones on each site. The sediment will be characterized and compared to the present baseline sediment data.

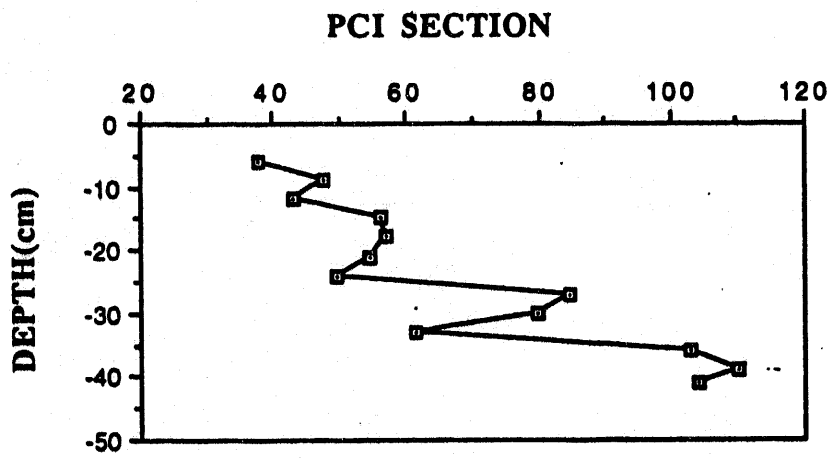
REFERENCES

DeLaune, R.D., W.H. Patrick, Jr., and R.J. Buresh. 1978. Sedimentation rates determined in ^{137}Cs dating in a rapidly accreting salt marsh. Nature 274:532-533.

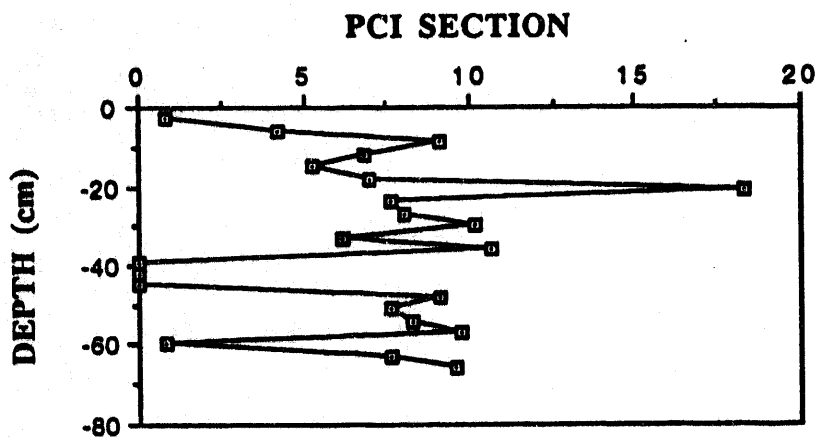
Plumb, R.H., Jr. 1981. Procedures for Handling Chemical Analysis of Sediment and Water Samples. Technical Report EPA/CE-81-1. Environmental Laboratory, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi.



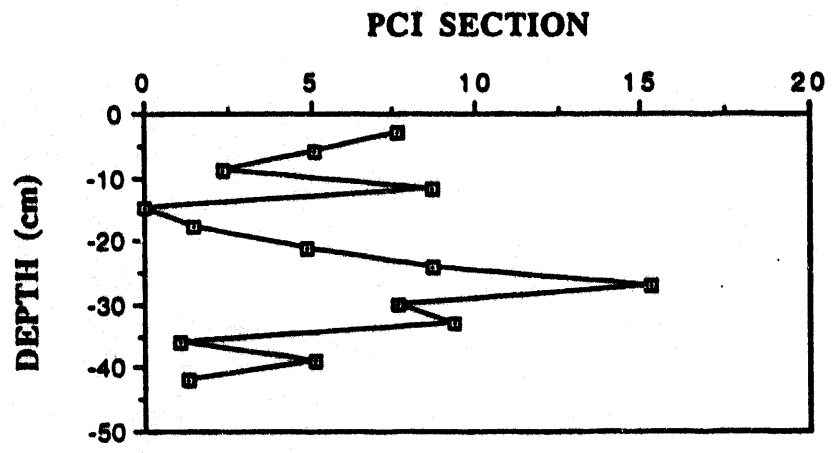
Cs Profile Distribution (Site 2 marsh)



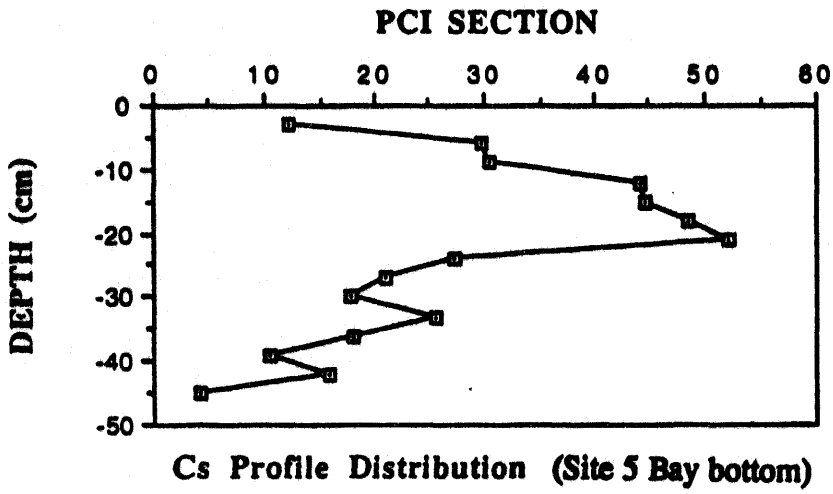
Cs Profile Distribution (Site 3 marsh)

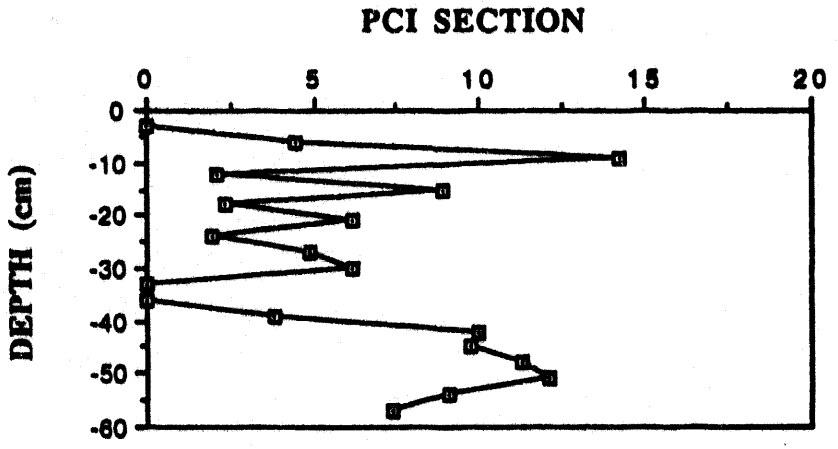


Cs Profile Distribution (Site 2 Bay bottom)



Cs Profile Distribution (Site 3 Bay bottom)


PCI SECTION
0
10
20
30
40
50
60
0
-10
-20
-30
-40
-50
DEPTH (cm)
Cs Profile Distribution (Site 5 Bay bottom)



Cs Profile Distribution (Site 6 Bay bottom)

(Site 2 marsh)

	depth	dry wt.	area	pci section
1	-3.000	213.487	283.000	60.126
2	-6.000	167.476	141.000	29.957
3	-9.000	246.886	332.000	70.537
4	-12.000	171.804	234.000	49.716
5	-15.000	184.213	309.000	65.650
6	-18.000	197.284	287.000	60.976
7	-21.000	149.993	237.000	50.353
8	-24.000	173.847	316.000	67.137
9	-26.000	130.654	229.000	48.653

(Site 3 marsh)

	depth	dry wt.	area	pci section
1	-3.000	207.539		
2	-6.000	179.400	179.000	38.030
3	-9.000	187.600	225.000	47.803
4	-12.000	188.300	203.000	43.129
5	-15.000	226.300	264.000	56.089
6	-18.000	213.700	268.000	56.939
7	-21.000	233.400	256.000	54.390
8	-24.000	195.100	233.000	49.503
9	-27.000	239.400	399.000	84.772
10	-30.000	223.900	375.000	79.673
11	-33.000	208.700	290.000	61.613
12	-36.000	219.500	484.000	102.831
13	-39.000	368.800	518.000	110.054
14	-41.000	112.000	490.000	104.105

(Site 2 Bay bottom)

	depth	dry wt.	area	pci section
1	-3.000	191.048	4.000	0.850
2	-6.000	118.661	20.000	4.249
3	-9.000	124.201	43.000	9.136
4	-12.000	106.218	32.000	6.799
5	-15.000	130.229	25.000	5.311
6	-18.000	124.934	33.000	7.011
7	-21.000	102.905	86.000	18.272
8	-24.000	85.803	36.000	7.649
9	-27.000		38.000	8.073
10	-30.000		48.000	10.198
11	-33.000	76.098	29.000	6.161
12	-36.000	119.930	50.000	10.623
13	-39.000	110.618	0.000	0.000
14	-42.000	163.144	0.000	0.000
15	-45.000	147.593	0.000	0.000
16	-48.000	145.349	43.000	9.136
17	-51.000	171.403	36.000	7.649
18	-54.000	80.869	39.000	8.286
19	-57.000	83.068	46.000	9.773
20	-60.000	120.020	4.000	0.850
21	-63.000	127.630	36.000	7.649
22	-66.000	121.290	45.000	9.561

(Site 3 Bay bottom)

	depth	dry wt.	area	pci section
1	-3.000	202.320	36.000	7.649
2	-6.000	170.456	24.000	5.099
3	-9.000	136.174	11.000	2.337
4	-12.000	163.187	41.000	8.711
5	-15.000	222.078	0.000	0.000
6	-18.000	152.422	7.000	1.487
7	-21.000	106.368	23.000	4.887
8	-24.000	145.746	41.000	8.711
9	-27.000	208.107	72.000	15.297
10	-30.000	202.810	36.000	7.649
11	-33.000	179.637	44.000	9.348
12	-36.000	183.658	5.000	1.062
13	-39.000	152.288	24.000	5.099
14	-42.000	226.491	6.000	1.275

(Site 5 Bay bottom)

	depth	dry wt.	area	pci section
1	-3.000	101.783	0.000	0.000
2	-6.000	111.549	21.000	4.462
3	-9.000	106.154	67.000	14.235
4	-12.000	76.152	10.000	2.125
5	-15.000	111.597	42.000	8.923
6	-18.000	91.603	11.000	2.337
7	-21.000	100.067	29.000	6.161
8	-24.000	103.314	9.000	1.912
9	-27.000	70.688	23.000	4.887
10	-30.000	120.263	29.000	6.161
11	-33.000	216.880	0.000	0.000
12	-36.000	272.820	0.000	0.000
13	-39.000	132.938	18.000	3.824
14	-42.000	157.563	47.000	9.986
15	-45.000	174.291	46.000	9.773
16	-48.000	220.022	53.000	11.260
17	-51.000	197.883	57.000	12.110
18	-54.000	101.952	43.000	9.136
19	-57.000	66.084	35.000	7.436

(Site 6 Bay bottom)

	depth	dry wt.	area	pci section
1	-3.000	78.637	57.000	12.110
2	-6.000	160.747	140.000	29.744
3	-9.000	152.570	143.000	30.382
4	-12.000	290.701	208.000	44.192
5	-15.000	191.131	210.000	44.617
6	-18.000	198.349	228.000	48.441
7	-21.000	407.724	246.000	52.265
8	-24.000	519.532	129.000	27.407
9	-27.000	563.099	99.000	21.034
10	-30.000	491.327	84.000	17.847
11	-33.000	640.002	120.000	25.495
12	-36.000	508.337	85.000	18.059
13	-39.000	685.698	49.000	10.411
14	-42.000	616.404	75.000	15.934
15	-45.000	719.853	19.000	4.037

Table 1. Elemental content of marsh vegetation

SAMPLE	Cu	Zn	Cd	Pb	Cr	Ni	As	Fe	Mn	Ca	Mg	Si	P	Al	K	Na
					µg/g								mg/g			
SITE 1	36	58	0.6	47	2.5	2.8	4.1	160	60	2.3	2.0	0.028	1.2	0.14	11	20
SITE 2	18	27	0.5	0.6	1.7	3.6	7.4	161	102	3.1	3.5	0.009	1.3	0.14	12	18
SITE 3	26	28	0.3	<0.035	1.1	2.8	6.8	90	138	2.8	3.4	0.013	1.3	0.050	15	24
SITE 4	14	30	0.2	<0.035	1.2	1.1	4.9	97	87	3.2	2.5	0.0080	1.2	0.056	15	17
SITE 5	15	24	0.2	<0.035	1.4	3.7	6.5	120	161	3.8	3.4	0.0086	1.3	0.11	9.6	24

Table 2. Elemental content of Bottom sediment

Sample	Cu	Zn	Cd	Pb	Cr	Ni	As
				µg/g			
REP 1	19	48	0.8	27	14	11	114
REP 2	21	49	1.1	38	17	13	147
REP 3	12	39	0.2	12	12	7.5	104
REP 1	22	54	1.1	46	18	12	159
REP 2	13	12	0.6	18	1.5	2.8	5.6
(SHELL)							
REP 3	17	43	0.9	31	11	8.3	82
REP 1	24	42	1.1	32	14	13	131
REP 2	26	61	1.1	45	24	17	225
REP 3	22	75	1.2	48	24	15	221
REP 1	26	76	1.5	63	29	20	274
REP 2	28	81	1.9	63	30	23	275
REP 3	23	59	1.3	43	22	17	201
REP 1	20	38	1.1	26	14	13	108
REP 2	21	37	0.9	19	14	15	99
REP 3	30	68	1.8	53	25	20	249
REP 1	30	63	1.5	43	20	18	179
REP 2	23	65	1.3	47	21	18	204
REP 3	30	87	1.4	39	20	17	176
REP 1	15	21	0.6	19	2.8	6.5	13
REP 2	37	92	2.2	81	38	26	370
REP 3	19	12	0.7	19	1.9	3.6	7.9

	Fe	Mn	Ca	Mg	Si	P	Al	K	Na
					mg/g				
SITE 1									
	9.9	0.12	3.9	3.3	0.066	0.35	7.7	1.9	5.6
	12	0.23	5.3	3.8	0.067	0.45	9.9	2.5	6.5
	8.6	0.13	5.6	2.8	0.041	0.30	7.7	0.97	4.2
SITE 2									
	11	0.17	26	3.9	0.063	0.44	11	3.5	7.2
	0.30	0.15	40	1.9	0.016	0.17	0.087	<0.001	3.1
	6.3	0.27	40	3.0	0.043	0.36	5.7	1.7	6.2
SITE 3									
	9.1	0.15	27	3.1	0.068	0.41	8.8	3.0	6.4
	14	0.15	5.0	4.4	0.13	0.42	16	4.7	7.4
	15	0.12	3.3	4.3	0.070	0.40	15	4.6	7.6
SITE 4									
	18	0.13	3.4	5.4	0.071	0.51	19	6.0	12
	20	0.36	5.3	6.4	0.093	0.54	19	6.1	8.9
	14	0.13	2.2	4.5	0.077	0.42	13	4.1	8.2
SITE 5									
	9.1	0.18	15	4.3	0.066	0.41	7.1	2.0	3.7
	8.5	0.14	18	4.4	0.065	0.42	6.8	1.6	5.2
	18	0.20	10	7.2	0.10	0.46	17	5.9	30
SITE 6									
	14	0.12	12	4.6	0.069	0.44	12	4.0	8.4
	14	0.11	9.1	4.7	0.092	0.42	14	4.1	8.2
	14	0.12	5.2	4.7	0.057	0.42	11	3.6	7.7
SITE 7									
	0.79	0.23	44	1.8	0.011	0.21	0.44	<0.001	4.0
	22	0.39	5.1	6.6	0.090	0.64	25	6.7	14
	0.45	0.16	44	1.8	0.016	0.19	0.14	<0.001	4.6

Appendix D

Annual Report from Xavier University

Appendix C

Annual Report from Xavier University

Report on the Trace Element Content of

Marsh Sediments in the Study Area

Research is being conducted at Xavier to determine the trace metal qualities of coastal marsh sediments, and the status of plants and symbiotic mycorrhiza within these same sediments. This report focuses on the results of the trace metal chemical analysis of marsh sediments from the coastal erosion study area.

The sediments were collected on May 1, 1992. A portion of the collected sediments were dried and crushed for extraction and trace element analysis. The Chaney-Mielke method was used to extract elements from the sediments. 5 g of dry sediment is mixed with 25 ml of 1MHNO_3 at room temperature. The 1:5 mixture is shaken for 2 hours and filtered. The trace element content of the filtrate were measured using two different analytical instruments, an old IL model atomic absorption spectrometer (AAS) and a new Spectral combination sequential and simultaneous inductively coupled plasma spectrometer (ICP).

TABLE 1 provides the raw data and calculations for the quantities of lead (ppm) measured in the marsh sediments by AAS. TABLE 2 provides a copy of the printout results of 19 metals (plus Ar) by the ICP.

Insert TABLES 1 and 2 here.

TABLE 1.

PROJECT Coastal Environment Project

Notebook No. _____

Continued From Page _____

Standards	Abs	X 5 Pb		
0.5	0.4			
1	0.9			
5	4.9			
10	9.8			
20	19.9			
		AA results (in ppm)	ICP results (in ppm)	
1A	2.8	14	18.53	
1B	3.0	15	18.60	
2A	2.9	14.5	18.[illegible]	
3A	.5	2.5	5.23	
3B	1.5	7.5	9.69	First six samples.
3C	1.8	9	10.25	[illegible]
4A	1.4	7	12.31	
4B	1.4	7	11.49	
4C	1.5	7.5	11.08	
5A	1.6	8	33.38	
5B	2.3	11.5	15.61	
5C	2.1	10.5	15.76	
6A	3.3	16.5	21.73	
6B	3.1	15.5	31.19	
6C	2.6	13	37.02	
7A	2.0	10	15.08	
7B	1.5	7.5	34.47	
7C	1.6	8	34.11	
Control			1.45	

Overall:
r = 0.34 between AA & ICP

Continued on Page

Read and Understood By

Signed: [illegible]

Date: 8-19-92

Signed: _____

Date: _____

Sample: blank Method: URBAN A (2) 04-01-93 08:56:19 (Ratio Int)

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	3423	2168	14875	692.4k	883	1694	2744	3012	2054	989	731	695	1172	1006	928	646

	As	Cal	Se	Hg	Sb
x̄	351	7377	622	4261	2270

TABLE 2.

Sample: 50ppm Method: URBAN A (2) 04-01-93 08:58:21 (Ratio Int)

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	32801	49201	!3253k	673.7k	186.2k	259.5k	80062	791.6k	68878	338.0k	296.2k	1378k	219.4k	730.8k	52661	727.0k

	As	Cal	Se	Hg	Sb
x̄	32357	12056	32252	83752	262.7k

Element	Wave	Typ	Factor	Offset	low - nom.	Low-act.	High-nom.	High-act
1 K	766.49	2pt. int	0.993	-47	3352	3423	32524	32801
2 Na	589.592	2pt. int	0.973	69	2179	2168	47952	49201
3 Ba	455.403	2pt. int	1.000	-710	14159	14875	3251443	3253359
5 Cu	324.754	2pt. int	1.012	-5	888	883	188366	186159
6 Ca	317.933	2pt. int	1.034	-112	1639	1694	268224	259480
7 Al	308.215	2pt. int	1.007	-19	2745	2744	80621	80062
8 V	292.402	2pt. int	0.998	-72	2933	3012	789771	791605
9 Mg	279.079	2pt. int	1.013	-27	2054	2054	69733	68878
10 Cr	267.716	2pt. int	1.007	-26	970	989	340376	337991
11 Fe	259.94	2pt. int	1.019	-28	716	731	301634	296165
12 Mn	257.61	2pt. int	1.016	1292	1998	695	1400845	1377781
13 Ni	231.604	2pt. int	1.003	-54	1121	1172	219972	219430
14 Cd	226.504	2pt. int	1.015	-12	1009	1006	741888	730834
15 Pb	220.353	2pt. int	0.996	-2	922	928	52445	52661
16 Zn	213.856	2pt. int	0.973	-30	599	646	707567	727039
17 As	189.042	2pt. int	0.932	21	348	351	30189	32357
18 Cal	431.865	2pt. int	0.948	103	7099	7377	11536	12056
19 Se	196.026	2pt. int	1.035	-16	628	622	33371	32252
20 Hg	253.652	2pt. int	1.061	-1	4520	4261	88853	83752
21 Sb	259.809	2pt. int	0.925	130	2230	2270	243227	262728

Sample: Control 1 Method: URBAN A (2) 04-01-93 09:00:27

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	0.989	1.006	1.060	687.1k	1.043	1.031	1.019	1.027	1.034	1.051	1.043	1.056	1.050	1.044	1.072	1.042

	As	Cal	Se	Hg	Sb
x̄	0.990	<1.591	1.009	3.524	0.983

Sample: 1a Method: URBAN A (2) 04-01-93 09:02:53

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	1148	≈14460	9.65	680.7k	7.61	≈ 3313	826	11.61	≈ 3021	<.1821	2139	23.68	3.121	<.1023	18.53	19.00

	As	Cal	Se	Hg	Sb
x̄	4.891	≈ 3202	3.060	867	2070

Sample: 1b Method: URBAN A (2) 04-01-93 09:04:55

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	1091	≈15577	7.15	678.6k	7.04	2813	869	12.22	≈ 3278	<.1821	1911	22.68	2.033	<.1023	18.60	15.27

	As	Cal	Se	Hg	Sb
x̄	5.13	2726	3.297	138.1	1789

Sample: 2a Method: URBAN A (2) 04-01-93 09:06:58

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	1189	≈13228	11.26	683.8k	7.24	1458	1013	9.71	2842	<.1821	2215	31.53	3.287	<.1023	18.28	22.09

	As	Cal	Se	Hg	Sb
x̄	4.696	1395	3.297	92.8	2079

Sample: 3a Method: URBAN A (2) 04-01-93 09:09:00

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	310.6	≈ 8299	6.02	686.5k	39.06	1201	738	5.68	1698	<.1821	2554	36.59	2.278	<.1023	5.23	20.81

	As	Cal	Se	Hg	Sb
x̄	4.696	1156	3.613	55.4	2372

Sample: 3b Method: URBAN A (2) 04-01-93 09:11:03

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	484.5	≈ 5478	8.45	687.0k	35.42	949	480.9	4.167	1186	<.1821	1801	18.07	0.831	<.1023	9.69	12.90

	As	Cal	Se	Hg	Sb
x̄	3.875	909	1.915	21.45	1655

Sample: 3c Method: URBAN A (2) 04-01-93 09:13:07

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	412.8	≈ 4479	7.74	687.5k	30.56	801	449.8	3.641	1012	<.1821	1757	13.72	0.945	<.1023	10.75	14.06

	As	Cal	Se	Hg	Sb
x̄	3.719	838	2.113	2.899	1736

Sample: 4a Method: URBAN A (2) 04-01-93 09:15:11

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	485.5	≈ 3129	22.20	678.5k	11.93	≈ 3817	618	3.676	2806	<.1821	2654	159.9	2.990	<.1023	12.31	13.05

	As	Cal	Se	Hg	Sb
x̄	4.305	≈ 4133	3.771	<2.694	2590

Sample: 4b Method: URBAN A (2) 04-01-93 09:17:14

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	583	≈ 3311	32.99	684.2k	13.38	2245	837	4.052	2109	<.1821	2909	224.6	5.90	<.1023	11.49	13.72

	As	Cal	Se	Hg	Sb
x̄	3.797	2368	3.968	<2.694	2848

Sample: 4c Method: URBAN A (2) 04-01-93 09:19:17

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x	641	* 4146	18.30	684.7k	6.69	1572	736	5.82	1689	<.1821	* 4170	47.54	1.224	<.1023	11.08	9.59

	As	Cal	Se	Hg	Sb
x	3.836	1661	4.166	<2.694	* 4007

Sample: 5a Method: URBAN A (2) 04-01-93 09:21:20

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x	138.8	2154	5.44	653.5k	<.2693	!31891	4.256	<.2106	733	<.1821	7.21	87.9	1.925	<.1023	33.38	<.0811

	As	Cal	Se	Hg	Sb
x	12.98	*85637	9.93	<2.694	2.765

Sample: 5b Method: URBAN A (2) 04-01-93 09:23:22

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x	935	*10004	10.50	682.8k	11.82	2469	830	7.58	2696	<.1821	* 3061	42.52	2.814	<.1023	15.61	18.97

	As	Cal	Se	Hg	Sb
x	4.891	2592	3.652	4.641	2861

Sample: 5c Method: URBAN A (2) 04-01-93 09:25:25

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x	949	* 9953	11.27	683.5k	5.52	2286	835	7.42	2839	<.1821	* 3041	50.2	2.837	<.1023	15.76	19.21

	As	Cal	Se	Hg	Sb
x	5.20	2456	3.771	19.33	3000

Sample: 6a Method: URBAN A (2) 04-01-93 09:27:29

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x	1189	*19061	6.85	681.0k	11.60	* 3121	869	12.06	* 4153	<.1821	* 5919	96.8	6.98	<.1023	21.73	31.38

	As	Cal	Se	Hg	Sb
x	9.74	* 3292	6.49	80.3	* 5403

Sample: 6b Method: URBAN A (2) 04-01-93 09:29:33

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x	955	*14751	7.64	667.3k	9.91	*18731	716	11.39	* 3712	<.1821	* 4456	83.3	7.56	<.1023	31.19	32.60

	As	Cal	Se	Hg	Sb
x	13.76	*21036	7.01	69.4	* 4360

Sample: 6c Method: URBAN A (2) 04-01-93 09:31:37

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x	756	* 8069	7.87	660.7k	5.63	!31881	582	6.72	2395	<.1821	2003	57.6	5.30	<.1023	37.02	17.57

	As	Cal	Se	Hg	Sb
x	14.11	*54558	10.05	21.46	1926

Sample: 7a Method: URBAN A (2) 04-01-93 09:33:40

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	960	*9851	11.60	686.8k	4.926	2393	778	7.63	2649	<.1821	2375	35.03	2.136	<.1023	15.08	15.11

	As	Cal	Se	Hg	Sb
x̄	4.657	2540	4.363	20.17	2304

Sample: 7b Method: URBAN A (2) 04-01-93 09:35:43

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	63.9	1824	5.23	657.9k	<.2693	!31890	5.53	<.2106	661	<.1821	3.332	81.8	1.942	<.1023	34.47	<.0811

	As	Cal	Se	Hg	Sb
x̄	14.27	*85841	10.09	<2.694	0.702

Sample: 7c Method: URBAN A (2) 04-01-93 09:37:46

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	176.1	2103	6.22	656.5k	<.2693	!31890	5.18	<.2106	955	<.1821	2.448	84.1	2.079	<.1023	34.11	<.0811

	As	Cal	Se	Hg	Sb
x̄	13.57	*82829	10.25	<2.694	1.437

Sample: control Method: URBAN A (2) 04-01-93 09:39:50

	K	Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	9.31	20.96	<.0546	692.3k	<.2693	117.7	2.770	<.2106	<1.578	<.1821	<.1492	<.1293	<.2931	<.1023	1.452	<.0811

	As	Cal	Se	Hg	Sb
x̄	<0.591	< 79.6	<0.966	<2.694	<.4995

Sample: Control 1 Method: URBAN A (2) 04-01-93 09:41:53

	K	†Na	Ba	Ar	Cu	Ca	Al	V	Mg	Cr	Fe	Mn	Ni	Cd	Pb	Zn
x̄	1.051	1.202	1.005	693.1k	0.999	1.021	1.008	0.977	1.025	1.002	0.992	1.016	1.013	1.021	1.059	1.022

	As	Cal	Se	†Hg	Sb
x̄	0.978	<1.591	1.060	4.264	0.911

The advantages of the ICP over the AAS is clear when table 1 is compared with table 2. The AA results were all run manually and the results were copied by hand from a digital readout. Only one element, lead, could be measured in a single run. The ICP is totally automatic. A program designed for urban soils was adapted for this first run of the coastal marsh sediments. In a single run, 19 different elements (plus Ar) where analyzed.

Comparison of the results for lead suggests some analytical problems. In previous comparisons for urban soil samples there has been outstanding correlation coefficients (r=>0.995) in the results between the two analytical instruments. For the first six samples the r-value is > 0.99, but after that the results differ markedly and the overall r-value is 0.34. There are several possible explanations for the descrepency. A clogged aspiration tube on the AA or a change in instrument parameters of either instrument would cause these results. Further research will be conducted to determine the source of the analytical differences. The first step will be to rerun the samples on the AA.

Note the results between the two different wavelengths used to analyze calcium. Ca 317.933 is the most sensitive wavelength. It "flared out" for sample 5a, 6c, 7b, and 7c. The correlation coefficient was 0.99967 for the 14 samples that were accurately measured in both wavelengths. The Ca

431.865 wavelength is less sensitive but more appropriate for measuring the calcium content in all samples.

Cadmium and chromium were undetectable in these sediment samples. Mercury is generally at the detection limit but shows up high in sample 1a, with traces in samples 1b, 2a, 3a, 3b, 5c, 6a, 6b, 6c and 7a. Cu, Mn and Ni vary a little and Fe, Sb and Al vary by several orders of magnitude. Further program development will be done to refine the method for sediment analysis.

In conclusion, the ICP results demonstrate major variations in the trace metal content of sediments from different sites. The work on plant identification and the results of the symbiotic mycorrhiza evaluation will be the focus of the next report. Future research will provide detailed results from the plant assessment study, show the degree of activity of mycorrhiza, and attempt to interrelate, if possible, the results from all of the environmental assessment studies.

Submitted by Howard W. Mielke, Ph.D., Xavier Univ. of LA

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