Monitoring Series No. CS-22-MSTY-0301-1

THREE-YEAR COMPREHENSIVE MONITORING REPORT
For the period March 01, 1997 to March 31, 2001

CLEAR MARAIS SHORELINE PROTECTION
CS-22

Second Priority List Shoreline Protection Project
of the Coastal Wetlands Planning, Protection, and Restoration Act
(Public Law 101-646)

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ACKNOWLEDGMENTS

The Louisiana Department of Natural Resources (LDNR) would like to acknowledge and extend its appreciation to the U.S. Geological Survey (USGS), National Wetlands Research Center (NWRC), for its help in acquiring and maintaining pre and post construction aerial photography analysis. Critical reviews of this document were provided by Ralph Libersat, Karl Vincent, Troy Barrilleaux, Rick Raynie, and Larry Reynolds of LDNR.

ABSTRACT

The Clear Marais shoreline protection project is located along the northern bank of the Gulf Intracoastal Waterway (GIWW) in Cameron Parish, Louisiana, between the Alkali ditch and Goose Lake. Erosion of levee banks along the GIWW threaten the integrity of adjacent interior ponds and marshes through increased exposure to tidal energy and salinity. In March 1997, a 35,000 ft (10.7 km) limestone breakwater was constructed adjacent to the northern bank of the GIWW to prevent additional erosion of the levee and potential encroachment of the GIWW into a highly organic freshwater marsh. Post-construction shoreline measurements conducted in 1997 and 2000 indicate that the total project area shoreline has pro-graded an average of 12.99 ft (3.89 m) and that the reference area has eroded an average of 20.52 ft (6.26 m). The data also suggest that no significant differences in rates of shoreline erosion have occurred among land types, although significant differences have occurred between land type one and the reference area. The preliminary results of the project suggest that the breakwater is effective in trapping sediments and preventing further erosion of the levee.

INTRODUCTION

The Clear Marais shoreline protection project area is located along the northern bank of the Gulf Intracoastal Waterway (GIWW) in Cameron Parish between the Alkali ditch and Goose Lake (figure 1). The project is designed to protect 4,311 acres (1,745 ha) of freshwater marsh that are threatened by saltwater intrusion and marsh loss from breaches in the GIWW shoreline (Soileau 1995). Of the 4,311 acres of fresh marsh, 2,056 acres (832 ha) are vegetated marsh and 2,255 acres (913 ha) are open water, with the dominant plant species present in the marsh being *Sagittaria lancifolia* (bulltongue), *Schoenoplectus californicus* (bullwhip), and *Juncus effusus* (soft rush).

The construction of the GIWW, which was deepened to its present depth of 12 ft (3.7 m) between 1942 and 1949, provides an avenue for high-action wave energy which increases during high river stages in the Calcasieu-Sabine basin (USDA/NRCS 1993). Marshes located adjacent to the GIWW are protected from rapid fluctuations of salinity and water level by a management levee. However, increased tidal action and boat wakes threaten to create breaches in the levee that would connect the GIWW with interior ponds and marshes. The susceptibility to saltwater damage and the erosional forces of the GIWW threaten the integrity of the remaining acres of vegetated freshwater marsh.

Preconstruction shoreline erosion rates in the vicinity of the project area have been estimated to be 3.9 ft/yr (1.19 m/yr) along the northern shoreline of the GIWW parallel to the (CS-24) Perry Ridge Shoreline Protection Project, (USDA 1994), and 16 ft/yr (4.88 m/yr) along the southern shoreline parallel to the (CS-27) Black Bayou Hydrologic Restoration Project (NMFS 1996).

Other projects that have successfully employed the use of a rock breakwater are the Blind Lake and Cameron Prairie Refuge (ME-09) projects. Both projects are located in Cameron Parish along the GIWW and have been subjected to the same high-energy wave erosion as the Clear Marais project area. Both projects have met their goals and objectives of preventing further erosion of existing spoil banks.

In March 1997, 35,000 linear ft (10,668 m) of rock breakwater were constructed along the north shore of the GIWW to protect the integrity of the Clear Marais freshwater wetlands north of the GIWW (figures 2 and 3). No connections for fishery exchange existed from the GIWW into the interior marsh prior to construction; therefore, the breakwater will have no impact on existing fishery access into the project area. The project objectives are to maintain and protect approximately 35,000 linear ft (10,668 m) of a management levee along the north bank of the GIWW that will contribute to protecting the integrity of the freshwater marshes of Clear Marais adjacent to the GIWW.

The following specific goals will contribute to the evaluation of these objectives:

1. Decrease the rate of shoreline erosion along the north bank of the GIWW south of the Clear Marais marshes through the use of a rock breakwater.

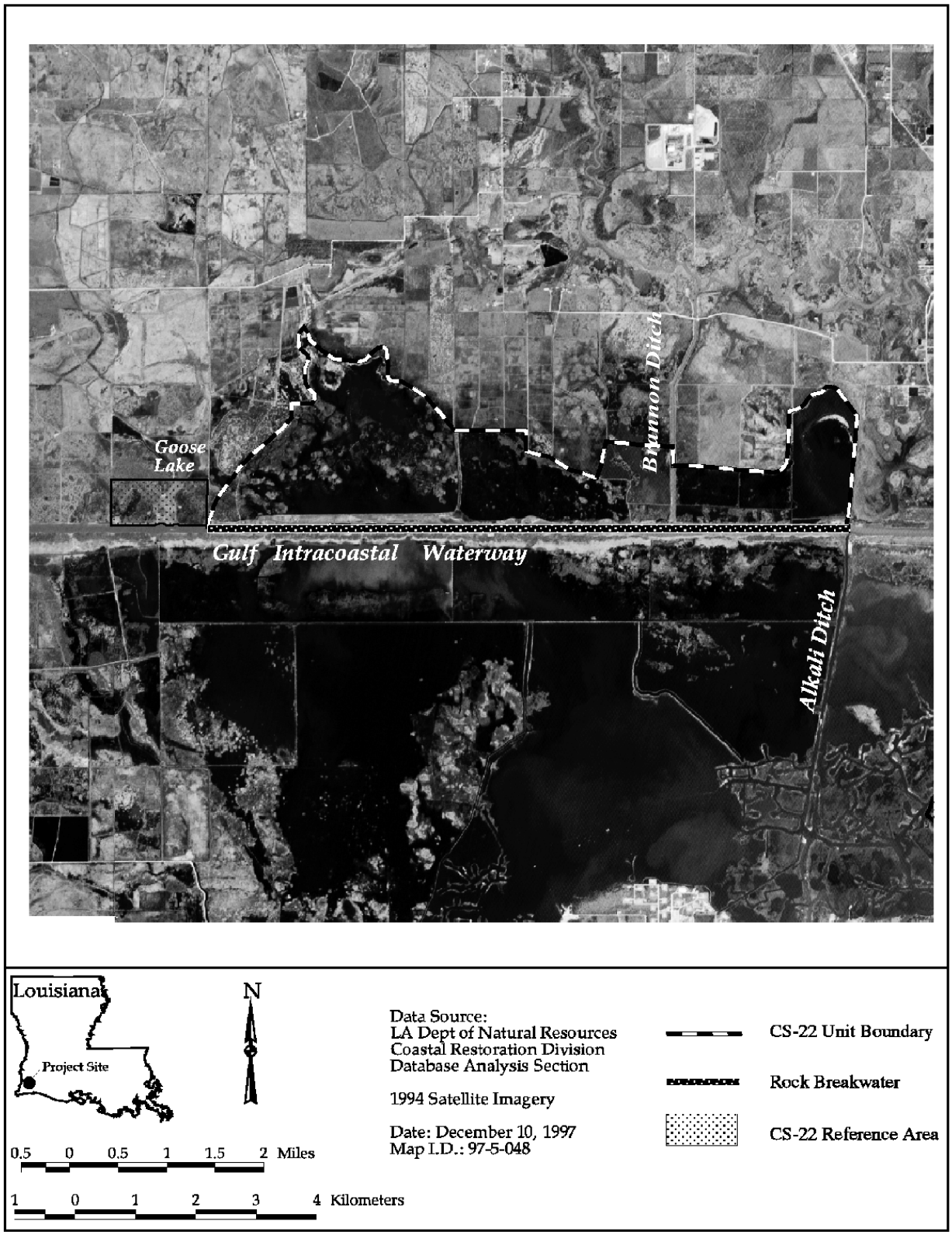

Figure 1. Clear Marais (CS-22) project area, reference area, and shoreline protection feature location

Figure 2. Photo of the rock breakwater looking W to E showing settlement plate (center), shoreline position (left side) and the GIWW Canal (right side).

Figure 3. Photo of the rock breakwater looking E to W showing shoreline position (right side) and the GIWW Canal (left side).

METHODS

A detailed description of the monitoring design over the entire project life can be found in Soileau and Horten (1998).

Aerial Photography:
To document vegetated and non-vegetated areas, near-vertical color-infrared aerial photography (1:12,000 scale) was obtained in 1994 (preconstruction), and will be used to measure vegetated and non- vegetated areas for the project and reference sites. The reference area was not dedicated before the preconstruction aerial photography flight, and was not officially included in the flight plan. However, the reference area was captured in the last frame for the project area. The reference area has since been included in the photo-mosaic and will receive GIS analysis to determine preconstruction conditions. The aerial photography will be interpreted by National Wetlands Research Center (NWRC) personnel according to the standard operating procedure described in the Quality Management Plan for Coastal Wetlands Planning, Protection, and Restoration Act Monitoring Program (Steyer et al.1995, revised 2000). Detailed photo-interpretation, mapping and GIS is not currently planned, although duplicate photography will be obtained in 2006 and 2015 post construction to determine if land/water analysis is feasible.

Shoreline Change:
Shoreline measurements were taken in 1997 as built and 2000 post-construction to determine the distance of the rock breakwater from the vegetated shoreline. To document shoreline movement, shoreline markers in the project area (n = 34) were placed at maximum intervals of 1,000 ft (305 m) on the existing vegetated shoreline behind the rock breakwater and in the reference area (n = 5) extending west from the project area for 1 mi (1.6 km). A global positioning system (GPS) was used to obtain coordinates for each settlement plate and shoreline marker to determine rates of change over time. Position of each settlement plate and shoreline marker was also documented by direct measurement at each settlement plate and shoreline marker to assure quality control over the GPS measurements. The shoreline was stratified into three different land types: (1) severe erosion directly adjacent to Clear Marais wetlands, (2) moderate erosion from the end of management levee to the Brannon Ditch and (3) mild erosion east of Brannon Ditch to the Alkali ditch. Determination of land types were made through the evaluation of aerial photography by the United States Department of Agriculture (USDA 1992) soil survey of Cameron parish. Land type 1 is located from settlement plate markers 22 to 34, land type 2 is located from markers 9 to 21, land type 3 is located from markers 1 to 8 and the reference area is located from markers 35 to 39 (figures 4 and 5).

Shoreline data sets were collected in years 1997, by Aucoin and Associates, Inc and in year 2000 by LDNR personnel (table 1). The data collected by Aucoin and Associates, Inc during the 1997 survey will be used as baseline data to compare future data sets of the shoreline position over time and for interpretation and evaluation of project effectiveness. Elevational data was collected every 1,000 ft (305 m) at permanent settlement plates established along the centerline of the rock breakwater and extending 50 ft (15.2 m) north of the vegetated marsh edge to approximately 50 ft (15.2 m) south of the breakwater centerline towards the GIWW channel. Roughly, every fifth cross-section was extended to include profiles for the entire

width of the GIWW including 50 ft (15.2 m) of the south shore. Elevational readings at each settlement plate were gathered at 10 ft (3 m) intervals between the actual shoreline (vegetation edges in project and reference areas), and the centerline of the rock breakwater.

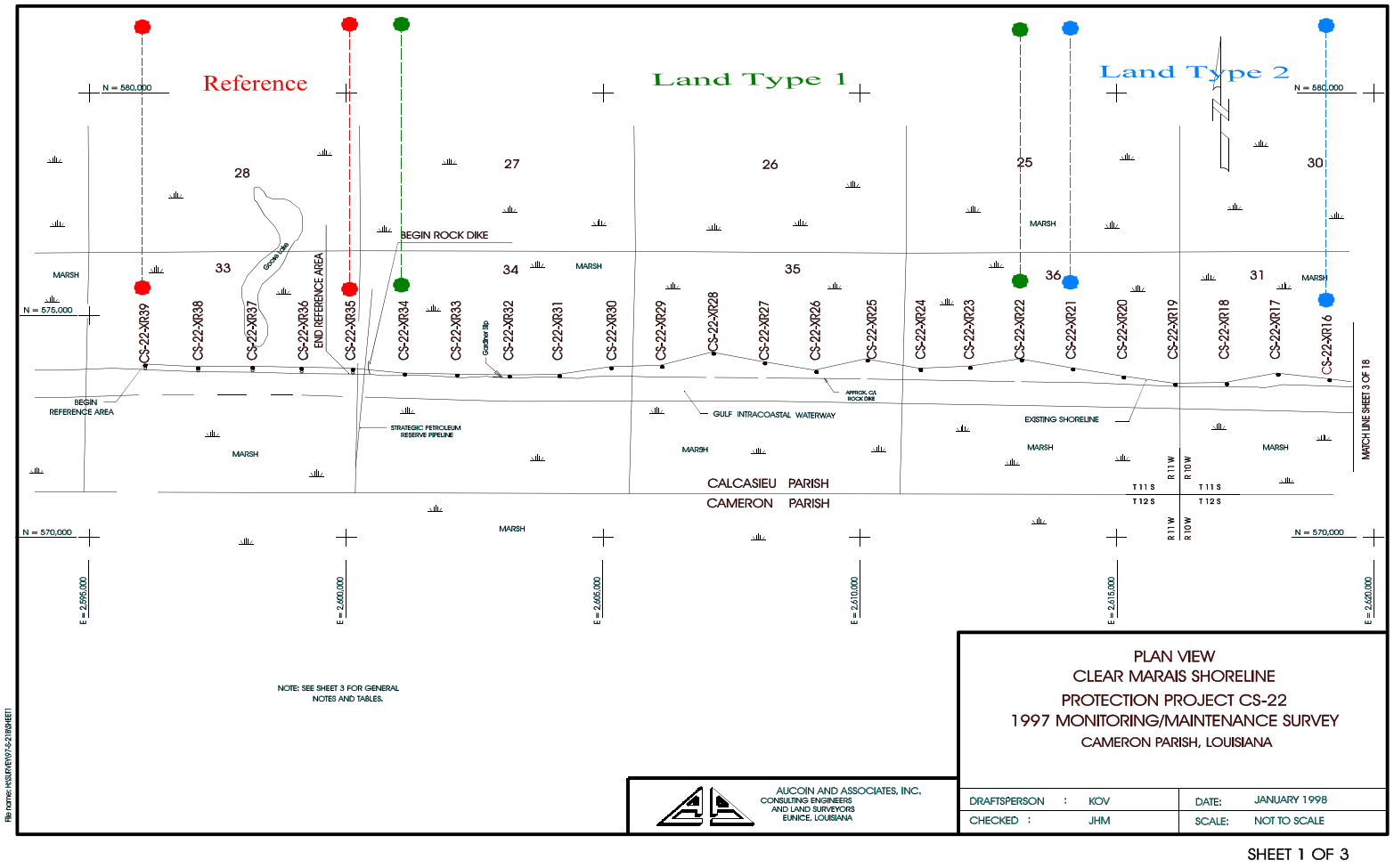

Figure 4. Partial plan view of the western portion of the Clear Marais (CS-22) project area incorporating shoreline markers 16 - 39. Markers 35 - 39 are in the reference area, markers 22 - 34 are in land type 1, and markers 16 - 21 are in land type 2.

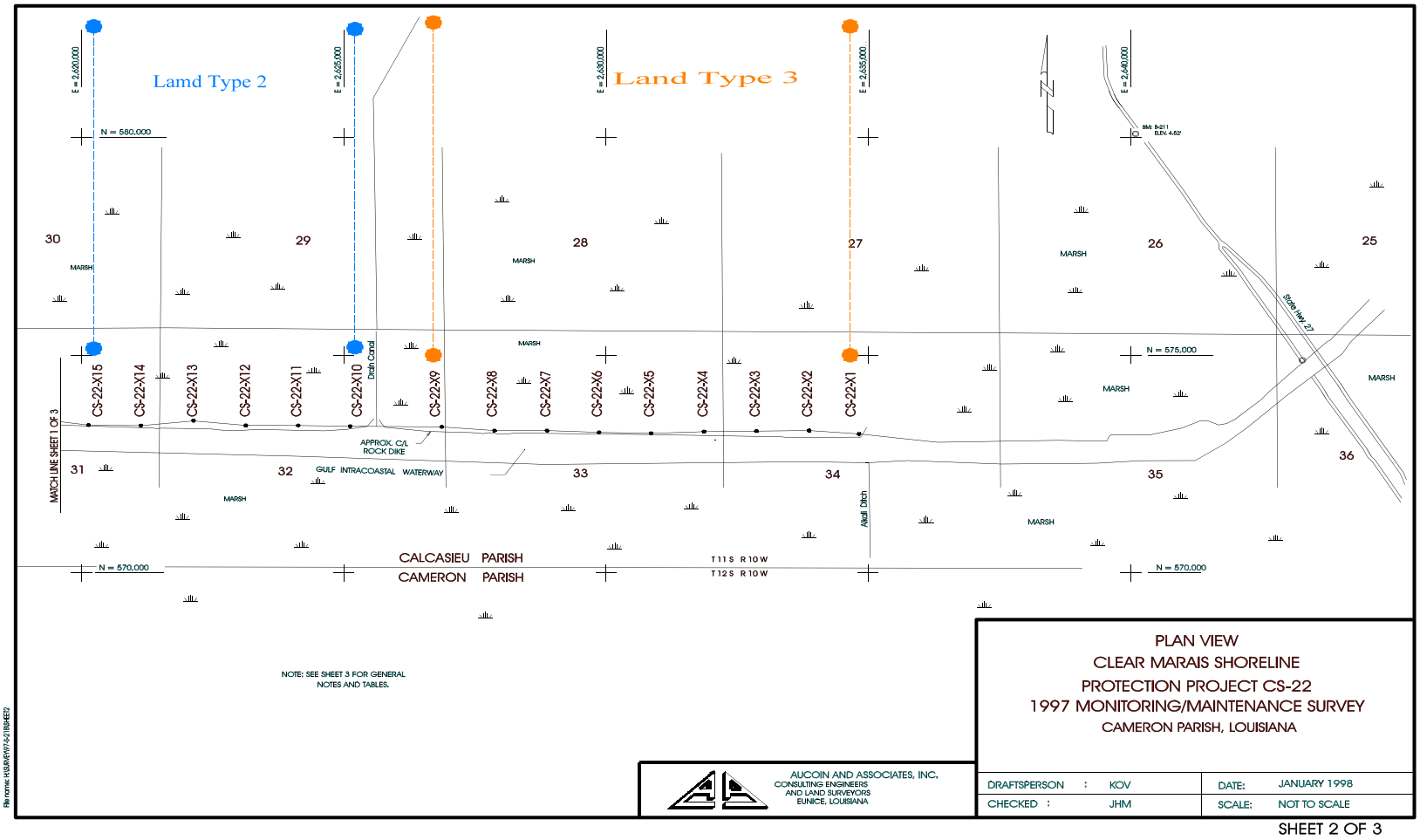

Figure 5. Partial plan view of eastern portion of the Clear Marais (CS-22) project area incorporating shoreline markers 1 -15. Markers 9 - 15 are in land type 2 and markers 1- 9 are in land type 3.

RESULTS

Aerial Photography:
The 1994 photo acquisition plans for the (preconstruction) aerial photography were acquired according to the original monitoring plan and approved by the LDNR. The photography was georectified, mosaicked, and a pre-construction land:water analysis was completed (figure 6). Results from this analysis indicate that the project area contained 32% land and 68% water. The next photo acquisition flights are scheduled in years 2006 and 2015 post construction, at which time land to water analysis can be initiated.

Shoreline Change:
Land types one and two, which were experiencing severe and moderate erosion respectively, before project construction gained 15.96 ft/yr (4.80 m/yr) and 1.62 ft/yr (0.49 m/yr), respectively. Land type three which was experiencing mild erosion showed a loss of 4.59 ft/yr (1.40 m/yr; table 1). Preliminary results for the first sets of data from September 1997 through May 2000 indicate that the total project area has pro-graded an average of 12.99 ft/yr (3.89 m/yr) and that the reference area has eroded an average of 20.52 ft/yr (6.26 m/yr; table 2). Shoreline progradation amongst individual sampling sites occurred at twenty four of the thirty four sites behind the rock breakwater while shoreline erosion occurred at all four sites located within the reference area (figure 7).

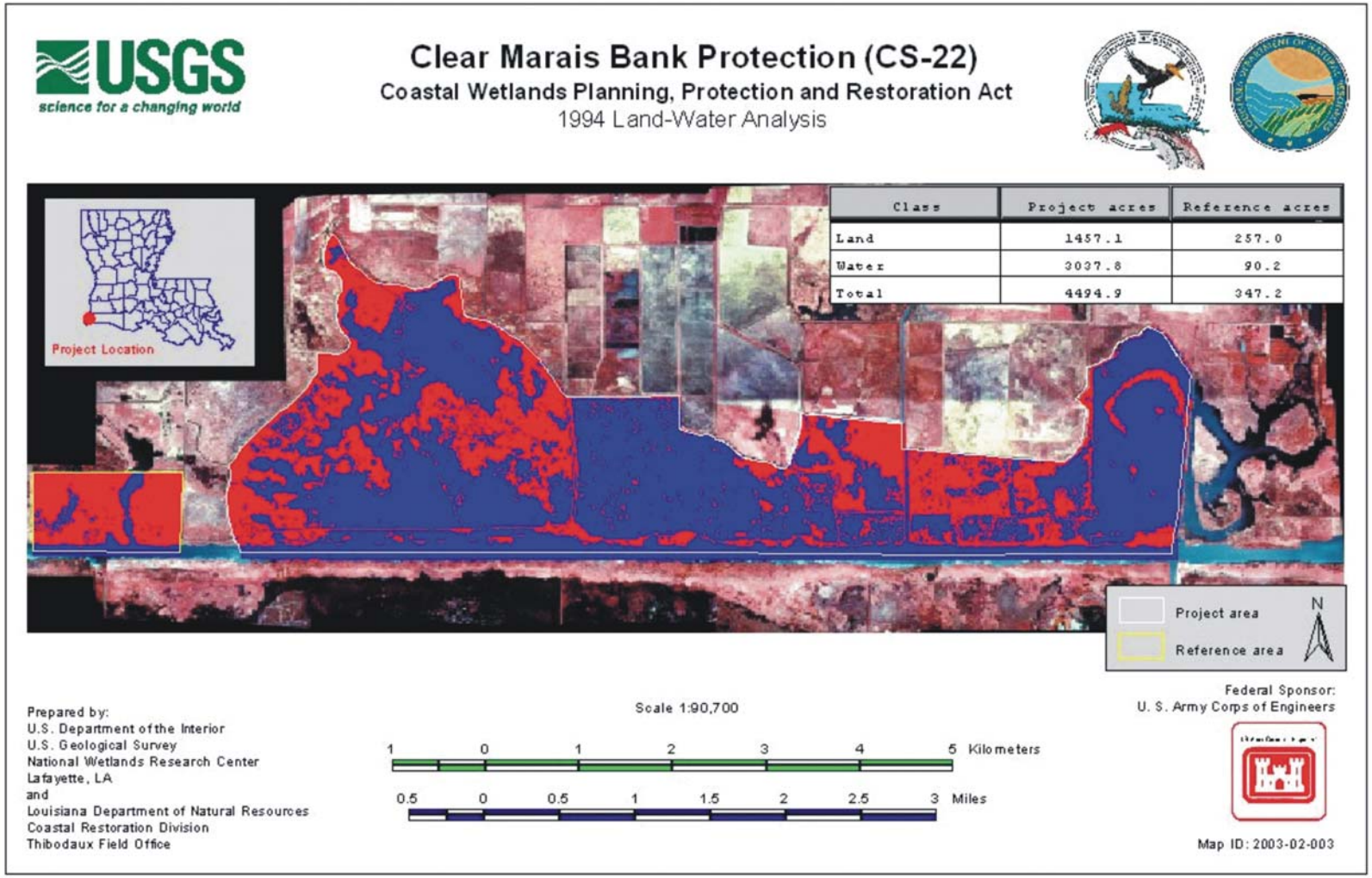

Figure 6. Land:water analysis from 1994 color infrared aerial photography collected for the Clear Marais Shoreline Protection (CS-22) project.

Table 1. Shoreline Changes at the project and reference monitoring stations along the North bank of the GIWW behind the CS-22 rock breakwater between September 1997 and May 2000. Stations are numbered from East to West.

Station No.	Land Type	September 1997 Baseline Data Distance (m)	September 1997Direct Measurements Distance (ft)	May 2000 Shoreline Distance (m)	May 2000 Shoreline Distance (ft)	Gain/Loss rates (m/yr)	Gain/Loss rates (ft/yr)
CS22-01	3	16.46	54.00	17.00	55.77	-0.20	-0.67
CS22-02	3	11.89	38.99	39.00	127.92	-10.19	-33.43
CS22-03	3	28.65	93.98	42.00	137.76	-5.02	-16.46
CS22-04	3	18.59	60.98	18.00	59.04	0.22	0.73
CS22-05	3	7.92	25.99	2.00	6.56	2.23	7.31
CS22-06	3	7.92	25.99	8.00	26.24	-0.03	-0.09
CS22-07	3	15.24	49.99	16.00	52.48	-0.29	-0.94
CS22-08	3	15.24	49.99	13.00	42.64	0.84	2.76
CS22-09	3	30.18	98.97	30.60	100.36	-0.16	-0.52
Average Land Type 3		**16.90**	**55.43**	**20.62**	**67.64**	**-1.40**	**-4.59**
CS22-10	2	9.14	29.99	7.00	22.96	0.81	2.64
CS22-11	2	28.35	92.98	27.00	88.56	0.51	1.66
CS22-12	2	29.26	95.98	23.00	75.44	2.35	7.72
CS22-13	2	48.77	159.96	49.00	160.72	-0.09	-0.29
CS22-14	2	13.11	42.99	12.00	39.36	0.42	1.36
CS22-15	2	7.01	22.99	4.00	13.12	1.13	3.71
CS22-16	2	39.01	127.97	40.00	131.20	-0.37	-1.21
CS22-17	2	62.79	205.95	62.00	203.36	0.30	0.97
CS22-18	2	16.46	53.99	16.00	52.48	0.17	0.57
CS22-19	2	7.32	23.99	5.00	16.40	0.87	2.86
CS22-20	2	46.33	151.96	47.00	154.16	-0.25	-0.83
CS22-21	2	83.21	272.93	83.00	272.24	0.08	0.26
CS22-22	2	135.94	445.89	NA	NA	N/A	N/A
Average Land Type 2		**32.56**	**106.81**	**31.25**	**102.50**	**0.49**	**1.62**
CS22-23	1	162.46	532.86	130.84	429.16	11.89	38.99
CS22-24	1	169.16	554.86	141.00	462.48	10.59	34.73

Table 1 continued.

Station No.	Land Type	September 1997 Shoreline Distance (m)	September 1997 Shoreline Distance (ft)	May 2000 Shoreline Distance (m)	May 2000 Shoreline Distance (ft)	Gain/Loss rates (m/yr)	Gain/Loss rates (ft/yr)
CS22-25	1	118.87	389.90	100.00	328.00	7.10	23.27
CS22-26	1	14.63	47.99	44.37	145.52	-11.18	-36.67
CS22-27	1	153.31	503.00	78.24	256.69	28.22	92.60
CS22-28	1	152.10	498.87	141.30	463.47	4.06	13.31
CS22-29	1	54.86	179.95	41.93	137.51	4.86	15.95
CS22-30	1	121.01	396.90	116.92	383.48	1.54	5.04
CS22-31	1	8.23	26.99	3.12	10.22	1.92	6.31
CS22-32	1	11.58	37.99	13.47	44.19	-0.71	-2.33
CS22-33	1	9.45	30.99	8.62	28.27	0.31	1.02
CS22-34	1	3.35	11.00	2.97	9.74	0.14	0.47
Average Land Type 1		**248.00**	**434.03**	**235.23**	**391.56**	**4.80**	**15.96**
CS22-35R	R	0.00	0.00	10.31	33.80	-3.87	-12.71
CS22-36R	R	0.00	0.00	13.51	44.32	-5.08	-16.66
CS22-37R	R	0.00	0.00	33.95	111.34	-12.76	-41.86
CS22-38R	R	0.00	0.00	8.80	28.86	-3.31	-10.85
CS22-39R	R	0.00	0.00	NA	NA	N/A	N/A
Average Reference Area		**0.00**	**0.00**	**16.64**	**54.58**	**-6.26**	**-20.52**

NA = No readings were available at this time period

Table 2. Mean shoreline gain/loss rates at the 3 land types within the project area and the reference area monitoring stations.

Land Type	No. Measurements	Time Period (yrs)	1997-2000 Mean Shoreline gain/loss rates (m/yr)	1997-2000 Mean Shoreline gain/loss rates (ft/yr)
1	12	2.66	4.80	15.96
2	12	2.66	0.49	1.62
3	9	2.66	-1.40	-4.59
Reference	4	2.66	-6.26	-20.52
Project Total	33	2.66	3.89	12.99

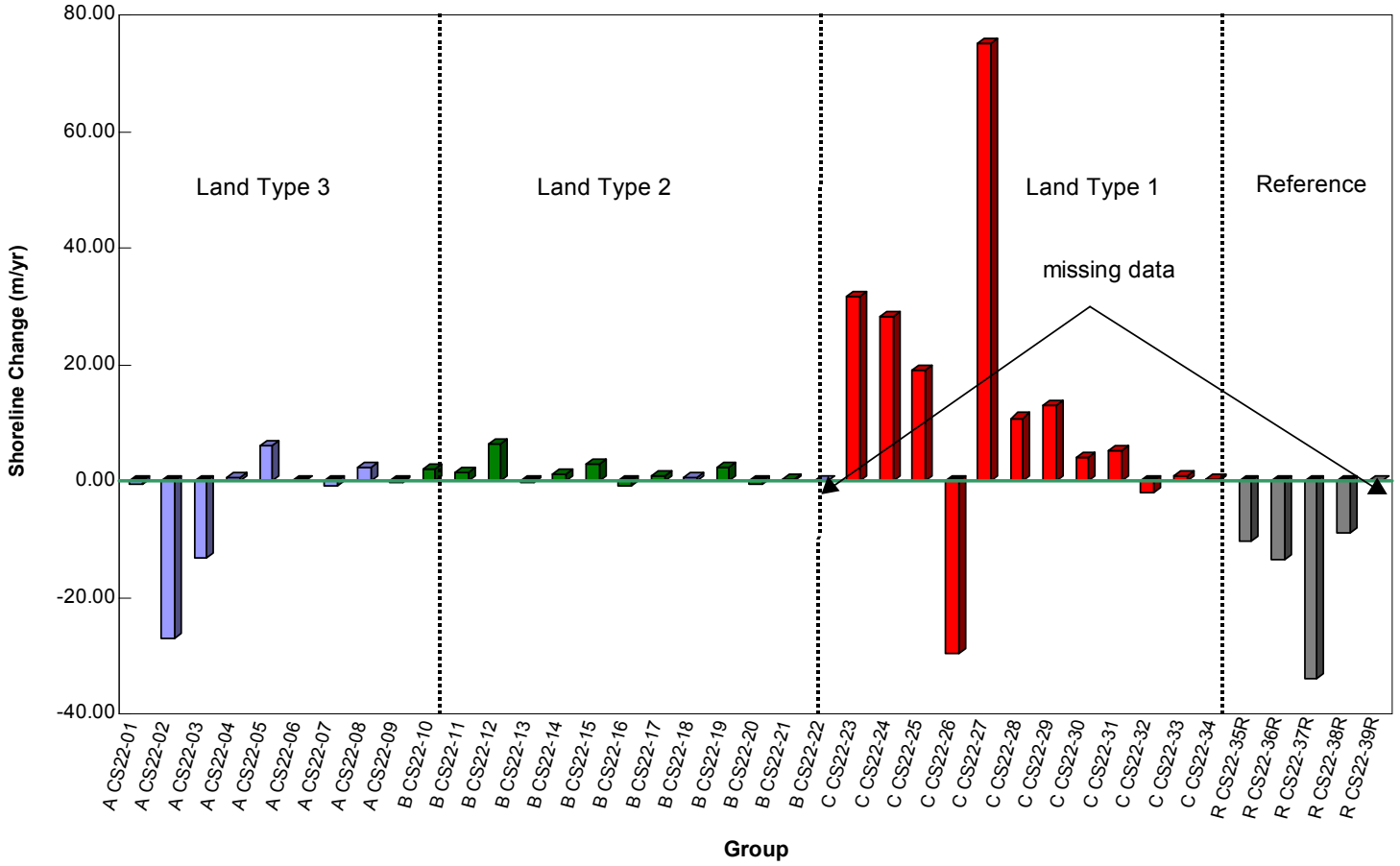

Figure 7. Absolute values of shoreline change at individual sampling sites, within the three land types from 1997 to 2000.

DISCUSSION

Aerial Photography:
The 1994 photo acquisition plans for the (preconstruction) aerial photography were acquired according to the original monitoring plan and approved by the LDNR. Preconstruction land:waster ratios for the project and reference areas were estimated to be 32% land:68% water and 74% land:26% water, respectively. The next photo acquisition flights are scheduled in years 2006 and 2015 post construction, at which time land and water changes can be evaluated..

Shoreline Change:
Land types one and two which were experiencing severe and moderate erosion, respectively, before project construction pro-graded an average of 15.96 ft/yr (4.80 m/yr) and 1.62 ft/yr (0.49 m/yr) respectively. Land type three, which was experiencing mild erosion, showed an average loss of 4.59 ft/yr (1.40 m/yr). This loss is most likely associated with the close proximity of the rock breakwater to the shoreline within this area. At some of the survey stations, vegetation was bordering the rock breakwater. Over topping of the rocks by barge traffic wakes has a direct effect on the shoreline within this area causing some erosion to occur. Due to land loss occurring within only land type 3, future shoreline surveys in this area will be monitored closely to determine the exact cause or causes of the land loss. However, in land types one and two, where the rock breakwater is positioned approximately 100 ft (30 m) away from the shoreline, pro-gradation of the shoreline was occurring, but will require more time because of the amount of sediments needed to fill these areas. Additional shoreline surveys to document shoreline position are scheduled in years 2003, 2006, 2010, and 2015.

CONCLUSION

The results presented in this report have shown that rock breakwaters are an effective erosion deterrent in sustaining and protecting shorelines in high barge traffic areas. The Clear Marais project has shown that, not only protecting the shoreline, but increasing land to water ratios behind the rock breakwater can be obtained in a few years. Shoreline gains have occurred at 24 of the 34 sampling sites behind the rock breakwater. However shoreline losses have occurred at all of the reference sites. Overall the project has shown a positive response of gaining an average of 12.99 ft/yr (3.89 m/yr) of land behind the rock breakwaters. When compared to the average loss of 20.52 ft/yr (6.26 m/yr) within the unprotected reference area, the overall benefits of constructing, maintaining and monitoring the rock breakwater cannot be underestimated. Wetland creation behind the rock breakwater is expected to continue only until the area between the existing shoreline and the rock breakwater is filled by vegetated wetland.

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For further information on this report, please contact Charles M. Miller at (337) 893-1256 or the LDNR and CWPPRA homepages at http://www.savelawetlands.org and http://www.lacoast.gov,

APPENDIX

Shoreline Cross Sections
Shoreline Photography

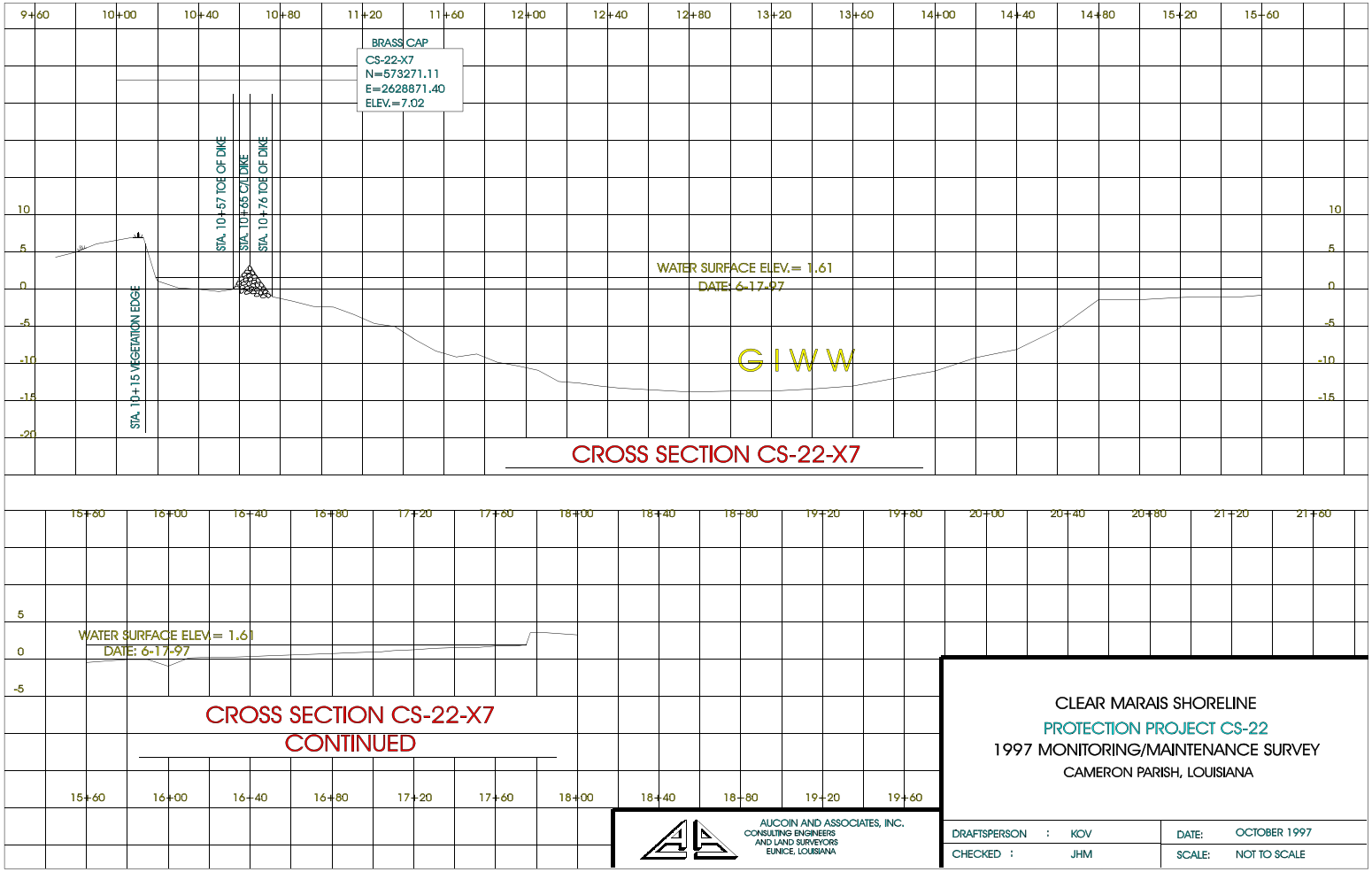

Figure A-1. Representative cross-section from land type 3 (station 7) in the project area.

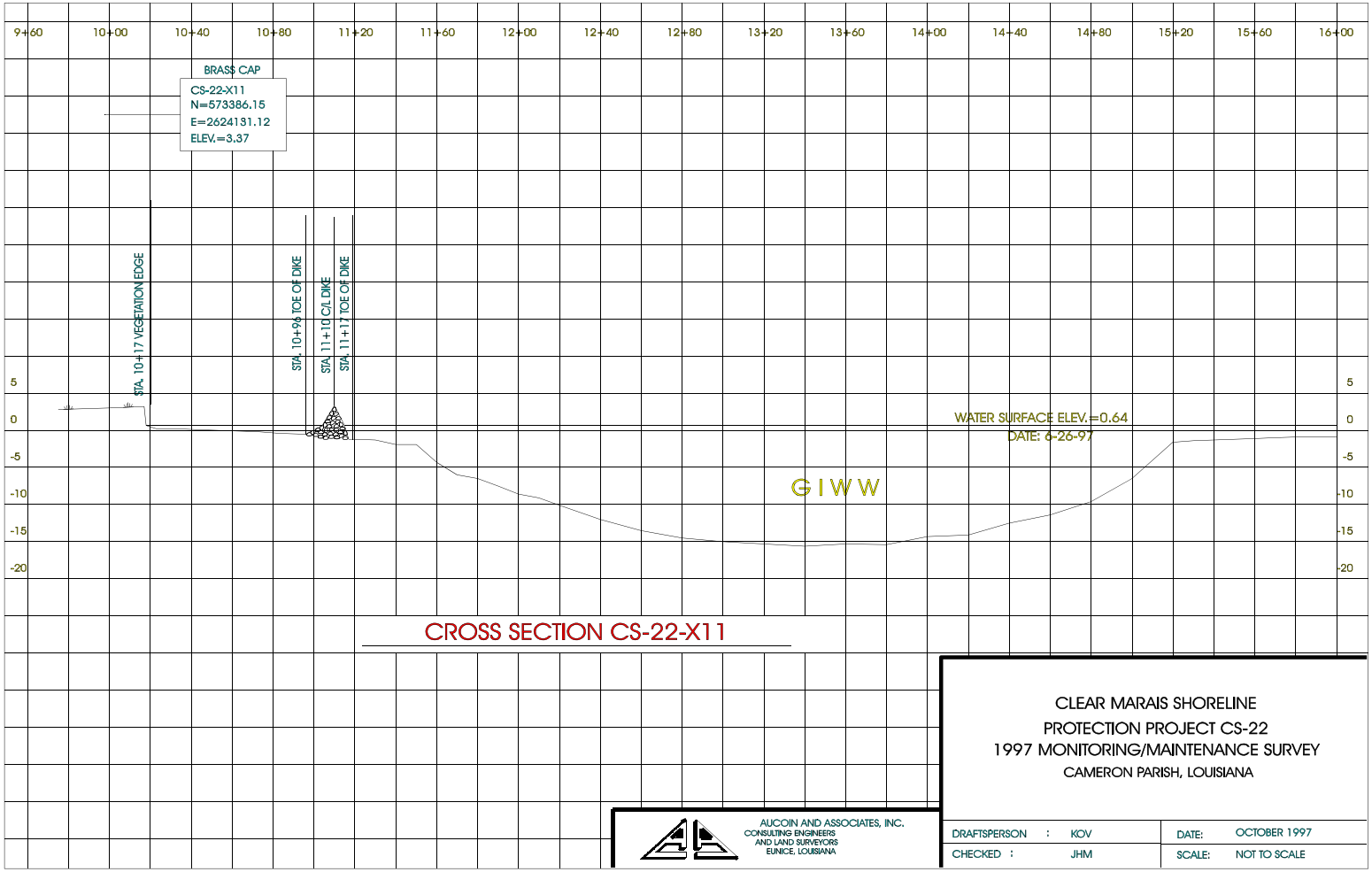

Figure A-2. Representative cross-section from land type 2 (station 11) in the project area.

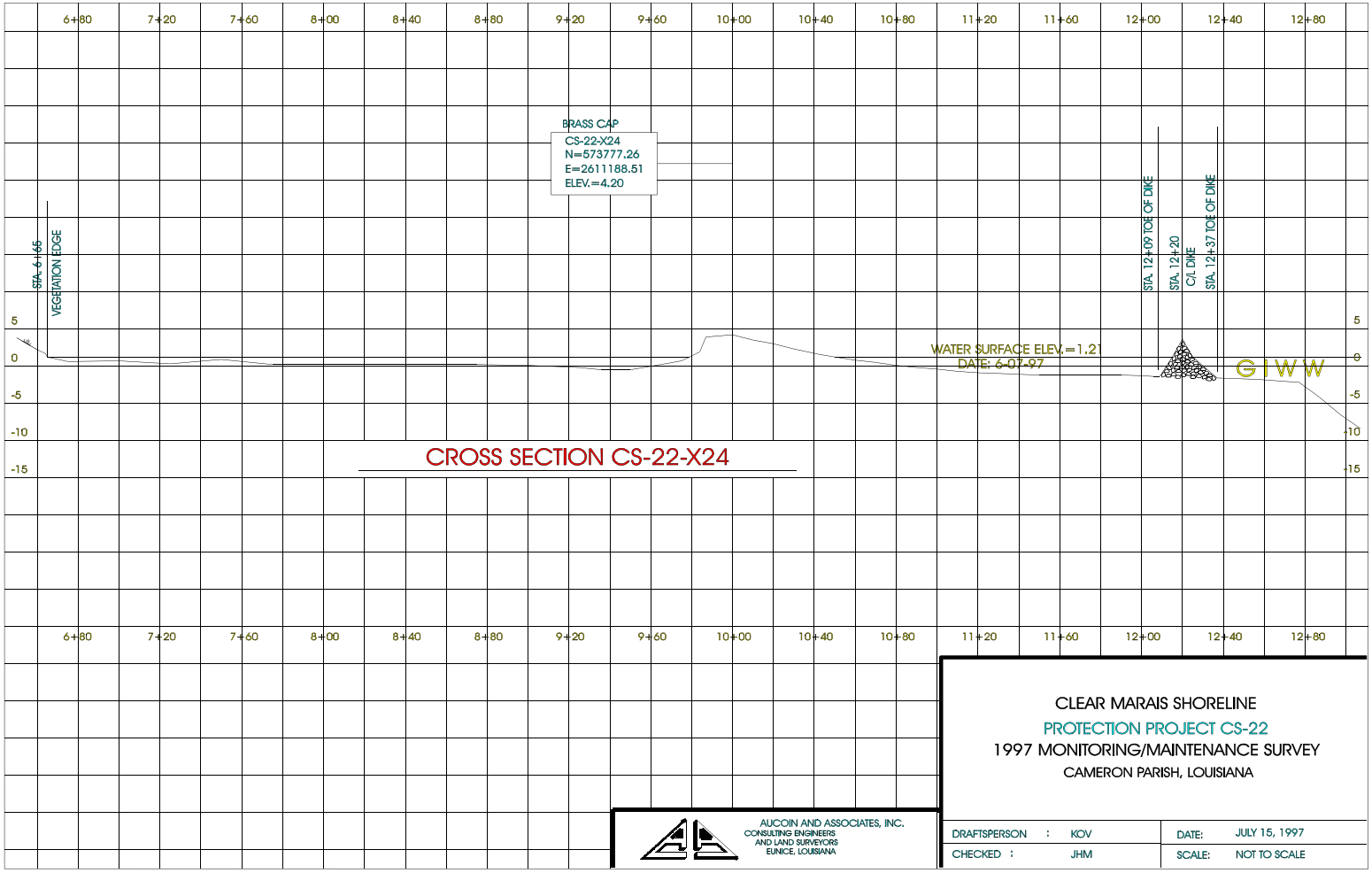

Figure A-3. Representative cross-section from land type 1 (station 24) in the project area.

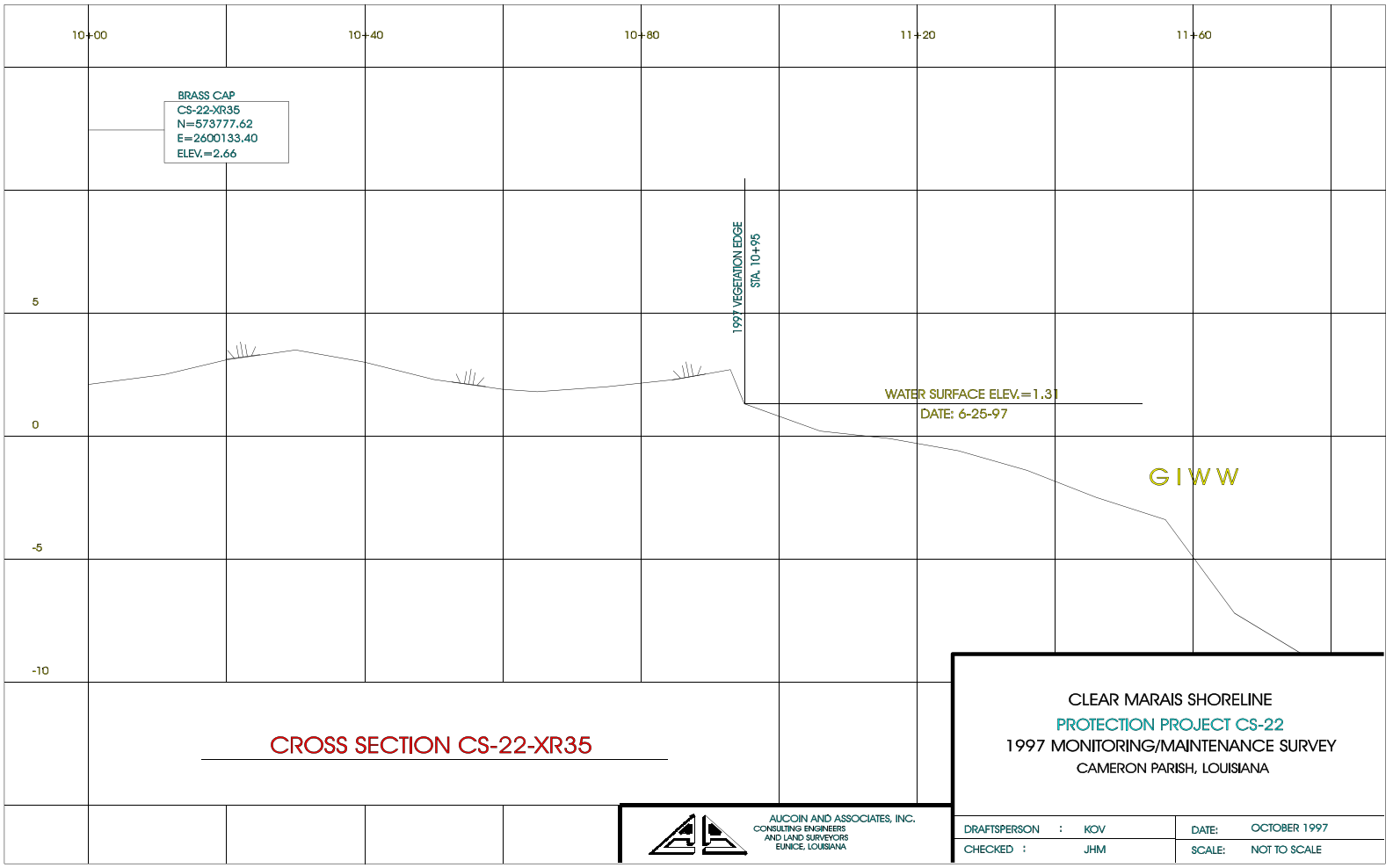

Figure A-4. Representative cross-section taken in the reference area (station 35).