BLIND PASS
INLET MANAGEMENT PLAN

DRAFT REPORT

Submitted To:

CAPTIVA EROSION PREVENTION DISTRICT

March 1992

COASTAL PLANNING & ENGINEERING, INC.

DRAFT

VII. COMPREHENSIVE INLET MANAGEMENT PLAN

The recommended plan for Blind Pass inlet management is a comprehensive plan addressing storm protection, erosion control, mitigation, sand bypassing and (to a lesser extent) navigation. The plan is a composite of alternatives designed to meet physical requirements and local desires. The recommended plan (Figure 46) consists of placement of 300,000 cubic yards of sand on northern Sanibel to restore the shoreline, with periodic nourishment to replace expected losses. A feeder beach is to be placed on southern Captiva to increase sand bypassing. Additionally, overwash areas in Clam Pass Bayou and Old Blind Pass are to be mechanically pushed westward, into a dune with the placed fill. An 800 foot revetment is to be constructed along the road area most vulnerable to storm damage on northern Sanibel. Finally, five private parcels south of the pass will be purchased to create public beach.

A more detailed explanation of the individual components of the plan follows:

A. Storm Protection Element

A revetment will be constructed along 800 feet of Sanibel-Captiva Road in 1993 to provide protection of the evacuation route. Part of the storm protection element will be to leave in place the groin built by Lee County and extended by CEPD. This action will maintain a protective beach in front of the Sanibel-Captiva Road just north of the Blind Pass bridge.

B. Mitigation for Past Inlet Improvement Effects

A total quantity of 300,000 cubic yards of sand will be placed on northern Sanibel to mitigate for effects that have been caused by the groin constructed by Lee County in 1972. This amounts to 15,000 cubic yards per year over a 20-year period. The construction will be accomplished in two phases. The first phase is to be implemented with the revetment construction in 1993; a total of 200,000 cubic yards will be placed at that time. The second phase will be constructed in 1996 as part of the Captiva Island beach renourishment program. Approximately 100,000 cubic yards of additional fill will be placed along with that project.

C. Sand Bypassing Element

To increase sand bypassing from Captiva to Sanibel Island, a feeder beach will be placed near the southern end of Captiva Island which will increase sand bypassing around the groin. This feeder beach is intended to mitigate future potential impacts of the groin and inlet system to the beaches to the south. The feeder beach would be placed every six years as part of maintenance. The feeder beach would consist of 15,000 cubic yards per year, or 45,000 cubic yards in 1992 and 90,000 cubic yards every six years thereafter.

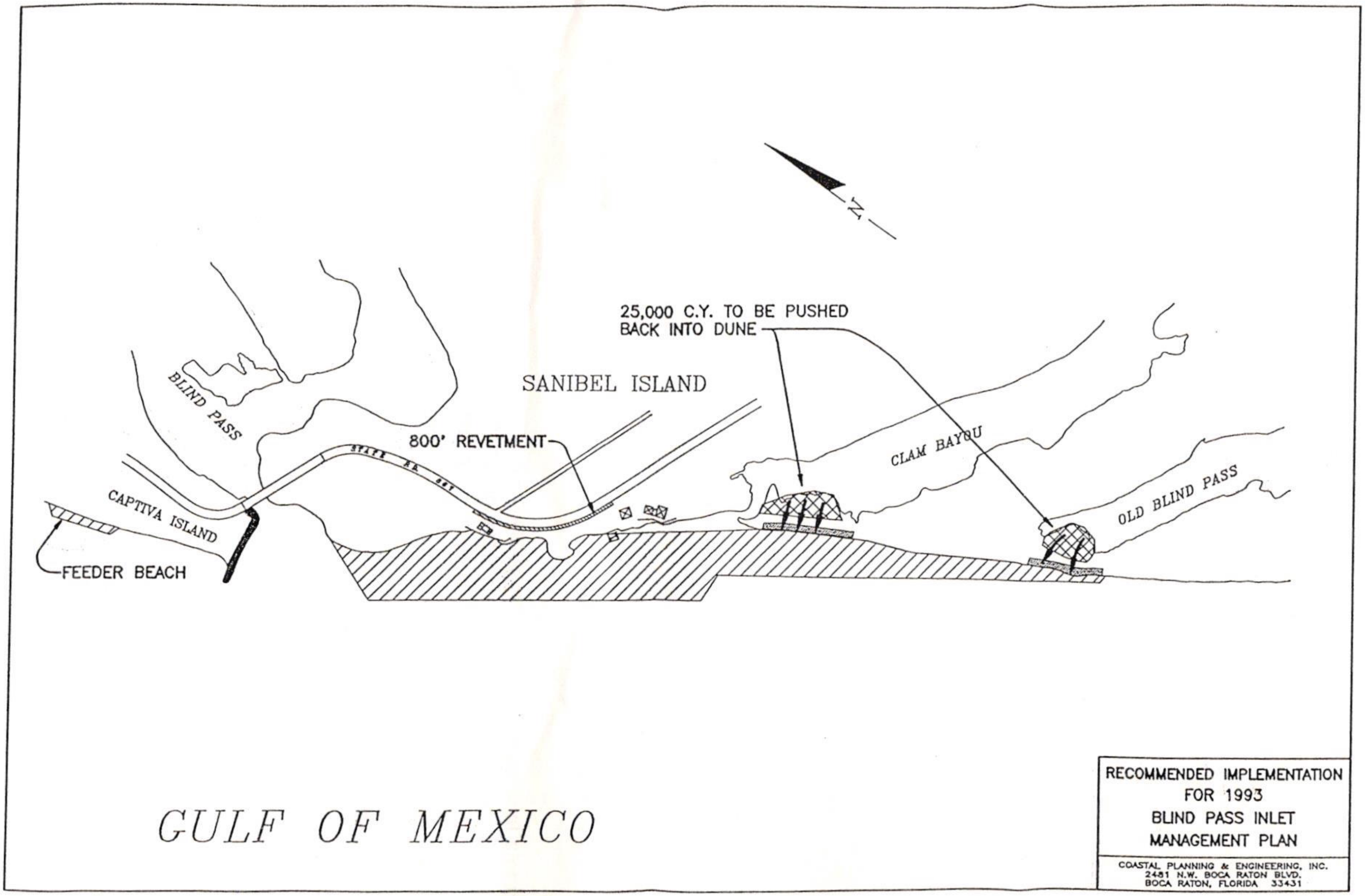

N
25,000 C.Y. TO BE PUSHED
BACK INTO DUNE
SANIBEL ISLAND
BLIND PASS
800' REVETMENT
CLAM BAYOU
OLD BLIND PASS
CAPTIVA ISLAND
FEEDER BEACH
GULF OF MEXICO
RECOMMENDED IMPLEMENTATION
FOR 1993
BLIND PASS INLET
MANAGEMENT PLAN
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 46

D. Erosion Control Element

The erosion control element consists of two components. The first component is intended to control the high retreat rates in the vicinity of Clam Pass Bayou and Old Blind Pass. Sand that has washed into the bayou will be pushed up into a berm and integrated with the beach nourishment program so that frequent overwash can be avoided. This element also ties in with the environmental element in that it allows the beach to be intermittently breached at this location. This provides for flushing of Clam Pass Bayou and Old Blind Pass as has been historically the case. Should a major storm overwash these islands and again lower the elevation, immediate emergency action would be undertaken to rebuild these spits to protect against frequent winter storm events. It is estimated that 25,000 cubic yards of sand is available for this purpose.

The second part of the erosion control element is the long term maintenance of the beaches adjacent to the pass. This includes both Captiva and Sanibel Islands. Captiva Island already has planned to renourish its beach on approximate 6-year intervals. Under the inlet management program, northern Sanibel beaches will be renourished on the same interval. Fill will be required in addition to the mitigation fill placed in 1993 and 1996 to address historical erosion rates for northern Sanibel. These rates have been estimated to be approximately 20,000 cubic yards per year. This amount is based on an historical erosion rate of 35,000 c.y./yr. less 15,000 c.y./yr. extra bypassing as a result of the feeder beach. Based on these projections, northern Sanibel's beaches will need approximately 60,000 cubic yards in 1993, and 120,000 cubic yards as part of the renourishment program in the year 1996 and every 6 years thereafter.

E. Navigation and Flushing Element

Part of the navigation and flushing element is to leave the north jetty in place which has apparently increased the stability and flushing capability of the pass. It is recognized that the feeder beach proposed under the sand transfer element will increase the sediment loads moving past the inlet. However, it has been determined that intermittent closure of the pass is acceptable to the adjacent communities as it replicates the historical, natural functioning of the pass. It is believed that the pass will remain as stable (or more stable) than it has been in the past with the above described actions undertaken.

Future consideration should be given to the potential construction of a south jetty on the pass to help direct tidal currents moving through the pass and to assist in stabilizing the sand transfer system along the ebb tidal shoal.

Consideration should also be given to dredging of active shoaling areas within the pass to improve the hydraulic stability of the pass as well as to recapture sand that is lost from the beach system. Dredge planning should be sensitive to seagrass communities and bird feeding areas that have developed within the pass as a result of historic and active shoaling.

The interior of the pass should be monitored annually subsequent to beach fill south of the inlet. It is possible that placement of fill immediately south of the inlet without a south jetty in place may increase shoaling within the pass. The monitoring would enable future evaluations for the need for a south jetty and/or interior dredging of Blind Pass.

F. Environmental Elements

The first environmental element for this program includes the movement of sand out of Clam Pass Bayou and Old Blind Pass to rebuild the beachface berm and dune system. This will enable Old Blind Pass and Clam Pass Bayou to interact with the Gulf in a manner in which they have historically, with intermittent flushing of the estuary systems.

The second environmental element of the program is to leave the jetty and jetty extension built by Lee County and the CEPD in place. This has shown to improve flushing of the pass and provides for water quality improvement within the pass.

The third component of the environmental plan is to forego consideration of dredging interior shoals within Blind Pass at this time. Portions of the flood shoal of Blind Pass are covered with seagrass and serve as nursery grounds for fish. In the surrounding tidal flats, terns, egrets, and herons forage upon small crustaceans, gastropods, worms and fish.

G. Public Access/Use Element

To address the public need for beach access, five private parcels located south of Blind Pass will be purchased, and the homes and structures will be removed. A parking lot will be constructed and dune vegetation will be planted on the vacant property. This will cause part of future expenditures for erosion control to be used for maintenance of public beach. The public beach will also provide storm protection for the evacuation route.

H. Cost Estimates

Table 26 shows the projected costs of the inlet management plan over a 50-year project life at an interest rate of 3%. The initial cost in 1993, which includes 800 feet of revetment, 200,000 cubic yards of fill on northern Sanibel, a 45,000 cubic yard feeder beach on Captiva, 60,000 cubic yards of advanced fill on northern Sanibel, and redistribution of 25,000 cubic yards of overwash volumes into the dune is $5,200,000.

In 1996, the remaining 100,000 cubic yards of fill and 210,000 cubic yards for advanced fill and the feeder beach will be placed at the same time as renourishment on Captiva at a cost of approximately $2,400,000. Maintenance would continue on the Captiva renourishment schedule every six years at a cost of approximately $1,600,000. Purchase of parcels will cost an estimated $900,000. The annual cost of implementing the plan, over a 50-year project life is $478,000.

TABLE 26

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
FINAL MANAGEMENT PLAN COST ESTIMATE

CONTINGENCY	15%	MOBILIZATION (1993 ONLY)	$500,000
E&D&S&A	10%	UNIT COST	$6.00
		FILL VOLUME (1993)	200,000
REVETMENT	$800,000	FILL VOLUME (1996)	100,000
LAND PURCHASE	$900,000	ADV. NOUR. - CAPTIVA/YR.	15,000
		ADV. NOUR. - SANIBEL/YR.	20,000
		OVERWASH VOLUME @$2.50	25,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	
1993	$5,161,200	0.97087	$5,010,874	305,000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$2,352,900	0.88849	$2,090,521	310,000
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$1,593,900	0.74409	$1,186,011	210,000
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$1,593,900	0.62317	$993,266	210,000
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$1,593,900	0.52189	$831,844	210,000
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$1,593,900	0.43708	$696,657	210,000
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$0	0.39999	$0	
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$1,593,900	0.36604	$583,439	210,000
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$1,593,900	0.30656	$488,621	210,000
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$1,593,900	0.25674	$409,212	210,000
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	
SUM OF PRESENT WORTHS			$12,290,445	
CAPITAL RECOVERY FACTOR			0.03887	
AVERAGE ANNUAL VALUE			$477,674	

VIII. FUNDING/GOVERNMENTAL ANALYSIS

Governmental Analysis

The purpose of this section is to establish sponsorship and funding of the inlet management plan. The implementation of the inlet management plan will be undertaken by a local sponsor(s) with funding assistance from the State of Florida. Since no one government agency has total responsibility for Blind Pass it may be appropriate to share the duties of the local sponsor between the following local governments:

A. Lee County
B. The City of Sanibel
C. Captiva Erosion Prevention District (CEPD)
D. West Coast Inland Navigation District (WCIND)

While each government may participate financially in the plan, it would be appropriate for one government to take the lead in the administration of the program. Each government agency has a vested interest in seeing inlet improvements as follows:

A. Lee County - The County constructed the 1972 jetty at Blind Pass; maintains a public beach north of the Pass (Turner Beach), is responsible for coastal management countywide and is interested in maintaining the passes and bays. The County maintains the bridge and roads of Captiva Island and has planned a revetment to protect the roadway in Northern Sanibel Island. The County should provide the local funding for the mitigation, sand bypassing, navigation and flushing, environmental and public use element. They should share costs with Sanibel on the erosion control element.

B. The City of Sanibel - Northern Sanibel suffers from high erosion and is vulnerable to storm damage putting Sanibel residents at risk. The Sanibel/Captiva Road that Sanibel maintains is threatened by natural background erosion of the beach of 20,000 c.y./yr. The City should help facilitate the public access and use element by coordinating the land purchase. The City should also be joint sponsor of the erosion control element with the County.

C. CEPD - The CEPD is responsible for erosion control on Captiva Island. In 1988-89 an erosion control project was constructed which restored the beach and extended a terminal groin. The groin extension and beach erosion control project permits require mitigation for impacts caused by the extension. The beaches in northern (6300') Sanibel have been retreating faster since the completion of the Captiva erosion control project. Since the groin may be partially responsible for this retreat, a mitigation amount of 32,000 cubic yards has been identified. This amount is approximately 10% of the total mitigation fill. The CEPD should initiate its role of joint sponsorship in planning the implementation of the inlet management plan, and by incorporating the 1996 Inlet Management Plan in their construction plans for their renourishment project. If monitoring of the constructed plan shows that the groin extension is not causing erosion, then their responsibility under the mitigation element should be re-evaluated.

D. WCIND - The WCIND is responsible for navigation and boating in Lee, Charlotte, Sarasota and Manatee Counties. The WCIND collects taxes in the four county area for use by navigation and marine-related public projects. The WCIND should participate in the navigation and flushing element and future inlet construction.

Table 27 shows a schedule of costs, broken down by element for the inlet management plan implementation. Table 28 shows the percentage of funding to be provided by the various governments that will share in the costs of the program. DNR representatives have indicated that a funding share of 75% for the State would be acceptable. The local government shares are based on the benefits and responsibilities of the governments as described previously. Tables 29-31 present the levels of funding to be provided by each government for each phase of implementation of the inlet management plan.

TABLE 27

SUMMARY OF COSTS FOR THE INLET MANAGEMENT PLAN

	1993	1996	2002
A. STORM PROTECTION ELEMENT	1,000,000		
B. MITIGATION ELEMENT	2,200,000	800,000	
C. SAND BY PASSING ELEMENT	300,000	700,000	700,000
D. EROSION ELEMENT	500,000	900,000	900,000
E. NAVIGATION ELEMENT			
F. ENVIRONMENTAL ELEMENT	100,000		
G. PUBLIC ACCESS & USE	1,100,000		
TOTAL COST	$5,200,000	$2,400,000	$1,600,000

TABLE 28
FUNDING LEVELS FOR SPONSORS

	STATE	COUNTY	SANIBEL	CAPTIVA	WCIND
A. STORM PROTECTION ELEMENT	75.0%	25.0%			
B. MITIGATION ELEMENT	75.0%	22.5%		2.5%	
C. SAND BY PASSING ELEMENT	75.0%	25.0%			
D. EROSION ELEMENT	75.0%	12.5%	12.5%		
E. NAVIGATION ELEMENT	75.0%				25.0%
F. ENVIRONMENTAL ELEMENT	75.0%	12.5%	12.5%		
G. PUBLIC ACCESS & USE	75.0%	22.5%	2.5%		

TABLE 29
COST SHARING FOR 1993 PROJECT

	STATE	COUNTY	SANIBEL	CAPTIVA	WCIND
A. STORM PROTECTION ELEMENT	750,000	250,000	0	0	0
B. MITIGATION ELEMENT	1,650,000	495,000	0	55,000	0
C. SAND BY PASSING ELEMENT	225,000	75,000	0	0	0
D. EROSION ELEMENT	375,000	62,500	62,500	0	0
E. NAVIGATION ELEMENT	0	0	0	0	0
F. ENVIRONMENTAL ELEMENT	75,000	12,500	12,500	0	0
G. PUBLIC ACCESS & USE	825,000	247,500	27,500	0	0
	3,900,000	1,142,500	102,500	55,000	0

TABLE 30
COST SHARING FOR 1996 PROJECT

	STATE	COUNTY	SANIBEL	CAPTIVA	WCIND
A. STORM PROTECTION ELEMENT	0	0	0	0	0
B. MITIGATION ELEMENT	600,000	180,000	0	0	0
C. SAND BY PASSING ELEMENT	525,000	175,000	0	0	0
D. EROSION ELEMENT	675,000	112,500	112,500	0	0
E. NAVIGATION ELEMENT	0	0	0	0	0
F. ENVIRONMENTAL ELEMENT	0	0	0	0	0
G. PUBLIC ACCESS & USE	0	0	0	0	0
	1,800,000	467,500	112,500	0	0

TABLE 31
COST SHARING FOR 2002 PROJECT

	STATE	COUNTY	SANIBEL	CAPTIVA	WCIND
A. STORM PROTECTION ELEMENT	0	0	0	0	0
B. MITIGATION ELEMENT	0	0	0	0	0
C. SAND BY PASSING ELEMENT	525,000	175,000	0	0	0
D. EROSION ELEMENT	675,000	112,500	112,500	0	0
E. NAVIGATION ELEMENT	0	0	0	0	0
F. ENVIRONMENTAL ELEMENT	0	0	0	0	0
G. PUBLIC ACCESS & USE	0	0	0	0	0
	1,200,000	287,500	112,500	0	0

Captiva beaches stabilized

Erosion panel told sand drift is low in most places

By Max Lee Friedersdorf
Staff Writer

Captiva's Erosion Board Commissioners received a good-news, bad-news report from their consulting engineer late Wednesday night that the $10 million beach replenishment along the resort island has eroded an average of 2 1/2 feet since last September, but the sand loss is well within expectations and much of the beach has stabilized.

Engineer Tom Campbell, of Coastal Planning & Engineering, of Boca Raton, Captiva's beach erosion and renourishment engineer, briefed the Erosion Board Commissioners on the latest beach monitoring results from a survey conducted between last September through the past April.

Campbell said the Captiva beaches have actually added sand in several areas, the most noticeable at the extreme far end of the island at the South Seas Plantation property, and another sector in mid-island.

At the same time, Campbell warned, three "hot spots" along the Captiva coast continue to erode at a faster than expected pace. These areas, Campbell explained are at the southern end of the South Seas Plantation property; another area also at mid-island and at the south end of Captiva just north of a controversial 100-foot boulder jetty that extends into the Gulf just north of Blind Pass at Turner Beach.

Most of the missing sand at the "hot spots," however, Campbell explained, has deposited just off shore and should move back to shore eventually.

The over-all effect of the Captiva shoreline, Campbell added, is one of "stability" and he suggested no change in the present 1995 target date for replenishment of the beach.

Campbell described the past winter as "unusual" in that the normal southward drift of the Gulf shore waters was instead a northern movement which explains the erosion north of the Turner Beach groin, Campbell explained, and the heavy accretion of sand at the northern end of Captiva.

Turning to the situation south of Blind Pass on Sanibel, Campbell said a buildup of sand has occurred in the very northern end of Sanibel's beach, but conceded that his study showed that significant shoreline erosion continues in the Clam Bayou area a bit further south on Sanibel.

Campbell said this erosion on Sanibel is still running higher than the historical average.

Campbell, however, vehemently denied to the Board that the jetty at Blind Pass was responsible for the continued erosion of Sanibel beaches.

Campbell explained that the "big surprise" his survey revealed about the northern drift of the Gulf waters during the past "atypical winter" was proof that the groin was not hurting Sanibel beaches because the tide had been running north all winter.

Campbell said his research had established the cause of the major erosion "hot spot" at the middle of the island due to a previous revetment built along Captiva Drive to protect the road from the encroaching Gulf waters and a little-noticed directional turn in the road where the land extends further into the Gulf.

Campbell estimated placing 200,000 cubic yards of sand fill to bring the eroded "hot spot" in line with the rest of the shoreline and an added 20 feet as compensation would cost about $1 million.

In other action during the four-hour meeting attended by three of the five Commissioners, the Board unanimously passed a resolution, at the request of Lee County Elections Office, authorizing the election of two Commissioners on Tuesday, November 5, 1991.

The election for the approximately 500 voters on Captiva will be held to fill the expiring terms of Erosion Board Chairman Stephen Cutler and Commissioner Sheila Hoen.

The non-partisan election will elect Commissioners for four-year terms to the posts that receive no salary.

Chairman Cutler said that he has not yet decided whether to seek re-election and possibly would not decide until near the filing deadline, September 22. He is serving his first term.

Commissioner Hoen was absent from this week's meeting.

At Wednesday's meeting the Commissioners also worked on the proposed 1992 Captiva Erosion Prevention District budget. The tentative final hearing on the budget is scheduled for September 11, with final adoption slated for September 25 before the October 1 start of the new fiscal year.

• please see page 12A

CAPTIVA

• from page 10A

At the urging of Chairman Cutler, the Board delayed acceptance of a new accounting agreement with the Andrew A. Barnette firm, of Fort Myers, and asked for a redraft of the proposal with the date and rate schedule affixed.

The Board also approved unanimously a recommendation by Bill Stronge, economic planner for the District, and the accounting firm, to open a third bank account. Community Bank of the Islands was designated by the Board.

In a bit of good news for the Commissioners, Stronge revealed that the U.S. Army Corps of Engineers at Jacksonville, had approved the Captiva Board's appeal of a nearly two-year old request for a $1.8 million federal aid request contained in a general design memorandum submitted by the Commissioners.

The request had originally been rejected at Jacksonville, but the favorable ruling now means the proposal moves along to the regional Corps office in Atlanta, according to Stronge.

Pending approval in Atlanta, the Captiva Erosion Board would be eligible to request up to the $1.8 million figure for assistance, which would be dependent upon Congressional appropriation. The Jacksonville Corps office had originally slashed the Captiva request to about $800,000.

Engineer Campbell also advised the Commissioners that $150,000 tentatively budgeted for sand search next year could be reduced to under $100,000 if the Board decides on just one area in the Gulf to transfer sand to the beach, rather than a series of sites.

At the request of the Board, Engineer Campbell also described a new beach retention method being tried at Fort Pierce that seeks to control wave action.

Captiva narrows Sanibel erosion solutions

11A ☐ NOVEMBER 29, 1991 ☐ ISLAND REPORTER

Captiva's Erosion Prevention District tentatively agreed to restore between 1,800 to 2,000 feet of Sanibel beaches and possible install dunes near Clam Bayou or an experimental dewatering system on the beach.

Board members last week kept two possibilities from among 15 suggested as part of a Blind and Redfish Pass Inlet Management study, with much of the discussion focusing on the repair of erosion along Sanibel's north shore.

Renourishment, if agreed upon, would be done in conjunction with work on Captiva Lee County plans to build 400 feet of revetment along area roads.

Board members suggested the revetment project be eliminated from the alternative 's agreed upon because it is a separate county project, but they also questioned the erosion district's role in choosing a solution which would curtail erosion in Sanibel.

"The best of these things may not be what we can justify to our constituents," board member Jack Zwick said.

Board member Sheila Hoen suggested the district look at what may be viable solutions based on the alternatives before them without committing to a specific plan.

The ad hoc committee in charge of the inlet management is made up of representatives from the Captiva district, the City of Sanibel, Lee County, the State of Florida and West Coast Inland Management District and was formed to study the viability of sand transfer at the inlets in an effort to create more stability at the passes.

But, committee members soon moved away from the idea of sand transfer because of potential permitting problems and environmental issues.

The erosion district is just one of the agencies which will select from the Coastal Engineering's list of alternatives.

However, Coastal Engineering's Tom Campbell said he would only take recommendations from the agencies before submitting his report to the state.

"My recommendations may not be what you select," Campbell said.

Sanibel has its own engineering firm.

A third alternative from the 15 was suggested by Sanibel resident Chet Smith who attended Wednesday's meeting.

Smith, a retired professor of geology, said an underwater breakwater 400 to 500 feet from Sanibel's eroding shoreline would stabilize the beach and cause it to accrete while at the same time causing some pass stabilization.

"I've been watching the beaches of Sanibel for 32 years," Smith said. "There are pockets of erosion. Where there are offshore sand bars missing there is erosion."

Board members asked Campbell to study the possibility of a breakwater.

Campbell is to present the list of alternatives to the Sanibel City Council Dec. 3. The Inlet Management Plan committee will meet again Dec. 4 at 2 p.m.

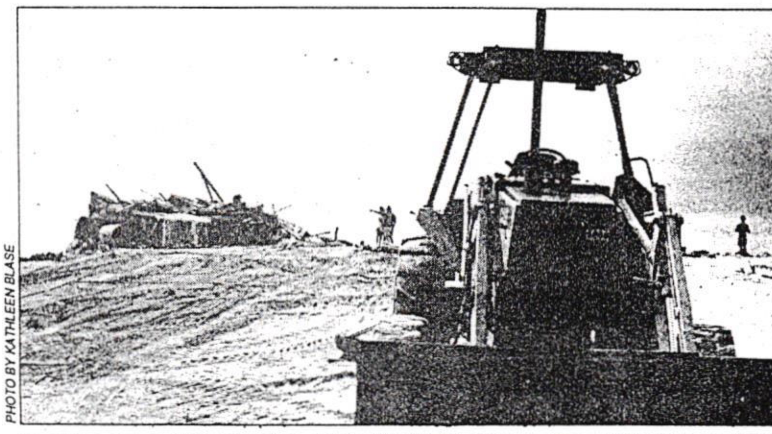


PHOTO BY KATHLEEN BLASE

Erosion caused the demise of the Santiva Cottages near Blind Pass which were bulldozed this week, at least what was left of them.

Erosion solutions point to $2 million system

ISLAND REPORTER ☐ NOVEMBER 15, 1991 ☐ 4A

By Dawn Grodsky
Staff Writer

Engineers submitted a final report regarding Sanibel's beach erosion, presenting three options to alleviate the problem including installation of a beach dewatering system, an off-shore breakwater or taking no action at all.

Taylor Engineering studied erosion data from as far back as the mid 1800s, examining changes in the approximately one mile of coastline from Gulf Pines to Bowman's Beach and determined the most serious erosion is from the Tradewinds Subdivision to the Gulf Shores.

The north end of the area contains a growing, healthy beach; the south end is "marginally stable" while the central section was classified as having a moderate, chronic problem.

Between 50,000-55,000 cubic yards of sand are lost annually along that stretch of beach, said Bruce Taylor, president of the engineering firm.

The off-shore breakwater system is the best option, according to the engineering firm and would cost about $2 million to construct. There would be little to no need for maintenance barring the event of a major hurricane, Taylor told council members last week.

The system would be constructed of high-density rock of a specific uniformity and size and set at a certain depth depending on the size of expected storm surges.

Vice Mayor Mark Westall voiced concern about a three ton rock ending up in an area living room after a major storm. The city needs to take the proper precautions for a hurricane, he said.

So far, 80 percent of the areas property owners signed a petition in favor of creating the special tax according to Gary Price, city manager. Councilman Jerry Muench said to do nothing would be "very unpopular with the residents." He asked if it was possible to move the houses further from the shore line.

Price said there is room on some of the lots but not every home could be moved. He said if the city chooses to do nothing it would not mean the property owners should also do nothing.

Residents from the area most affected have pledged some $600,000 toward a beach renourishment system designed by Dick Holmberg, from Michigan, who installs concrete, underwater jettys, perpendicular to the shore, in an effort to slow wave action.

The total price tag for the Holmberg system would be about $3 million for city's northern coastline, including the Gulf Pines area.

Sanibel's 1992 budget includes some $300,000 as a possible contribution for some type of beach renourishment program.

Florida's Department of Natural Resources ruled that Captiva's jetty extension, completed several years ago, was responsible for about a third of Sanibel's erosion, and ordered some sand replacement during Captiva's next scheduled renourishment project.

Sanibel appealed the on-third determination, clairning far more of the erosion was caused by the jetty, but a decision as to whether Captiva will share more of the blame, and provide more of a solution, has yet to be made.

The councilmen will study the report and discuss the options, including the creation of a special taxing district in the affected area to pay for an erosion prevention system, at the next council meeting.

Sanibel files new erosion complaint

By Dawn Grodsky 1R 2/7/92
Staff Writer

The city of Sanibel filed a complaint against the Florida Department of Natural Resources this week, claiming the department has been lax in enforcing Captiva's liability for its jetty and jetty extension at Blind Pass, which the city charges is causing erosion on Sanibel's northern beaches.

The new complaint is just an additional means by which the city hopes to force responsibility for erosion on the Captiva Erosion Prevention District.

A lawsuit has already been filed by Sanibel to force Captiva and the Department of Natural Resources to replenish city shores in the wake of a decision last year which fixed only partial blame on the Blind Pass jetty.

That suit stemmed from a department determination that the erosion in Sanibel's Gulf Pines, Gulf Shores and Chateaux Sur Mer area was caused by three separate factors: the Captiva jetty and extension was responsible for one-third; tropical storm Keith for one-third and the final third was caused by rock revetments just south of Blind Pass. Sanibel is appealing that decision.

City Manager Gary Price said it is the Department of Natural Resources job to mitigate the damage caused by the groin extension and "we feel the DNR plan is insufficient."

The department now has 60 days to respond. If the agency's response is unsatisfactory to Sanibel, the city can file another law suit charging the Department of Natural Resources is not enforcing Florida's Beach and Shore Preservation Statute. That would require the state agency to take action to mitigate the effects of the jetty and could include its removal.

The new complaint specifically states the jetty and extension are blocking sand from flowing south along the coast and preventing the natural nourishment of Sanibel's beaches.

"It is the policy of the DNR to require mitigation of the known adverse effects of coastal structures on natural resources and adjacent properties...The DNR has failed to enforce the constitutional provisions, statutes, policies, rules and regulations for the protection of the beaches and shores of Sanibel," the complaint said.

Captiva officials claim the erosion on Sanibel is natural and not caused by the jetty.

Officials with the Captiva Erosion Prevention District are opposed to removing the jetty because they believe it could destroy Captiva's beaches which, in addition to the jetty, are be-

• please see page 2A

EROSION

• from page 1A

ing enhanced by a $10 million beach renourishment program.

If erosion continues at this same pace, Gulf waters will claim several homes in a few years and in fact have already destroyed several others, including the Santiva Cottages.

Area home owners have asked the Sanibel City Council to install some type of artificial device to save their homes and the city is currently considering its options.

Erosion plan presentation

By Max Friedersdorf 1R 4/3/92
Staff Writer

A $5 million beach erosion alleviation plan to benefit ravaged northern Sanibel beaches near Blind Pass was unveiled Wednesday night.

The multi-faceted attack on Sanibel's erosion problem was disclosed in a presentation to the Captiva Erosion Prevention District members by their engineer, Tom Campbell.

The 300-foot boulder jetty at the south end of Captiva at Blind Pass, blamed by Sanibel for much of its erosion problems, would remain intact under the Campbell proposal.

However, a 45,000 cubic yard feeder beach would be constructed 1,000 feet north of the jetty which, Campbell claimed, would increase and mitigate the sand flow around the jetty and eventually eliminate the jetty as the cause of any erosion on Sanibel.

Campbell's proposal calls for 260,000 cubic yards of sand, dredged from just off-shore, be pumped back onto Sanibel beaches during 1993.

Another deposit of 100,000 cubic yards of sand for Sanibel would follow in 1996 and the proposed feeder beach would receive another 90,000 cubic yards of sand in 1996, according to the report.

Another portion of the $5 million proposal is an 800-foot revetment along the most threatened portion of Sanibel-Captiva Road, just south of the Blind Pass Bridge where encroaching surf and tides have endangered the island's main storm evacuation route.

Campbell's plan also includes moving 25,000 cubic yards of sand to form protective dunes at Clam Bayou and Old Blind Pass where both inlets have suffered over-washes in recent storms and subsequent erosion.

Campbell advised the Erosion Board of Commissioners that earlier plans to obtain the necessary sand from Blind Pass for all the replenishment associated with the project had been abandoned because of environmental concerns. This sand would be obtained by off-shore dredging.

Campbell told the board that currently, the Florida Department of Natural Resources estimates that the northern Sanibel beach area is losing 20,000 cubic yards annually because of natural causes, and another 15,000 annually because of effects from the Captiva jetty and extension.

The final component of Campbell's recommended implementation of the 1993 Blind Pass Inlet Management Plan includes acquisition of five real estate parcels along the badly eroded Sanibel coast.

Campbell, whose firm is Coastal Planning & Engineering of Boca Raton, characterized his plan as "preliminary," but said elements would be finalized within the next few days.

The Lee County Commission scheduled a special meeting for 2 p.m., Wednesday, April 15, to receive the formal submission of Campbell's proposal.

Campbell said he sought to hold the cost of the project to around $4 million, but to address the concerns of both Sanibel and Captiva, as well as the state, several components were required.

One difference which could lower the cost is the matter of revetments along the Sanibel-Captiva Road, Campbell said.

While he is recommending the armoring of the road be extended 800 feet, Lee County is recommending only 250 feet and would save $700,000.

In other matters, the board approved a $40,220 monitoring of Captiva's beaches and an aerial survey of erosion on Captiva and Sanibel.

This project will get underway next week, Campbell estimated, and is required every six months under terms of the resource department permit for the $10 million Captiva beach restoration project.

Alison Hagerup, administrator for the Captiva Erosion Prevention District, also reported to the board that the United States Army Corps of Engineers is supporting a $2 million federal reimbursement for the Captiva beach renourishment project.

Captiva seeks to delay erosion lawsuit filed by city

Sanibel's suit against jetty erosion damages may wait

By MaryJeanne McAward
Staff Writer

IR 9/6/91

Erosion District officials are trying to delay a lawsuit filed against Captiva and the state by the City of Sanibel concerning Sanibel's effort to pin more blame on a Captiva groin for current erosion problems.

City Attorney Robert Pritt said a joint motion was filed by Nancy Stroud, attorney for the Captiva Erosion Prevention District, to delay the suit until the Blind Pass Inlet Management Study is completed, sometime around January of next year.

A court date has been set for January 6 of 1992 and if the motion is approved the suit would be delayed for at least several weeks.

The joint motion means all parties--Sanibel, the Captiva Erosion Prevention District, and the Department of Natural Resources which permitted extension of the jetty which city officials claim is causing severe erosion--agree to postpone the court date.

Pritt said the city must notify the Department of Natural Resources of its intent in the motion and that it is up to the Department to enforce the terms of the permit it issued to allow construction of the Captiva jetty.

State permit requirements contained

• please see page 3A

Betty Cattell, and Nancy Mohr Kennedy, the President's director for the Conference on Aging, confer on Sanibel this week. See the full story on page 1-B

LAWSUIT

• from page 1A

clauses that would force Captiva's erosion district to reimburse Sanibel for any erosion caused by the jetty, but natural resources ruling made early this year claims the jetty is responsible for only a third of the city's sand loss.

Seawalls at the Santiva Cottages on Sanibel and tropical storm Keith are to blame for the remaining two-thirds according to the state.

Pritt told Sanibel's City Council this week that it could take the entire matter to Twentieth Circuit Court in Lee County instead of relying on the current lawsuit which is scheduled before a state hearing officer The pending litigation is a major undertaking, Pritt noted, and he wanted to make sure the city has the desire and the money to proceed.

Sanibel's attorney for the case, Michael S. Tammaro of Carlton Fields Ward Emmanuel Smith & Cutler in West Palm Beach, handled a similar erosion case involving Ocean Ridge, on the east coast, against the Department of Natural Resources two years ago.

Tammaro won the case which is being appealed.

"One reason for contacting him (Tammaro) was the case is very similar," Pritt said.

Sandbags may legally decorate shore

IR 9/6/91

Sanibel's City Council amended an ordinance to allow sandbags and other erosion control devices along Sanibel's bays and beaches.

No forms of development, including erosion control devices and sand bags were permitted along the city's coastline prior to the council's action Tuesday.

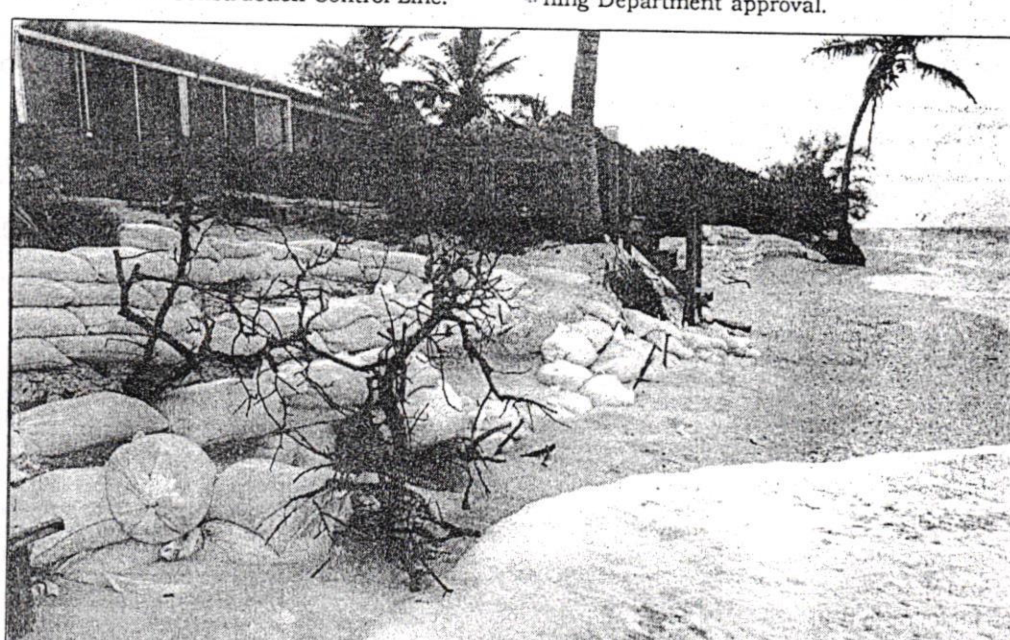
Residents can file short-form applications and the new codes are meant to provide immediate, albeit temporary, protection to buildings threatened by erosion.

State permission is necessary before erosion control structures can be located seaward of the Coastal Construction Control Line.

All installations must comply with law protecting nesting turtles and other wildlif sand bags may not exceed two cubic feet in siz and all native vegetation destroyed durin sandbagging or filling must be replaced wit plants that are compatible with the beac environment.

Exposed sandbags or structures may be re tained for one year but additional one-yea extensions can be obtained from the cit manager if a need exists.

Requests for longer extensions will be pro cessed as a long-form permit subject to Plan ning Department approval.



Residents along Sanibel's northern gulf shore installed sand bags to protect their homes months before the city finally approved the existence of erosion devices.

Captiva beach monitoring shows slight erosion

By Steve Ruedlger
Islander staff writer

Erosion on Captiva was slow during the period of the most recent six-month monitoring, consulting engineer Tom Campbell told the Captiva Erosion District Board at the group's meeting last Wednesday, Aug. 7, at the Captiva Civic Center.

The average loss was 2 1/2 feet in width while the beach actually accreted by 3,000 cubic yards in total sand volume, Campbell said. If it were not for local hot spot variations, this would mean no new project would be needed until the year 2004, Campbell said, adding quickly that the hot spots meant a project still would be needed in 1995.

The hot spots are areas such as the area in front of Jensen's that are continuing to erode even though most of the rest of the island's beaches have stabilized.

Campbell said this past winter was unusual in that tidal currents were predominantly from the south to the north. Usually in the winter, the currents are north to south. The survey covered the six month period through April 1991.

On northern Sanibel during that period, erosion was greater than the historical rate. However, Campbell said the groin at the south end of Captiva could not have had anything to do with that during a period of north flowing tidal currents.

In other action at its Wednesday meeting, the CEPD held a budget workshop (see related article), passed a routine election resolution, heard that more sea oats had been planted, learned that the Australian pine seedling problem is getting worse and heard that progress is being made regarding state and federal funding.

The resolution provides notice that elections need to be held this year for two CEPD board seats on Nov. 5. The seats of Sheila Hoen and Stephen Cutler are up for election. Cutler has not decided whether or not he will run. Hoen was not present at the meeting Wednesday. It is not known whether or not she plans to run.

A little over 1,000 additional sea oats were planted on the Captiva beach on July 29. Most were planted in the vicinity of the Grey Heron house and to the south.

It was reported to the board that getting state funding for the inlet management studies was "moving nicely" and that the federal government had gone back to the $1.8 million figure on reimbursement for the beach nourishment project. That money may come to the CEPD in a couple years if the funding request makes it through the appropriation channels.

A written proposal was presented to the board by Coastal Engineer Consultants of Naples, which suggested a way to prevent beach erosion by having pipes placed under the sand remove water from under the beach. The CEPD's consulting engineer Tom Campbell told the board this "dewatering" approach was experimental. He said Fort Pierce was currently installing a dewatering project and he suggested Captiva wait until that project has been operating for a couple of years to see how it works there.

Proposals for auditing and accounting services for the coming year by Andrew A. Barnette certified public accountants was given to the CEPD board. It was noted that not only was no estimate given for the cost of services but that hourly rates weren't even listed.

The board decided to delay signing the agreements to employ Barnette until at least hourly rates could be determined.

BLIND PASS INLET MANAGEMENT PLAN

Submitted To:

Captiva Erosion Prevention District

Submitted By:

Coastal Planning & Engineering, Inc.
Robert G. Dean, Sc.D.
Ashish J. Mehta, Ph.D.

March 1992

BLIND PASS INLET MANAGEMENT PLAN

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I. INTRODUCTION

A. Authorization

The Captiva Erosion Prevention District (CEPD) authorized the development of an inlet management plan by Coastal Planning and Engineering, Inc., of Boca Raton, Florida on August 7, 1991. This study is 75% funded by the State of Florida, Department of Natural Resources.

B. Purpose and Goals

The inlet management plan as outlined in Section 161.161(1)(b), Florida Statutes, analyzes Blind Pass to determine if the inlet is a significant cause of beach erosion. The plan addresses the extent to which Blind Pass causes beach erosion and provides recommendations to mitigate the erosive impact of the inlet, including but not limited to: inlet sediment bypass; channel dredging; jetty design; disposal of spoil material; establishment of feeder beaches; beach restoration and beach nourishment; and innovative methods of transferring sand or controlling erosion.

The goals for the Blind Pass Inlet Management Plan based on February 25, 1992 decisions of the ad hoc committee are:

A. Mitigate erosion caused by the inlet.
B. Re-establish littoral drift to downdrift beaches that are being affected by the existence of the inlet.
C. Develop a plan that interferes as little as possible with the natural functioning of the pass.
D. Protect the evacuation route from storm damage.
E. Control erosion north and south of the pass to protect public and private property and infrastructure.
F. Accomplish goals A - E addressing long term environmental impacts.
G. Accomplish goals A - F in an economically responsible manner.
H. Quantify the impacts that the 1972 groin built by Lee County may have had.
I. Quantify impacts that the 1988/89 Captiva beach restoration/groin extension project may have had.
J. Quantify the effects of Clam Bayou Pass on the beach in northern Sanibel.
K. Quantify the effects of structures on the beaches of Captiva and Sanibel Island.
L. Develop intergovernmental programs to implement the Inlet Management Plan.

C. General Description

Blind Pass is located in Lee County on the Gulf Coast of South Florida, approximately 90 miles south of the entrance to Tampa Bay. The Gulf coastline consists of a series of barrier islands broken by passes (tidal connections) separated from the mainland by shallow tidal lagoons.

Blind Pass is bounded on the north by Captiva Island and the south by Sanibel Island and connects Pine Island Sound to the Gulf of Mexico (Figure 1). Captiva Island is about 5 miles long, and varies in width from about 200 feet near the south end to about 2000 feet between the center and north end. Sanibel Island is approximately 13 miles long and varies in width from about 2 miles near the eastern end to about 1/2 mile at the northwestern end. Natural ground elevations are generally under 10 feet.

The adjacent inlet to the north is Redfish Pass. To the south an inlet is intermittently open to Clam Bayou and Old Blind Pass water bodies. At the south end of Sanibel Island, Pine Island Sound drains directly to the Gulf through San Carlos Bay entrance.

Access to both islands is by toll bridge from the mainland. Captiva can be reached by travelling north along Sanibel, and then across the bridge over the channel of Blind Pass.

At the present time there is no sand management program in place at Blind Pass. There is no maintenance or periodic dredging done to address inlet shoaling or to provide inlet sand bypassing.

D. Scope

This is a study of Blind Pass and adjacent beaches. The study includes a historical review of inlet changes and beach erosion and accretion patterns adjacent to the inlet.

The initial phase of the study involved research and collection of available historical photographs, survey information and existing reports. Organizations contacted for information included the Captiva Erosion Prevention District; Department of Natural Resources, Division of Beaches and Shores; Jacksonville District, U.S. Army Corps of Engineers; the University of Florida Coastal Engineering Archives and the University of South Florida, Geology Department.

Reference materials reviewed in this study are listed at the end of the report. A list of aerial photographs, their dates, types and source are included. Selected photographs were reproduced and are presented throughout the report. In addition, field measurements of tides, currents, and shoal characteristics were performed to support evaluation of physical processes.

An evaluation is made of the impacts that the inlet has had on adjacent beaches. The effects of structures on the beach and nourishment projects are determined. A study was

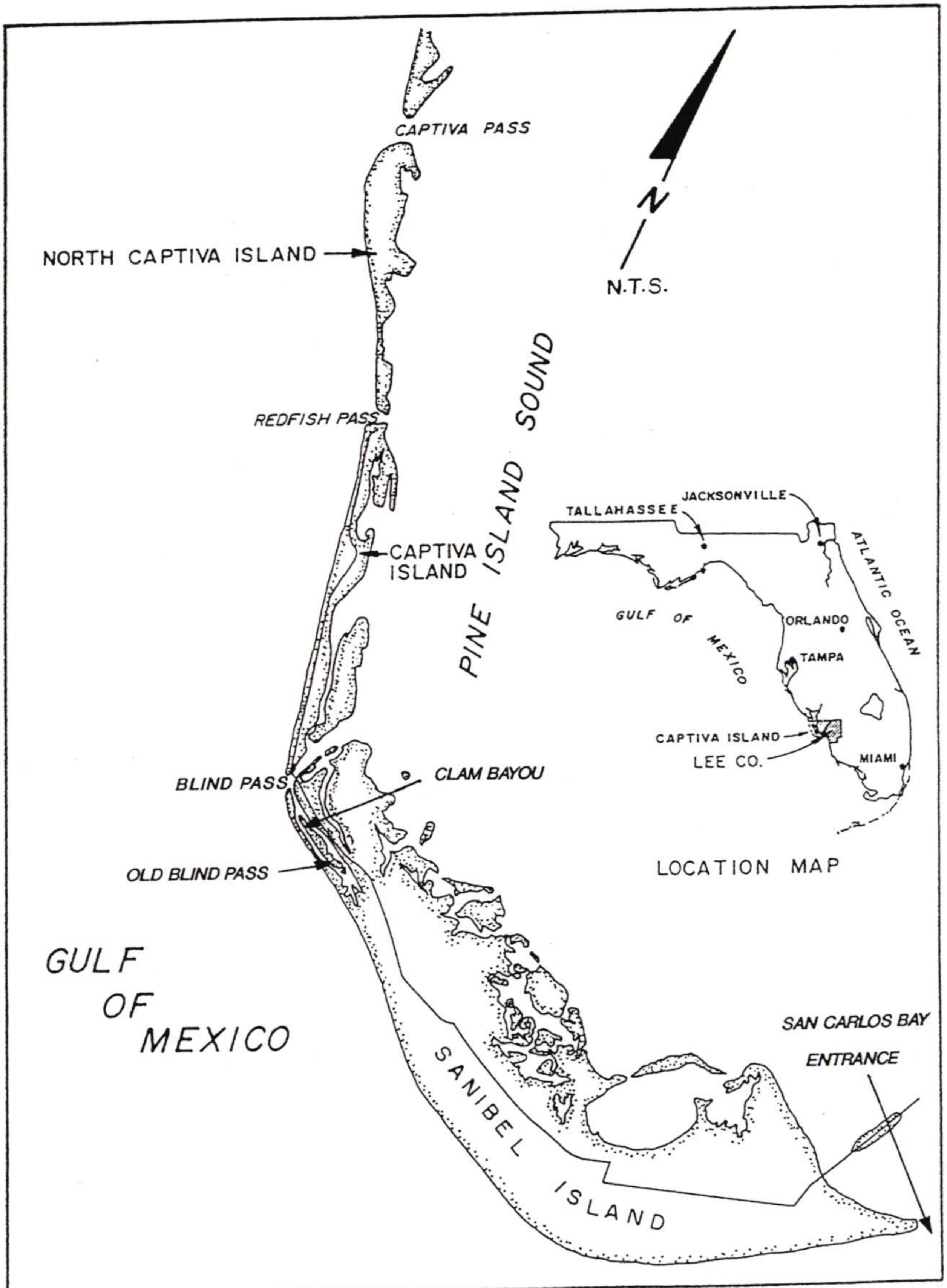


FIGURE I

REDFISH & BLIND PASS LOCATION MAP

made of the hydraulics of the inlet with a focus on inlet stability and bypassing. The hydraulic interaction of Redfish Pass and Blind Pass are discussed.

To estimate the effects of management alternatives on the environment, the local biota were examined and categorized. This compilation consisted of field inspections augmented by maps, reports and aerial photographs. The results of this research are presented in Section III of this report; which includes a biotic community map of the areas surrounding Blind Pass. The goal of the environmental analysis is to quantify the impact of the inlet and potential erosion control solutions on the study area.

An array of alternative inlet management plans were evaluated and compared. An inlet management plan has been defined and recommended.

The end product of this report is a comprehensive inlet management plan outlining possible physical modifications or other improvements to optimally utilize available resources associated with Blind Pass. These alternatives are evaluated and analyzed with respect to feasibility, funding and benefits for the local community and the environment.

E. Public Interest and Use

Immediately north of Blind Pass is Turner Beach, a county maintained park. A parking lot adjacent to the Blind Pass bridge provides parking for 50 vehicles. The Blind Pass bridge provides the only vehicular access to Captiva Island. It serves as a vital link in the evacuation route from Captiva Island. The approach roads of the bridge both north and south have been threatened by erosion. Recent nourishment of the beach in Captiva Island, along with a 100 foot groin (jetty) extension, has provided for storm protection of the northern approach.

Blind Pass is not an improved navigation inlet and is used sparingly by boat traffic. The controlling depth of the inlet is below six feet (MLW) which is too shallow to be safely navigated by large vessels. With the addition of waves, the inlet can become impassible to all but the smallest craft. Channel constriction caused by shoaling further limits safe navigation. Most local day charter fishermen and recreational crafts use Redfish Pass to the north, to reach the Gulf of Mexico from Pine Island Sound.

Blind Pass provides tidal flushing for Pine Island Sound, although to a lesser extent than both Redfish Pass to the north and San Carlos Pass to the southeast. The water quality of the inland basins is dependant on this daily tidal exchange with the Gulf of Mexico. This water circulation promotes the growth of a host of marine organisms that depend on the estuarine waters of the sound for protection, spawning grounds and other critical physiological factors. These organisms, in turn, support the abundant fisheries of the Gulf of Mexico.

The inlet and adjacent beaches are frequented by locals and tourists alike for both fishing and shell collecting. Fishes commonly caught in the vicinity of Blind Pass include snook, redfish, sea trout and tarpon. Captiva Island, Sanibel Island and Blind Pass are popular locations for shell hunters as well, because of their unusually abundant supplies of a wide array of shells.

F. History of Blind Pass

Both Captiva Island and Sanibel Island were formed by deposition of material that was moved south by wave action over the past 5000 years (Missimer). The basic island configurations were attained approximately 1400 years BP (before present), when southward progradation of Sanibel effectively ended (Missimer 3).

Blind Pass apparently broke through the barrier island about 300 BP (Missimer 73), although evidence of earlier breach was identified by Winton, Brooks & Degner, in their 1981 study. Winton's study suggests the original Blind Pass opened as early as 995 BP-655 BP.

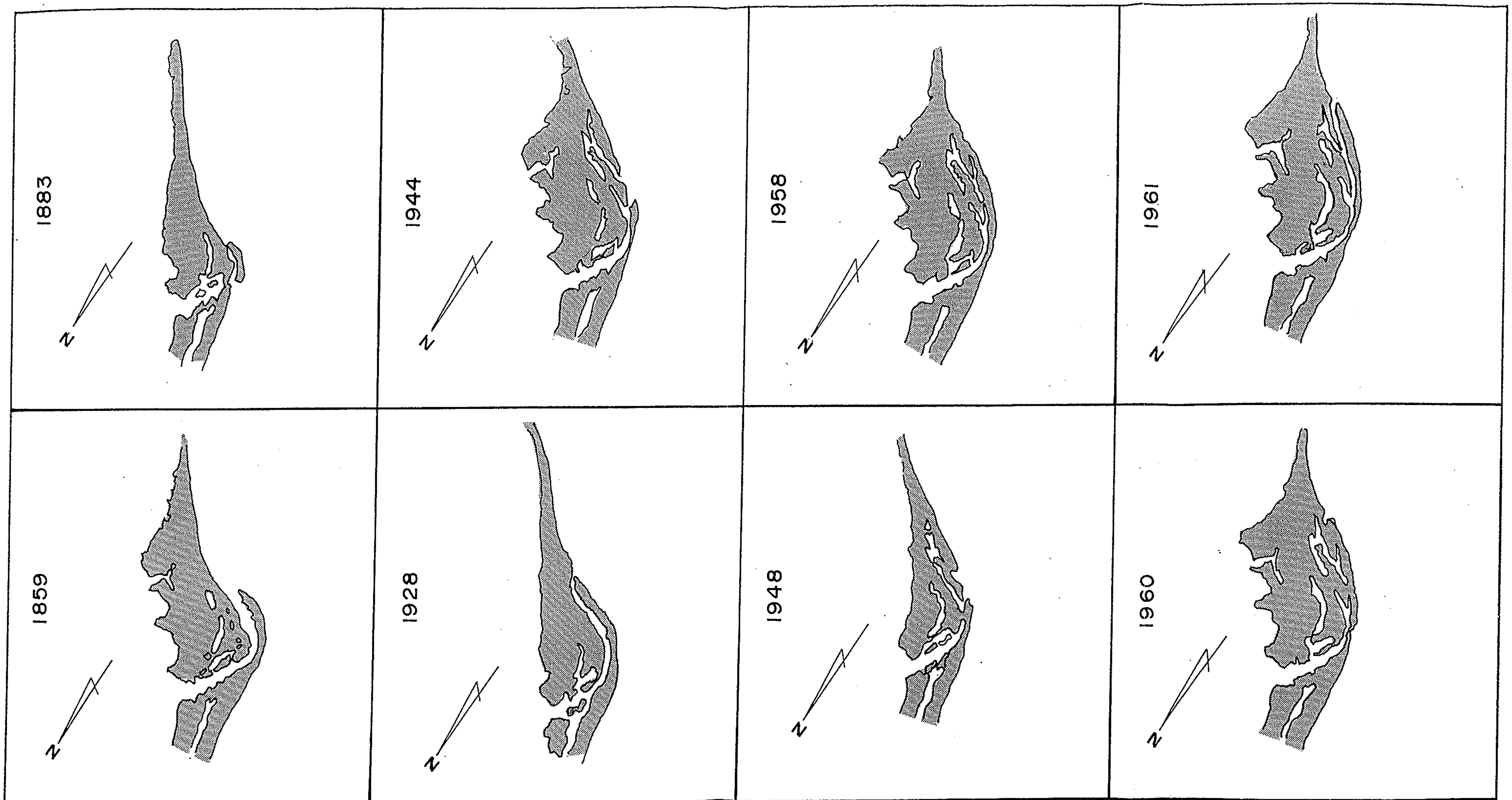
After Captiva Pass opened 845 BP (Winton) it is likely that the island to the south (now North Captiva and Captiva Island) eroded due to lack of littoral material. Sanibel Island, however, continued to build with sand that eroded from the two Captiva Islands (north and south).

The survey of 1859 indicates that Blind Pass was open at that time, far to the south of the interior channel (see Figure 2). The inlet broke through the spit near the current position by 1883, probably due to a hurricane. After 1883, this inlet feature again migrated south in front of a prograding spit from Captiva Island.

There is conflicting information of when Redfish Pass opened. Previous reports suggest a 1926 hurricane created Redfish Pass; local residents recall the 1921 hurricane causing the opening. For purposes of this report we will use 1921 as the date of the opening of Redfish Pass.

Before Redfish Pass opened (1921), Blind Pass was a more substantial inlet with a larger tidal prism. Large quantities of sand moving south along Captiva Island would cause a spit of sand to grow southward at the south end of the island. The spit would periodically breach in a storm leaving an island in front of northern Sanibel Island; the island would move to the beach by wave overwash and rollover. This episodic spit building and attachment caused a buildup of the north end of Sanibel Island. Between 1859 and 1944 over 2000 ft. (See Figure 3) were added to the north end of Sanibel Island (Harvey 1979). The Blind Pass ebb shoal associated with the larger (pre-Redfish Pass) tidal prism probably helped maintain the seaward position of the south end of Captiva Island and the north end of Sanibel Island.

When Redfish Pass opened in the 1920's, it captured a significant portion of the tidal prism of Blind Pass making Blind Pass a smaller, more unstable inlet. The ebb shoal of Blind Pass migrated to shore and no longer provided protection for southern Captiva and



APPROXIMATE SCALE

0 1250 2500

METERS

HISTORY OF BLIND PASS CAPTIVA ISLAND 1859-1961

COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BOULEVARD.
BOCA RATON, FL 33431

FIGURE 2

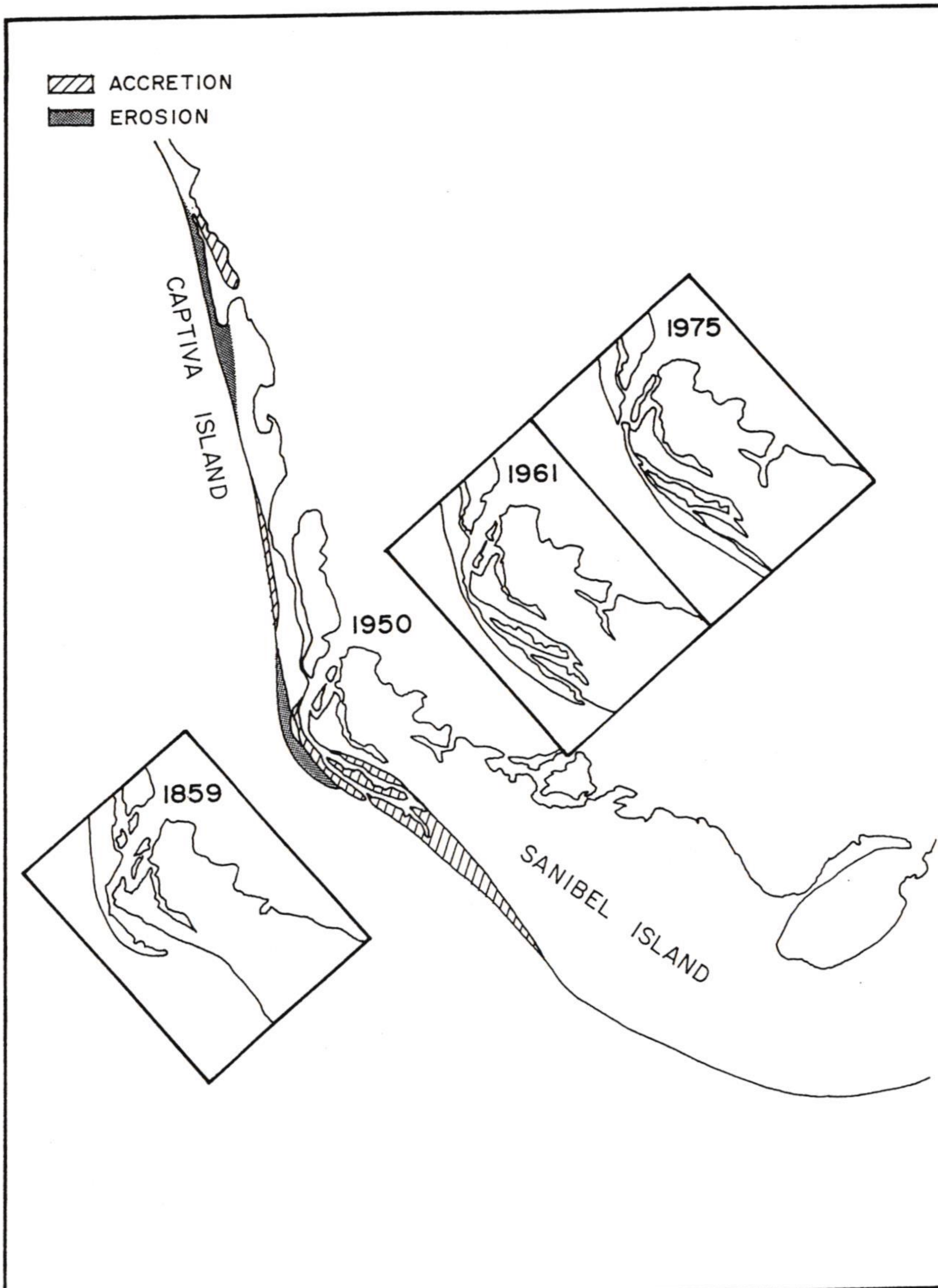


FIGURE 3

EROSION & ACCRETION PATTERNS
CAPTIVA / SANIBEL

northern Sanibel. The inlet cross section decreased (due to shoaling), to the point of complete closure of the channel.

A new inlet opened again, possibly during the hurricane of 1941, and the isolated sand extension attached itself to Sanibel Island. This cycle was repeated again between 1941 and 1969, when Hurricane Donna opened the pass. In 1961, this gap closed and Blind Pass opened further to the south (see Figure 4). By 1964, the spit had once again migrated to the south and closed the pass (see Photo 1). The pass was not reopened again until 1972 following Hurricane Agnes (See Photo 2).

In 1972 a terminal groin was installed by Lee County on the north side of the pass, to protect the bridge by stabilizing the beach to the north at Turner Beach Park.

The pass was closed again between 1975 and 1980. Photo 3 shows the pass before closure in 1975, and Photo 4 shows Blind Pass closed with Old Blind Pass to the south open. The Pass was reopened in its present position by a subtropical storm in June of 1982. Photo 5 shows the pass in 1985, and Photo 6 shows that both Clam Bayou and Blind Pass were open in 1987. (A summary of openings and closings of Blind Pass is included in Table 14, Hydraulic Analysis section of this report.)

Clam Pass/Old Blind Pass has intermittently opened and closed over the past 20 years. A review of available aerials shows the instability of this area as documented in Table 1.

In October and November of 1988, the terminal groin on the north side of the pass was extended 100 feet, to stabilize the beach nourishment material which was placed along the entire length of the Gulf side of Captiva between August 1988 and April 1989. Photo 7 was taken in January 1992 and shows present-day conditions at Blind Pass.

The Lee County Department of Transportation maintains the Blind Pass bridge and the Turner Park jetty. Excepting this service, no maintenance of the inlet is provided by Federal or local agencies. Blind Pass has never been dredged.

G. Significant Storm Events

Hurricanes have had a major effect on the Lee County coastal area. Between 1830 and 1969, 46 hurricanes and tropical storms have passed within 50 miles of the Lee County coast, according to the Department of the Army (1969). Between 1969 and 1988, a minimum of 6 additional hurricanes and tropical storms in the eastern Gulf of Mexico generated winds and waves that affected the Lee County coast (Lee County, 1988). Maps of hurricane tracks indicate that most storms entering the Gulf of Mexico pass to the north and northwest; and as such, the west-central Florida coast has not been entirely dominated by hurricanes and large storms. Table 2 lists hurricanes and major storms affecting the Captiva Island area.

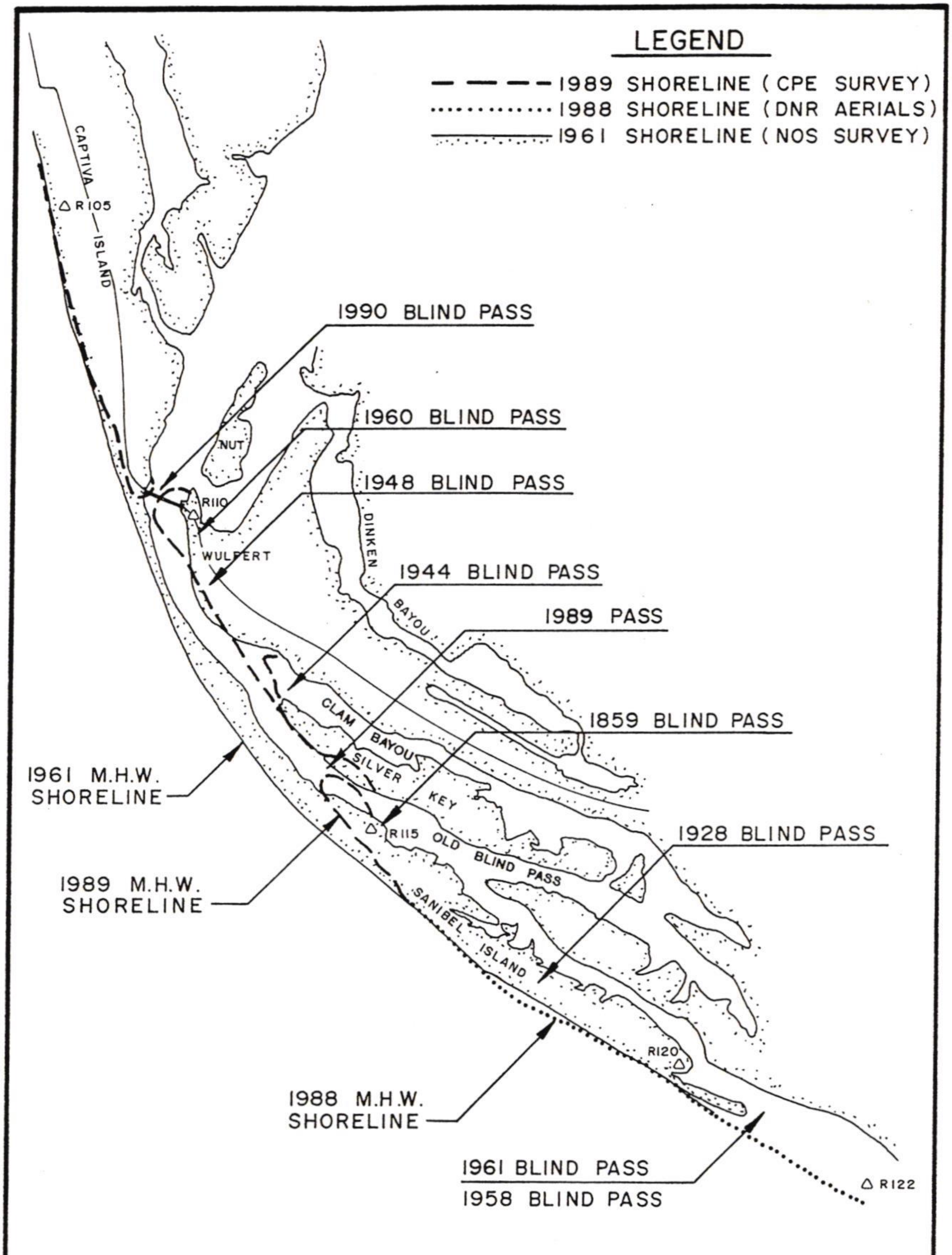


FIGURE 4

BLIND PASS HISTORICAL LOCATION MAP

Table 1

Status of Clam Pass
From Aerial Photographs

Month	Year	Status
February	1966	Closed
January	1970	Closed
July	1972	Open
February	1974	Open
March	1975	Open
December	1980	Closed
May	1985	Closed
August	1985	Open
November	1985	Open
January	1986	Open
September	1986	Open
November	1986	Open
January	1987	Open
August	1988	Closed
April	1989	Closed
October	1989	Open
February	1990	Closed
May	1990	Closed
September	1990	Closed
April	1991	Open
December	1991	Open

Photo No. 1

February 1970
Blind Pass closed.

Photo No. 2

June 1972
Immediately following Hurricane Agnes

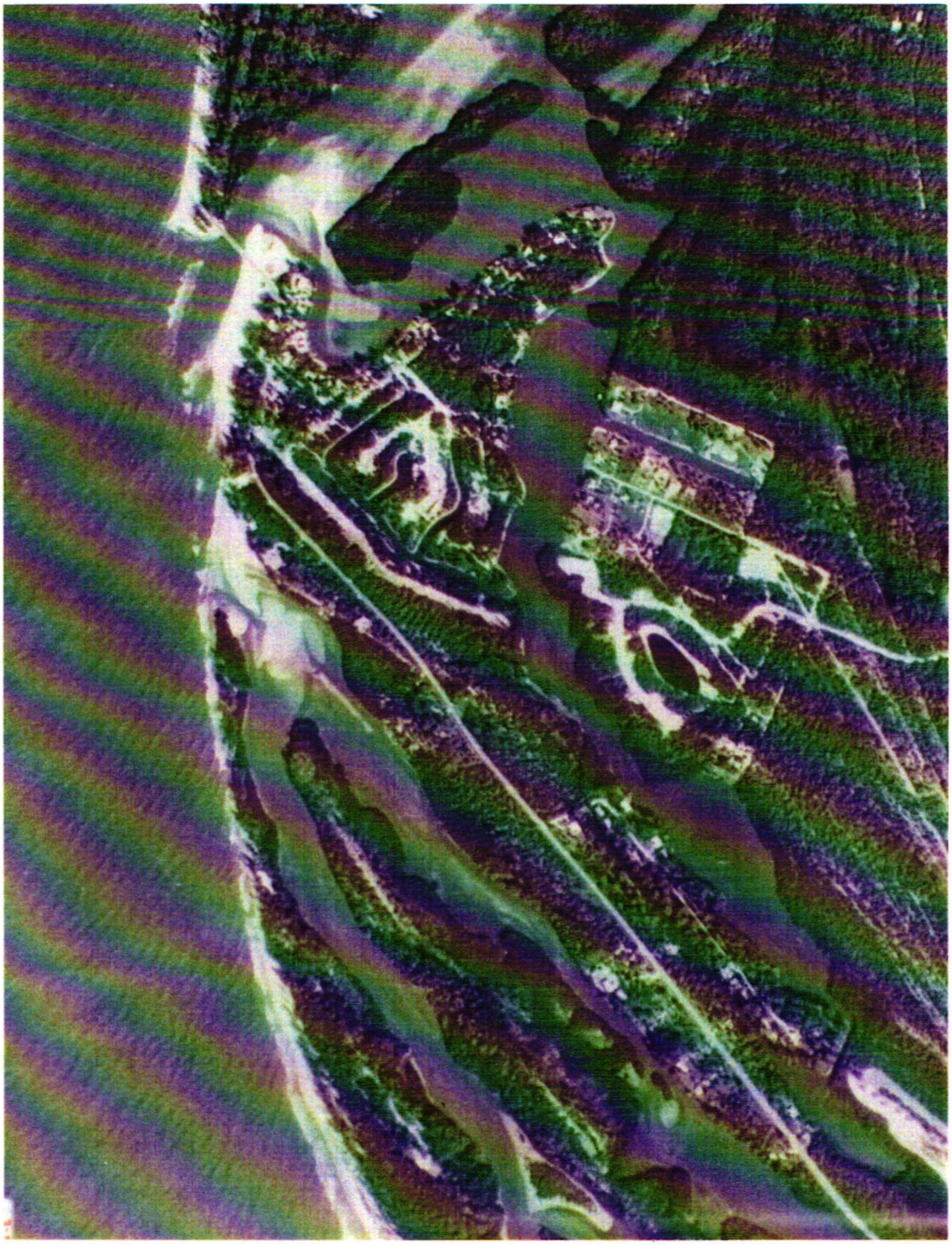


Photo No. 3

March 1975, before closure of the pass.

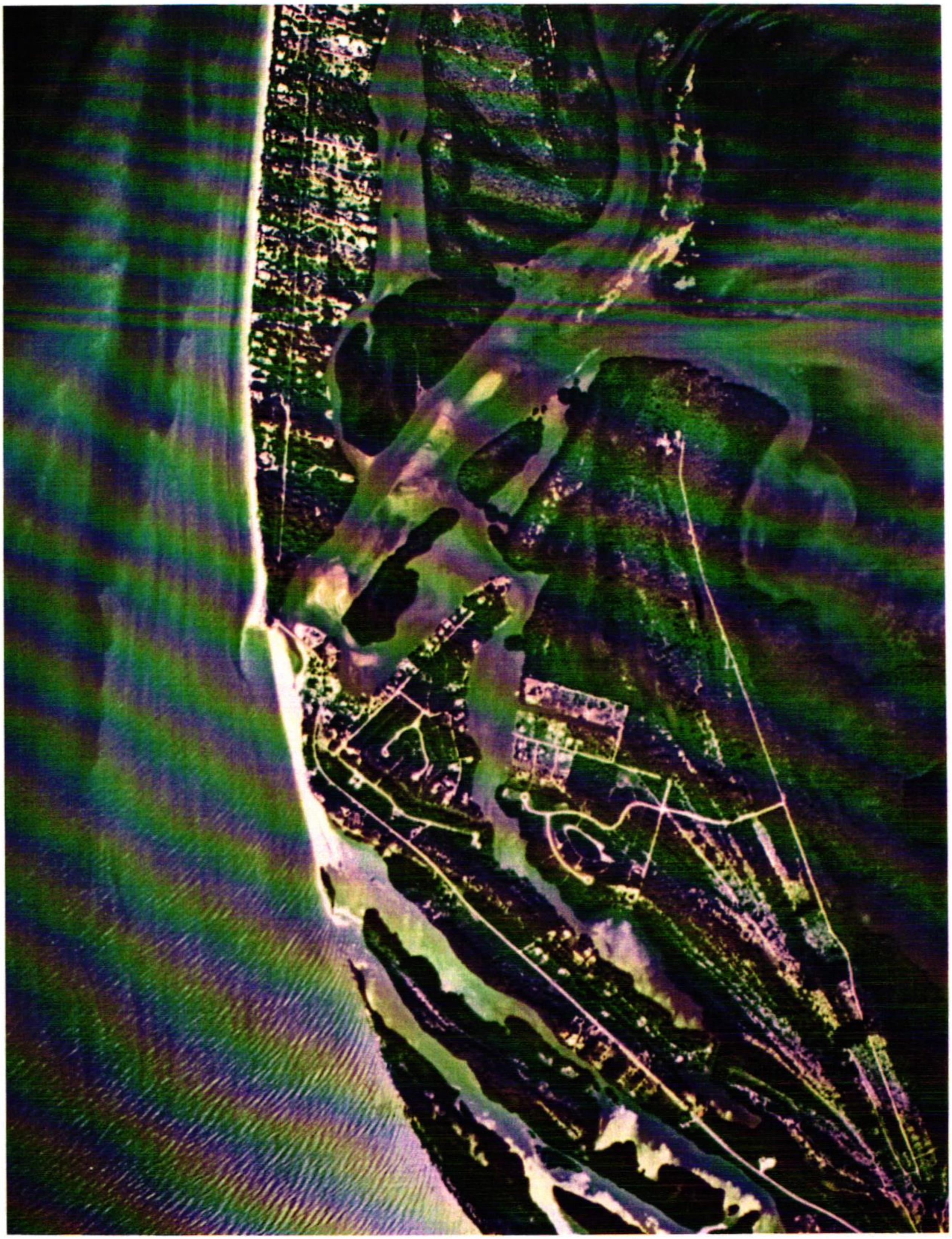


Photo No. 4

November 1978
Blind Pass closed, Old Blind Pass open.

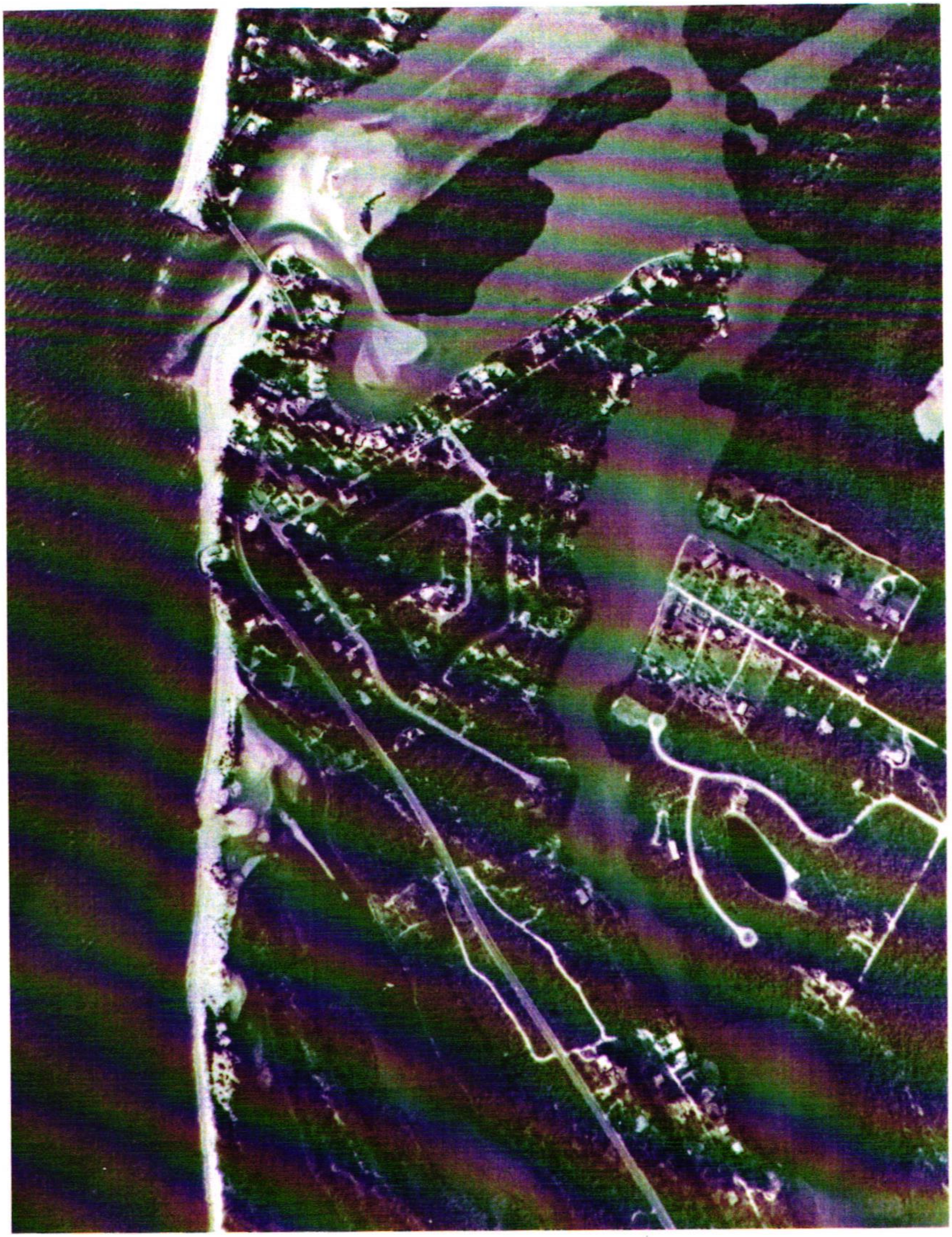


Photo No. 5

May 1985
After reopening in 1982.

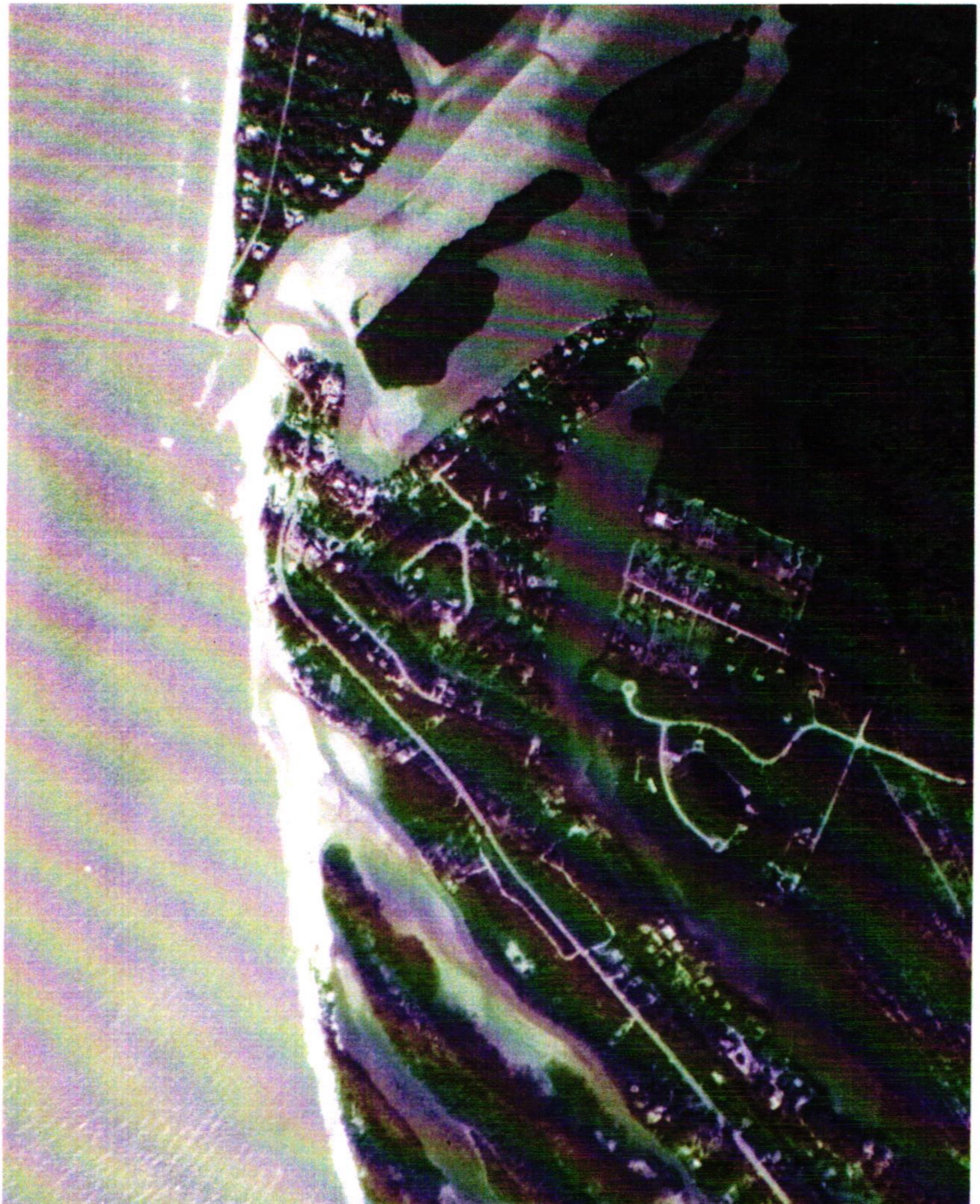


Photo No. 6

January 1987
Blind Pass and Clam Bayou open.

Photo No. 7

January 1992
Blind Pass present-day conditions.

Table 2

SIGNIFICANT STORM EVENTS
1873 - 1991

YEAR	DATE	AREA	INTENSITY	NOTES
1873	Oct. 5-7	Punta Rassa	Major	Punta Rassa destroyed, tide 14 feet
1878	Oct. 21-22	SE coast	Minimal	
1882	Oct. 9-11	Near Cross City	Minimal	
1891	Aug. 24	SE coast	Minor	
1896	Oct. 8	Ft. Myers	Minimal	
1910	Oct. 17-18	Entire peninsula	Major	30 killed, damage $365,000
1921	Oct. 25	West-central coast	Major	6 killed, damage $1,000,000; Local residents believe this storm opened Redfish Pass.
1926	Sept. 18-20	NW Florida	Extreme	Miami bar. 27.61 in.; wind 138 mph; Previous reports suggest this storm opened Redfish Pass.
1928	Sept. 16-17	Entire peninsula	Extreme	1836 killed, damage $25,000,000
1935	Sept. 2-4	Keys, Taylor Co.	Extreme	Keys bar. 26.35 in.; wind 200+ mph
1941	Oct. 20	Cedar Keys	Minor	10-15 in. rain
1944	Oct. 18-19	Peninsula	Major	18 killed, damage $60,000,000

Table 2

SIGNIFICANT STORM EVENTS
1873 - 1991
(Continued)

YEAR	DATE	AREA	INTENSITY	NOTES
1946	Oct. 7-8	West coast	Minimal	Tides high, damage $5,200,000
1947	Sept. 17-18	South Florida	Extreme	Pompano bar. 27.97 in.; wind 155 mph
1949	Aug. 26-27	South Florida	Extreme	2 killed, damage $45,000,000
1950	Sept. 3-5 (Easy)	SW Florida	Major	Category 4 hurricane. Winds to 125 mph. Cedar Key bar. 28.30 in.
1951	Oct. 2	SW coast	Minor	Strong cold front. Heavy NW winds. Damage $2,000,000
1953	Oct. 9	SW Florida	Minor	Okeechobee City bar. 29.15 in.
1960	Sept. 10-12 (Donna)	South Florida	Major	Cape Verde hurricane; bar. 27.52. Winds to 140 mph. Opened Blind Pass to Gulf.
1964 (Cleo)	Aug. 27-28	SE Florida	Minor	Hurricane lost much strength before impacting SE coast of Florida. Winds reported to 65 mph on Gulf coast.
1965	Sept. 7-9 (Betsy)	South Florida	Minor	Meandered 2 weeks in S. Atlantic before entering Bahamas. A category 3 storm with winds of 130 mph, passed south of Captiva 27.49°

Table 2

SIGNIFICANT STORM EVENTS
1873 - 1991
(Continued)

YEAR	DATE	AREA	INTENSITY	NOTES
1966	June 8-9 (Alma)	W. Florida from Key West to Panama City	Major	Early season storm. Wind 115 mph; Bar. 28.76 in.
1968	Oct. 18-20 (Gladys)	South Florida	Minor	Bar. 28.52 in; wind = 80 mph
1972	June 5-22 (Agnes)	SW Florida	Major	Blind Pass broke through, just south of Turner Park groin.
1982	Nov. 10-11 No Name Storm	SW Florida	Minor	Strong Northeaster caused accelerated beach erosion on Gulf Coast.
1985	Sept. 1-2 (Elena)	SW Florida	Major	Tampa. bar. 28.67 in. Winds to 125 mph. Caused road damage in Captiva.
1985	Oct. 26 - Nov. 1 (Juan)	Gulf	Major	Winds 86 mph when it struck LA coast, travelling north from center of Gulf. Caused road damage in Captiva.
1988	Nov. 21-23 (Keith)	SW Florida	Minor	Hurricane downgraded to tropical storm before striking Gulf Coast. Central bar. 29.38 in. Winds to 60 mph.

II. PHYSICAL INLET CHARACTERISTICS

A. General

Blind Pass is the result of the influence of many complex and interrelated natural factors. Human intervention has also played a part in the present condition and state of the inlet. This section will outline and discuss the factors influencing the inlet.

The most prevalent natural influence on the inlet is wave action. Through continuous exposure to the local wave climate, large scale sediment movement has altered the features of both Blind Pass and the adjacent islands. Wind is the primary driving force behind these waves (see Section II. H - Wind and Wave Climate).

Tides are also capable of molding the bathymetric features, and to a lesser extent, the features of the shoreline. Tidal currents if of sufficient magnitude will scour the sea bed. If this scouring occurs close to the shoreline, the land features may also be affected.

These currents cause sand to accumulate irregularly, forming shoals both within the inlet and in the nearshore regions. These shoals, called the flood shoal and ebb shoal because of the direction of the current that forms them, alter the prevailing longshore transport of sediment on the beach. If this sediment flow is interrupted or altered, the shoreline will show accretional and erosional patterns over time.

B. Inlet Influence

Based upon analysis which is summarized below, Blind Pass's influence is felt approximately 2 miles either side of the inlet.

Before Redfish Pass opened (1921), sand bypassed Blind Pass along a well developed ebb shoal. The large ebb shoal of Blind Pass provided protection for beaches in South Captiva Island and northern Sanibel Island and allowed them to maintain a position seaward of the adjacent beaches.

After 1921, Redfish Pass captured most of the tidal prism of Blind Pass. Since the ebb shoal of an inlet is proportional to its tidal prism, the ebb shoal of Blind Pass started to migrate to shore after 1921.

The shoreward migration of the Blind Pass ebb shoal created a strong accretional trend in the northern 4 miles of Sanibel Island, where almost 2.3 million cubic yards has built up from 1941-1988.

The northern mile of Sanibel originally benefitted from the shoal sand by building up 742,000 cubic yards between 1941 and 1955. After 1955, however, the north mile has shown steady erosion, losing 703,000 cubic yards from 1955-1974 and losing another

518,000 cubic yards between 1974 and 1988. The average shoreline retreat rate during the later period was 13.3 feet/year in the northern mile of Sanibel (DNR permit).

The cause of the high erosion rate in the north mile of Sanibel is related to three factors:

1. The loss of the ebb shoal reduced the protection from wave action on northern Sanibel that had previously enabled this first mile of Sanibel to maintain a seaward position relative to the adjacent shore.

2. The sand migration rate from the shoal to the shore decreased as the shoal reduced in size.

3. Sand quantities coming from Captiva Island reduced as a result of sand depletion and coastal structures built on Captiva Island. These structures included a groin built by Lee County at Blind Pass in 1972 to protect the north approach road to the Blind Pass bridge.

The average annual erosion rate of Captiva Island reduced from 67,000 c.y./yr. in 1955-1974 to 42,000 c.y./yr. in 1974-1988. The groin built by Lee County has caused 15,000 c.y./yr. of the erosion in northern Sanibel. For the time period of 1972-1992, this would total 300,000 cubic yards of sand.

In 1988-89 a beach nourishment project was constructed on Captiva Island and the groin at Blind Pass was extended 100 feet. Subsequent to construction of that project;

a. Captiva beaches have eroded at an average annual rate of 47,000 c.y./yr. (This is faster than the previous time period.)

b. Northern Sanibel (first mile) has eroded at 33,000 c.y./yr. (This is slower than the previous time period.)

c. Northern Sanibel beaches have retreated at 20 ft./yr. (This is faster than the previous time period.)

d. An ebb shoal has built up with 80,000 cubic yards of sand.

e. Tropical Storm Keith has caused significant overwash and lowering of the beach fronting Clam Bayou and Old Blind Pass. The beaches in northern Sanibel are losing less sand but retreating faster after the 1988/89 Captiva beach project.

> The ebb shoal has created a littoral drift reversal or nodal point in the area where the island is backed by water. Tropical Storm Keith overwashed and lowered the elevations of the water backed segments allowing for continued overwash and rapid retreat of these segments.

The groin extension of 1988 may have contributed to the higher than average retreat rate of northern Sanibel. Other factors have also contributed to the erosion. As a conservative approach, an amount of sand has been identified to mitigate for the high retreat rates.

To mitigate for the excess retreat of beach experienced from April 1989 through 1992, an amount of 32,000 cubic yards would be needed. This considers that most of the erosion has been of the dry beach and assumes that each foot of excess shoreline retreat (along the 6300 foot shore) would equal 1450 cubic yards of sand (0.23 c.y./ft. - see Appendix C).

C. Shoreline and Volume Changes

Historical shoreline and volume changes reflect the overall forces and processes acting on the shoreline. However, the two types of data differ in terms of their reliability, accuracy and significance on coastal processes.

One disadvantage in using shoreline positions is that they change seasonally due to profile flattening and steepening which usually occur in winter and summer months, respectively. Shoreline changes may occur without a corresponding change in profile volume. A second disadvantage is that a small datum error (reference elevation) can yield significant error in the position of the mean high water line.

In the short term, careful and tightly controlled measurements of volumetric profile changes are necessary since shoreline changes can occur simply due to seasonal or unusual storm effects. If data are available over a long period, shoreline changes will usually be reasonably representative of volumetric changes and may be more accurate than profile comparisons when the offshore portions of the profiles show divergence and significant closure error.

Beach cross-sections measure the change in the entire profile and directly represent volume changes. Offshore measurement accuracy can affect volume estimates. Cross-sections are less dependent on the profile shape than volume estimates based on shoreline position. The profile does not have to remain in equilibrium to develop an accurate volume measurement. However, offshore profile data can be a source of error. Offshore profiles are measured by a fathometer and adjusted for tide. These profiles are less accurate than the onshore measurements and small differences can result in large volumetric change estimates. Longer term comparisons are better indicators of volume change rates, as errors in the offshore record can be less significant when compared to larger long term changes. Also, long term comparisons avoid cumulative errors that can occur when comparing sequential surveys.

Considering the merits of shoreline and profile surveys, the best understanding of shoreline processes or impacts will usually be provided by an analysis which includes consideration of both shoreline and volume changes, with careful scrutiny of the data for indications of accuracy and consistency. In the following sections, analyses are presented for both shoreline and volumetric historical changes in the Captiva-Sanibel vicinity with special emphasis in the Blind Pass area. The long term results will first be presented followed by an analysis for the period 1988 to the time of the most recent available data.

1. Long Term Historical Data

a. Shoreline Changes

The Division of Beaches and Shores (DBS) of the Florida Department of Natural Resources (FDNR) maintains an excellent shoreline position data base of the sandy shorelines of the State of Florida. For Captiva Island, data are available for 1859, 1941, 1951, 1956, 1961, 1972, 1974, 1979, 1985, 1988, 1989, 1990, and 1991. For Sanibel Island, data are available for 1859, 1941, 1951, 1956, 1961, 1972, 1974, 1979, 1985, 1988, 1989, 1990, and 1991.

For each of the times for which data are available, the shoreline changes at each monument were calculated relative to the initial survey. These were then summed over approximately one-mile intervals, weighting each change by the appropriate alongshore spacing of the monuments at which the data are available. These results are shown in Figures 5 and 6 for Captiva and Sanibel, respectively, and are discussed in the following paragraphs.

b. Captiva Island Shoreline Changes

The total length of Captiva Island is 26,169 ft. or 4.96 miles. Therefore, Captiva Island was divided into five equal segments of 5233.8 ft. each. Referring to Figure 5, it is seen that the northerly two segments (mile 1 and 2) have experienced general retreat over the period of record. This is undoubtedly due to the opening of Redfish Pass in 1921. The shorelines represented by Miles 3 and 4 advanced until 1951, then experienced general retreat. The southerly mile (Mile 5) has generally retreated over the period of record with increased recession rates commencing in 1951 and 1972. The effects of the beach nourishment projects conducted in 1981 and 1988-1989 are evident in Figure 5.

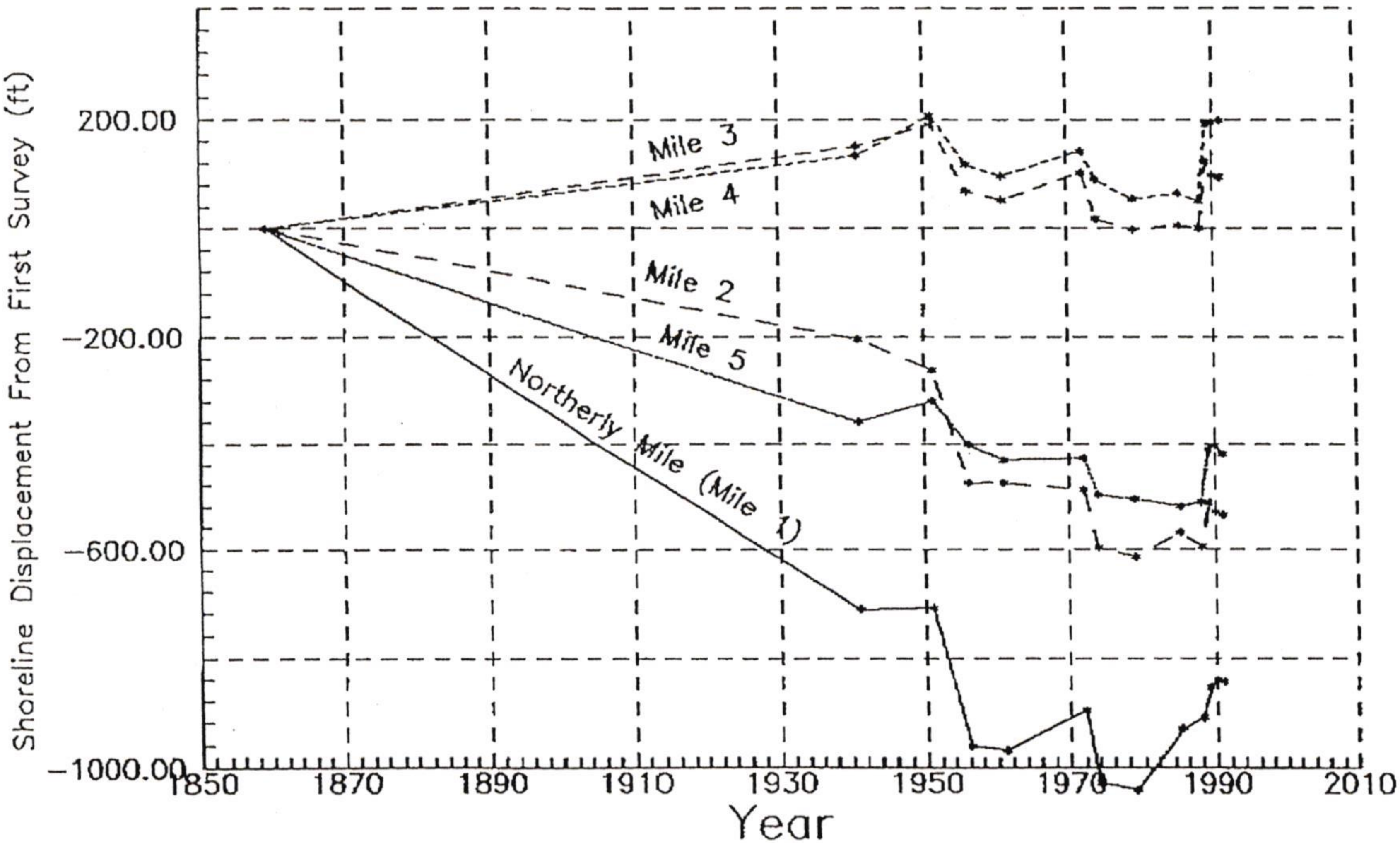


Figure 5. Shoreline Positions on Captiva Island Averaged Over Approximately One-Mile Intervals.

SOURCE: DR. ROBERT DEAN

c. Sanibel Island Shoreline Changes

The data analyzed on Sanibel extended from DNR monument R-110 immediately south of Blind Pass to monument R-130. The overall length represented by these monuments is 21,062 ft. or 3.99 miles. Thus, this area was divided into four equal segments, each 5265.5 feet in length. The changes in average shoreline positions for each of these four segments has been shown in Figure 6. The northerly mile experienced retreat from 1859 to 1941, then stability and/or advancement from 1941 to 1951. A moderate retreat rate during the 1950's and 1960's was followed by a steady recession after 1972. Miles 2 and 3 show general accretion over the period of record whereas Mile 4 has been generally stable.

d. Captiva Island Volume Changes

Volumetric changes on Captiva Island were estimated based on the historical record of shoreline changes and profiles. Shoreline change was used through 1985 to determine volume changes; after 1985 profile comparisons were used.

A review of 1974 DNR profiles showed them not to be usable for volume estimates (see Appendix C) because of offshore closure errors on Captiva Island and the limited number of long lines on Sanibel Island.

Shorelines can be converted to volume changes using conversion factors that are based on total depth of change. This conversion technique is a standard coastal engineering practice. In Captiva Island, the active profile is assumed to extend from the +6 foot contour on the beach to the -12 foot contour offshore. This would suggest a conversion factor of 0.67 c.y./ft. (18 ft. ÷ 27 c.y./ft.^{3} x 1 ft.). For each foot of advance or retreat of the shoreline, the beach gains or loses 0.67 c.y. This conversion assumes that a profile maintains the same shape, but translates uniformly in retreat or advance. This is a good assumption for long term comparisons, but is less accurate on short term comparisons.

To minimize error in the profile comparisons, long term comparisons were chosen from the data sets that demonstrate good offshore closure. The volume change above the 12 ft. contour was reported as the volume change. The change between the 12 ft. and 18 ft. contour was noted as a measure of offshore closure. The closer the volume change (12' to 18' contour) was to zero, the smaller the closure error.

An exception to this approach was made in the August 1988 - December 1991 comparison where volume changes between the 12 foot and 18 foot contour were included. Investigations show that the widened beach (1988/89) would have moved some material beyond the 12 foot contour that should be accounted for. To address offshore closure and to be conservative in the calculation of volumes

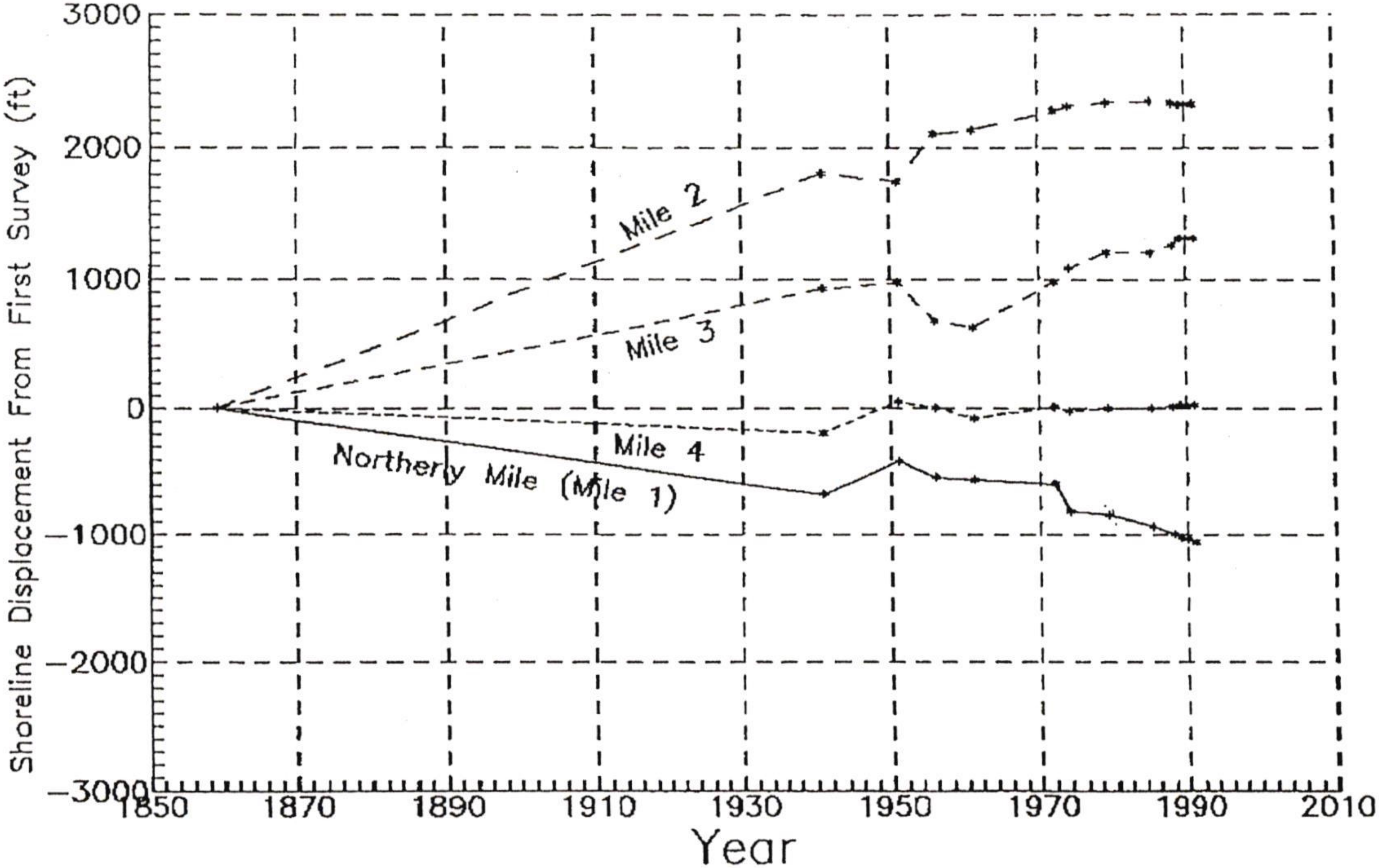


Figure 6 . Shoreline Positions on Sanibel Island Averaged Over Approximately One–Mile Intervals.

SOURCE: DR. ROBERT DEAN

beyond the 12 foot contour, each plotted profile was analyzed and a closure correction was computed if the comparison showed significant divergence on the seaward end of the profile (see Appendix C). The results of this evaluation are shown in Table 4.

Volume changes on Captiva Island were computed for three time periods using shoreline changes. Table 3 presents the results of this analysis from 1941 through 1985. The time periods were selected because the data appeared to be well behaved. The selected time periods show a continued erosion trend for Captiva Island consistent with the long term record. Selection of other time periods would have suggested periods of accretion on Captiva Island which would be anomalous behavior for the island.

There is some uncertainty in the selection of time frames. The data when taken in the aggregate do not clearly indicate selection of certain time frames. For that reason, we have included a 1941-1985 comparison in Table 3.

Table 3

Annual Volume Change Rates
Captiva Island
Based on Shoreline Changes 1941-1985
(cubic yards x 1000/yr.)
Based on a Conversion Factor of 0.67 c.y./ft.

Reach	1941-55	1955-74	4/74 - 4/85	1941-85
Mile 1	-73	-14	+5*	-28*
Mile 2	-61	-24	-17*	-34*
Mile 3	-17	-7	-3	-9
Mile 4	-5	-5	-9	-6
Mile 5	-9	-17	-6	-12
	-165	-67	-30	-89

* Beach nourishment volumes have been deducted from these numbers.

After 1985, the beaches of Captiva and northern Sanibel were monitored twice/year. An analysis of the data sets showed good offshore closure between September 1985 and August 1988 profiles with less than 3% change in volume from the 12 ft. to the 18 ft. depth contours (when compared to the total volume change above the 12' depth contour). The erosion rate of Captiva Island between 1985 and 1988 was 85,000 cubic yards/year, as shown on Table 4.

Table 4

Captiva Island Volume Change Rates
Based on Beach Profile Comparisons
(In Thousands of Cubic Yards)

Mile	Sept. '85 - Aug. '88 (Above 12' Contour) Total	Annual	Aug. '88 - Dec. '91 (Above 18' Contour)	Placed Volume	Aug. '88 - Dec. '91 Net Erosion
1	-63	-21	+122	+113	+9
2	-79	-26	+263	+392	-129
3	-46	-15	+327	+384	-57
4	-61	-20	+454	+342	+112
5	-8	-3	+272	+362	-90
	-256	-85	+1,438	1,593	-155

The period 1974 through 1988 is an important pre-construction time period for later analysis. The following volumetric composite was generated for the '74 - '88 time period using both shoreline and profile data (Table 5). From 1974 through 1988 Captiva Island eroded at 42,000 cubic yards/year.

Table 5

Composite Based on Shoreline Changes and
Profile Comparisons
Captiva Island Volume Change Rate
(In Thousands of c.y./yr.)

	4/74 - 8/88
Mile 1	-1
Mile 2	-19
Mile 3	-6
Mile 4	-11
Mile 5	-5
Total	-42

Table 6

Annual Erosion Rate
(Thousands of Cubic Yards/Year)
Aug. '88 - Dec. '91
(Above the 18' Contour)

Mile 1	+3
Mile 2	-39
Mile 3	-17
Mile 4	+34
Mile 5	-28
Total	-47

The next profile comparison chosen was August '88 through December '91 (Table 6). This comparison shows less than a 5% change between the 12 ft. and 18 ft. depth contour, an indication of good offshore closure. The volume change above the 18 ft. contour was a gain of 1,438,000 cubic yards and reflects the beach nourishment construction of 88/89. When placed volumes are deducted from measured quantities, a total erosion of 156,000 cubic yards is estimated over the 3.3 year period, or 47,000 c.y./yr.

The cumulative volume change for Captiva Island is Shown in Figure 9.

e. Volume Changes in Northern Sanibel

Volume changes on the northern 4 miles of Sanibel Island were estimated from 1941 through 1985 using shoreline changes. The conversion factor used varied with the amount of island rollover/overwash estimated.

On Sanibel Island, segments of the shoreline are backed by water. When these segments retreat, the upper portion rolls over into the bay and does not erode. Over short time periods the rollover can cause shoreline retreat with little or no volumetric loss. Over the long term, however, the profile will evolve to an equilibrium cross-section. For rollover segments the volume conversion is smaller (0.33 c.y./ft.) than for non-rollover segments. To establish the amount of overwash shoreline in each mile of northern Sanibel, inland water bodies were measured and compared to land areas. The conversion factors for each mile are shown in Table 7. Table 7 shows computed conversion factors for miles 1 through 4 based on land and water areas. The Mile 4 conversion factor is assumed to be 0.67 c.y./ft.

Table 7

Conversion Factor for Volume Changes
in Northern Sanibel From 1941-1985

	% Water	% Land	% Water (0.33)	% Land L (0.67)	Conversion Factor
Mile 1	48	52	0.16	0.35	0.51
Mile 2	33	67	0.11	0.45	0.56
Mile 3	7	93	0.02	0.62	0.65
Mile 4	0	100	0.00	1.00	0.67

Table 8 shows the volumetric changes in northern Sanibel based on shoreline changes. The north mile erosion rate changed from a strong accretion of 53,000 c.y./yr during the 1940's and '50's to an erosion of 34,000 c.y./yr in the late 1970's and early '80's.

Table 8

Annual Volume Change Rates
Sanibel Island
Based on Shoreline Changes 1941-1985
(In Thousands of Cubic Yards)

Reach	1941-1955	1955-1974	1974-1985
Mile 1	+53	-37	-34
Mile 2	+16	+50	N/A
Mile 3	-29	+50	N/A
Mile 4	+39	-4	N/A

Since 1985, profiles have been measured twice/year along the first mile of Sanibel Island. Aug. '85 through Aug. '88 and Aug. '88 through Dec. '91 have been compared to analyze volumetric changes (Table 9). Both of these comparisons show good offshore closure in Sanibel.

To account for sand stored in the ebb shoal of Blind Pass (a sediment sink) the offshore changes of the first 1200 feet of beach have been subtracted from the direct profile comparison. This assures that any loss of sand to the ebb shoal will not be counted as an increase of sand to the beach system.

To account for volumes of sand that moved into Clam Pass Bayou that were not computed by direct profile comparison, estimates have been made of those quantities. Overwash and shoreline retreat in the vicinity of R112.5 and R114 has extended landward of the 1985 and 1988 survey limits (see Figures 7 and 8). Sand has moved into Clam Bayou that was not directly accounted for by direct profile comparison. These volumes have been estimated by extending historical profiles landward using aerials to identify land/water areas and assuming the depth in Clam Pass Bayou to be -3 NGVD. The area between the measured profile and the estimated historic profile was computed. Volume estimates were developed by multiplying by the effective distance of observed overwash. These calculations are shown on Figures 7 and 8.

These results introduce some uncertainty into the analysis. The amount of unmeasured overwash from 1985-88 was computed to be an order of magnitude less than the 1988-91 time period. From 1984-1988, the area was affected by Hurricane Elena, Tropical Storm Juan and Hurricane Kate. The island retreated by 59 feet. These storms probably overwashed the island and pushed sand into Clam Bayou and Old Blind Pass. However, no survey cross-section existed in front of Clam Bayou in 1985. It is likely that the estimates for unmeasured overwash are low, based on this analysis.

To address this concern a review of 1985 and 1987 aerials was made. These aerials did not show evidence of overwash during that time period. This would appear to support the lower overwash estimate in Table 9 for the 1985-88 time period. Based on this analysis, we have held this estimate at the computed value.

Table 9 shows the measured volume and the net changes that have occurred from 1985 through 1991.

Table 9

Volume Changes on the Northern One Mile of Sanibel
Based on Profile Surveys

	8/85 - 8/88	8/88 - 12/91
A - Measured Volumes	-148,053	-100,738
B - Shoal Change	-4,897	+53,042
C - Overwash Not in "A"	+3,100*	+46,648
	-140,056 c.y.	-107,132 c.y.
Annual Change	-46,685 c.y./yr.	-33,172 c.y./yr.

*May be a low estimate based on limited profile information in Clam Bayou area.

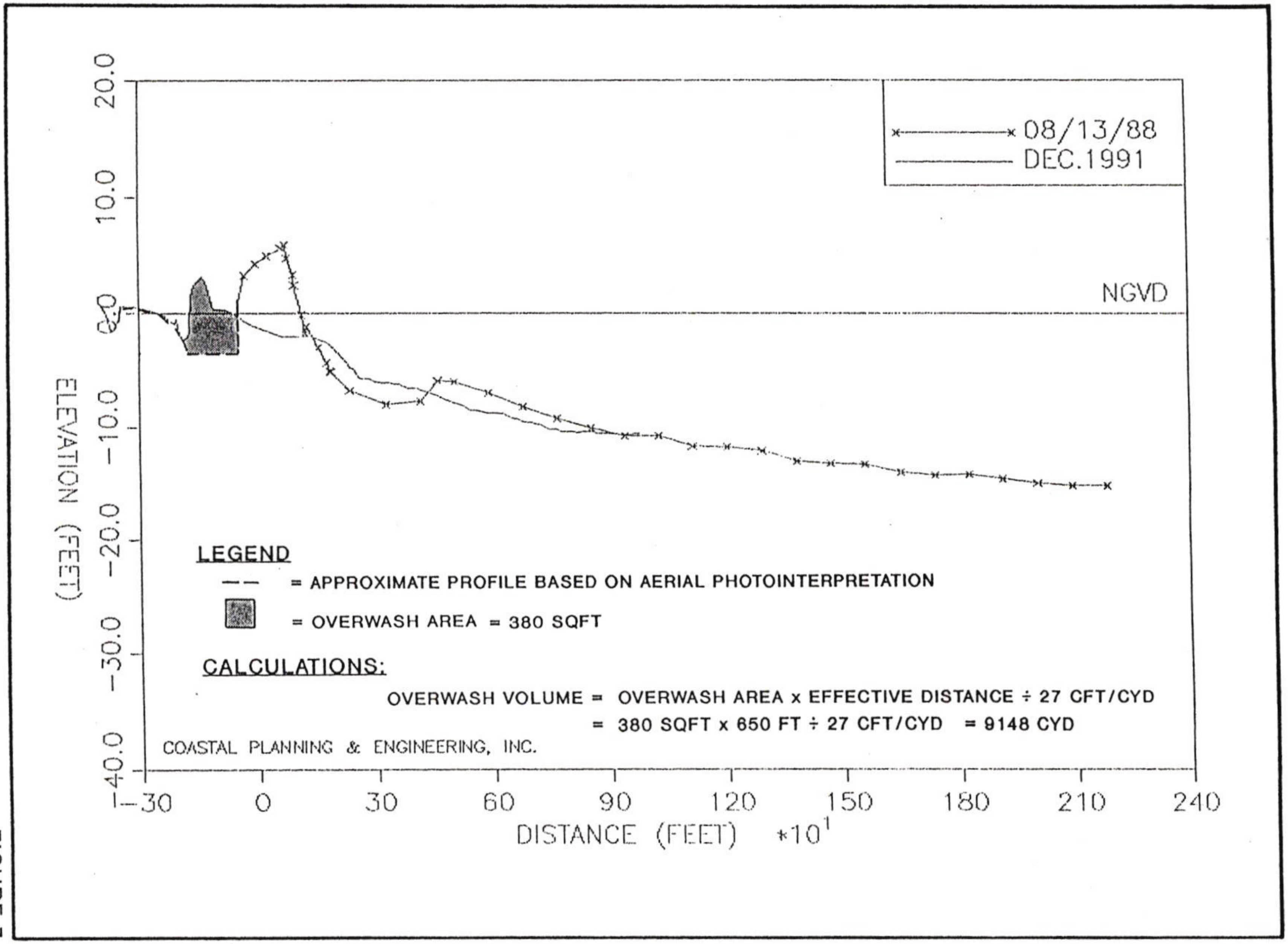


FIGURE 7

SANIBEL ISLAND OVERWASH CALCULATIONS

PROFILE LINE 112.5

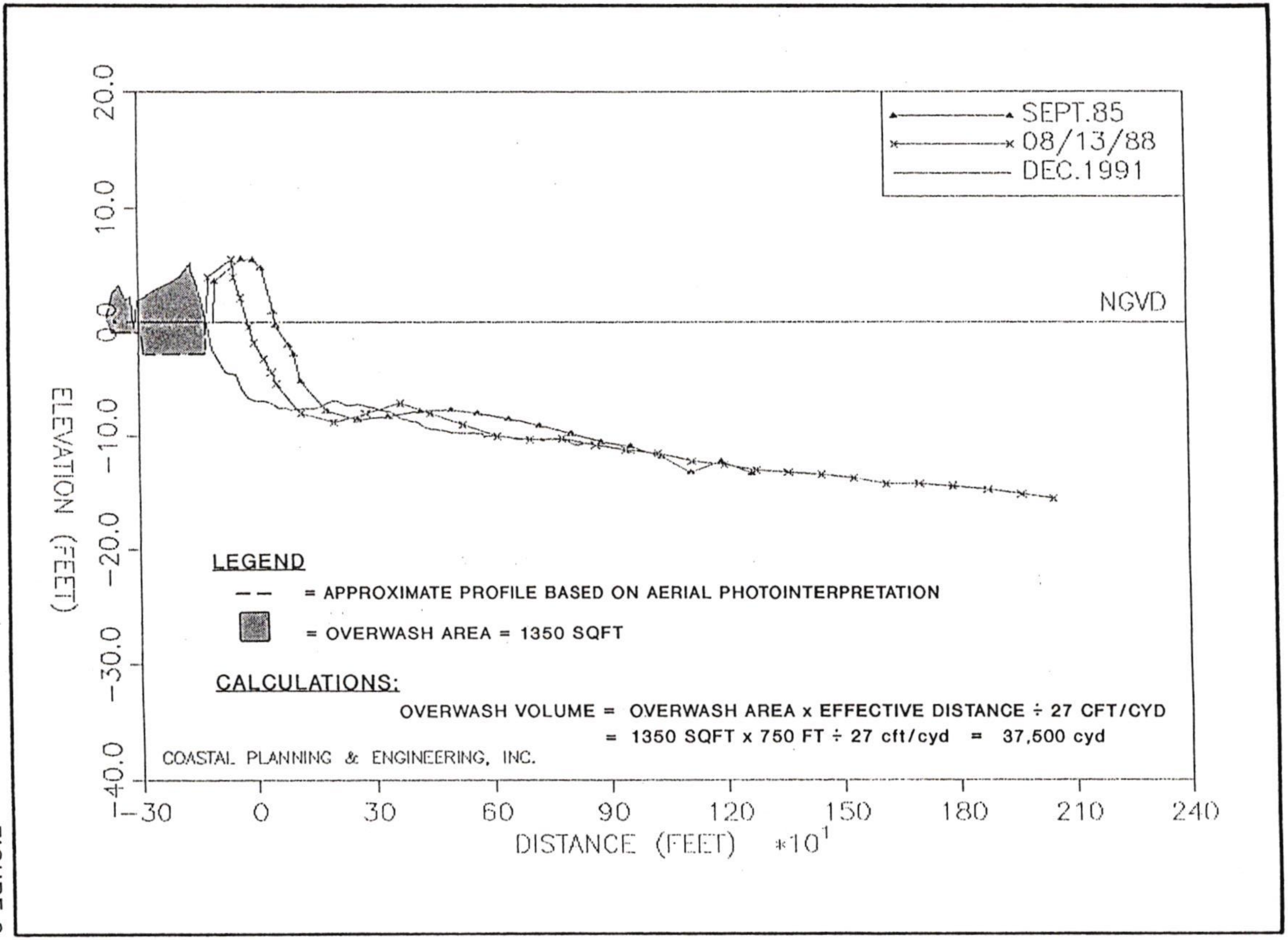


FIGURE 8

SANIBEL ISLAND OVERWASH CALCULATIONS
PROFILE LINE R114

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Table 10

Volume Change Northern Sanibel From 1974-1991
Based on Shorelines and Profile Surveys
(In Thousands of c.y./yr.)

	1974-1988	Aug. '88 - Dec. '91
Mile 1	-37[1]	-33[3]
Mile 2	+13[2]	+2[4]
Mile 3	+30[2]	-23[4]
Mile 4	+4[2]	+45[5]

[1] Based on profiles and shorelines composite
[2] Based on shorelines
[3] Based on profiles from Table 9
[4] Based on '89-'91 shorelines
[5] Based on '89-'90 shorelines

Table 10 shows the composite volumetric change estimates in northern Sanibel from 1974 through 1991. Since August of 1988 the northern one mile has eroded at 33,000 c.y./yr. or about 9% slower than the erosion rate of the previous period.

The cumulative volume changes in the northern one mile of Sanibel are shown on Figure 9.

2. Analysis of Recent Data

a. Sanibel Island Shoreline Changes

Prior to the 1988/89 nourishment project on Captiva Island, a retreat rate for shoreline positions along northern Sanibel Island was established by the DNR. The weighted average retreat rate was 13.3 ft./yr. (Leadon, Conference Report, DNR, DBS 86-182 permit).

Data available from August 1988 to December 1991 extend from DNR monument R-110 located immediately south of Blind Pass to R-116 located approximately 6314.6 ft. south of Blind Pass. The analysis method consisted of weighting the shoreline positions by shoreline distances appropriate to the spacing of the adjacent monuments. The results are presented in Figure 10 and the interpretation is discussed in the following pages.

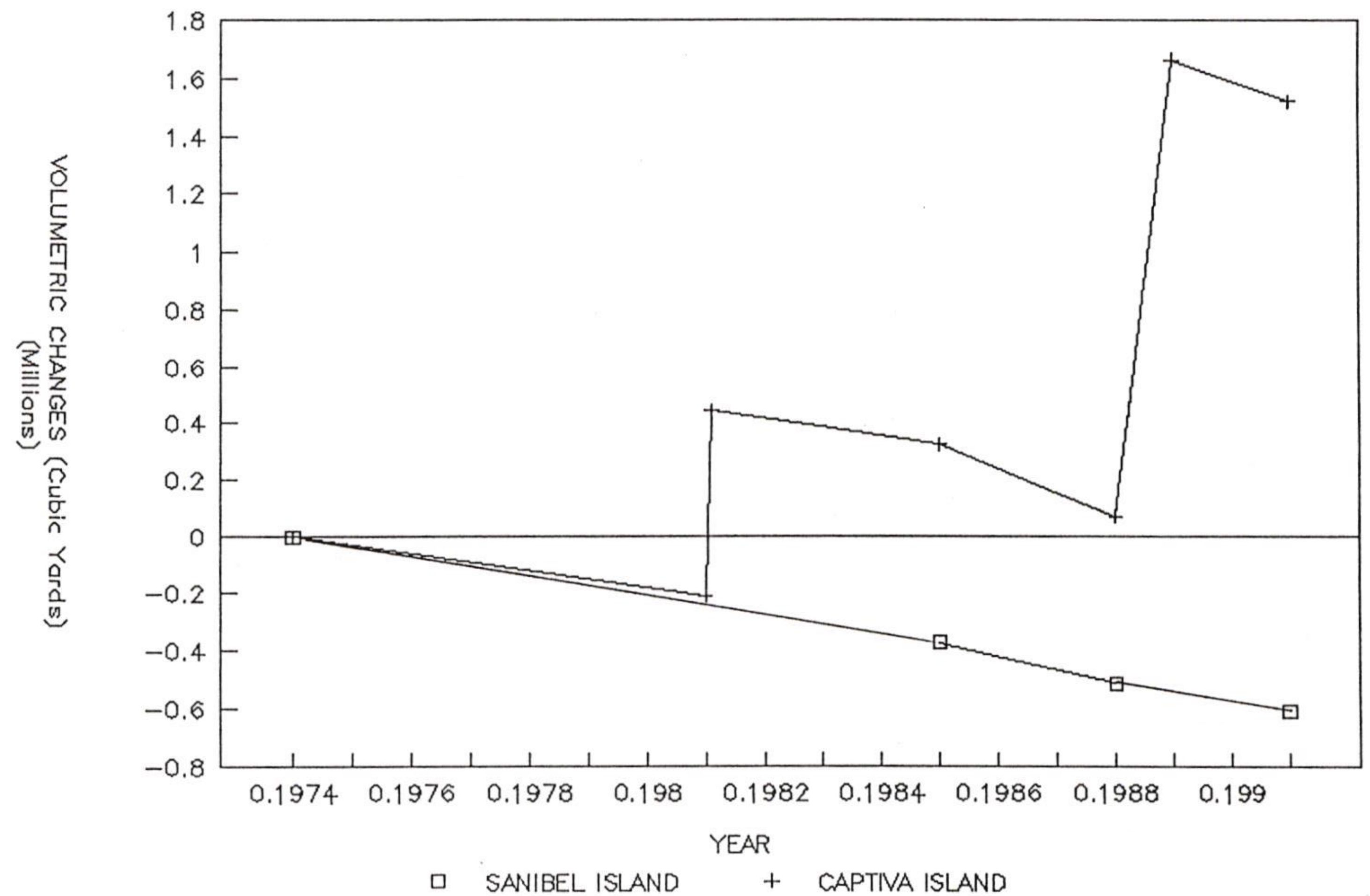

FIGURE 9

CAPTIVA – SANIBEL
CUMULATIVE VOLUMETRIC CHANGES
1974 – 1991

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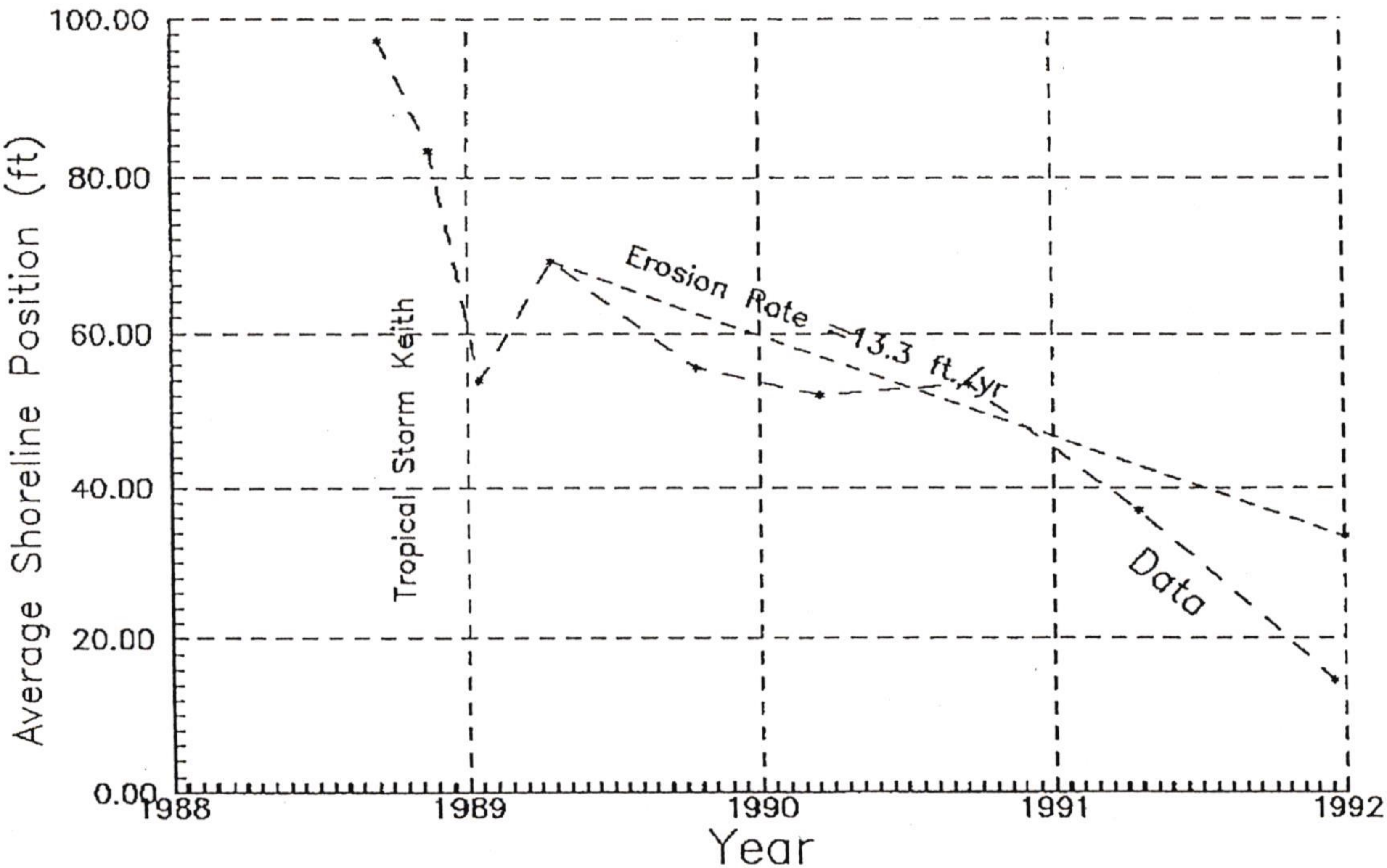


Figure 10. Weighted Average Shoreline Positions Along The Northerly Mile of Sanibel Island. Data Furnished Predominantly by the Department of Natural Resources.

SOURCE: DR. ROBERT DEAN

Tropical Storm Keith occurred in November 1988 and has caused some difficulty in interpretation. It appears that Keith caused some irreversible shoreline retreat through overwash and possibly anomalous longshore sediment transport. Figure 10 shows the shoreline retreat in northern Sanibel compared to the DNR rates. This includes the effects of Keith. However, referring to Figure 11, it is clear that as of the April 1989 survey, significant shoreline recovery following Keith has occurred.

Using the adopted pre-groin extension erosion rate of 13.3 ft./yr., the projected shoreline position in December 1991 would have been at station 34.1 ft. versus a measured average station of 14.6 ft. This represents an excess recession of 19.5 ft., which over the 2.63 year period averages to an excess recession rate of 7.4 ft./yr. The 1988/89 Captiva beach restoration and groin extension may be part of the cause for the excess recession.

Figure 11 presents a comparison of the average mean high water change and the DNR rate in three segments on Sanibel Island since completion of the fill project. In the northern segment between R110 and R112, erosion has been slower than the DNR rate. The middle segment between 112.5 and R114 eroded at a much higher rate. However, the high shoreline retreat rates in this segment may be caused by overwash rather than impacts caused by construction of the terminal groin. The southern segment between R115 and R116 has also eroded slower than the DNR rate. This segment has experienced shoreline advance since completion of the beach fill.

Figure 12 presents the comparative rates of shoreline retreat from August 1988 through December 1991. An analysis of this data in Appendix C suggests that overwash and rollover was the major cause of erosion during this time period.

b. Sanibel Island Volume Changes

The erosion rate of northern Sanibel (6300 ft.) has averaged 37,000 c.y./yr. from April 1974 through August 1988. In the time period from August 1988 through December 1991, the erosion rate was only 33,000 c.y./yr. This represents a reduction of 11% over the previous time period. This reduction in erosion rate could represent a positive impact from the 1988/89 Captiva Island Beach Nourishment/Groin Extension Project.

D. Inlet Bathymetry

The present bathymetry of Blind Pass reflects the historical trends observed since the mid-1800's. As noted earlier, the inlet has shifted considerably in the last 150 years (see Figure 2). This migration has affected the current configuration and bathymetry of the nearshore regions.

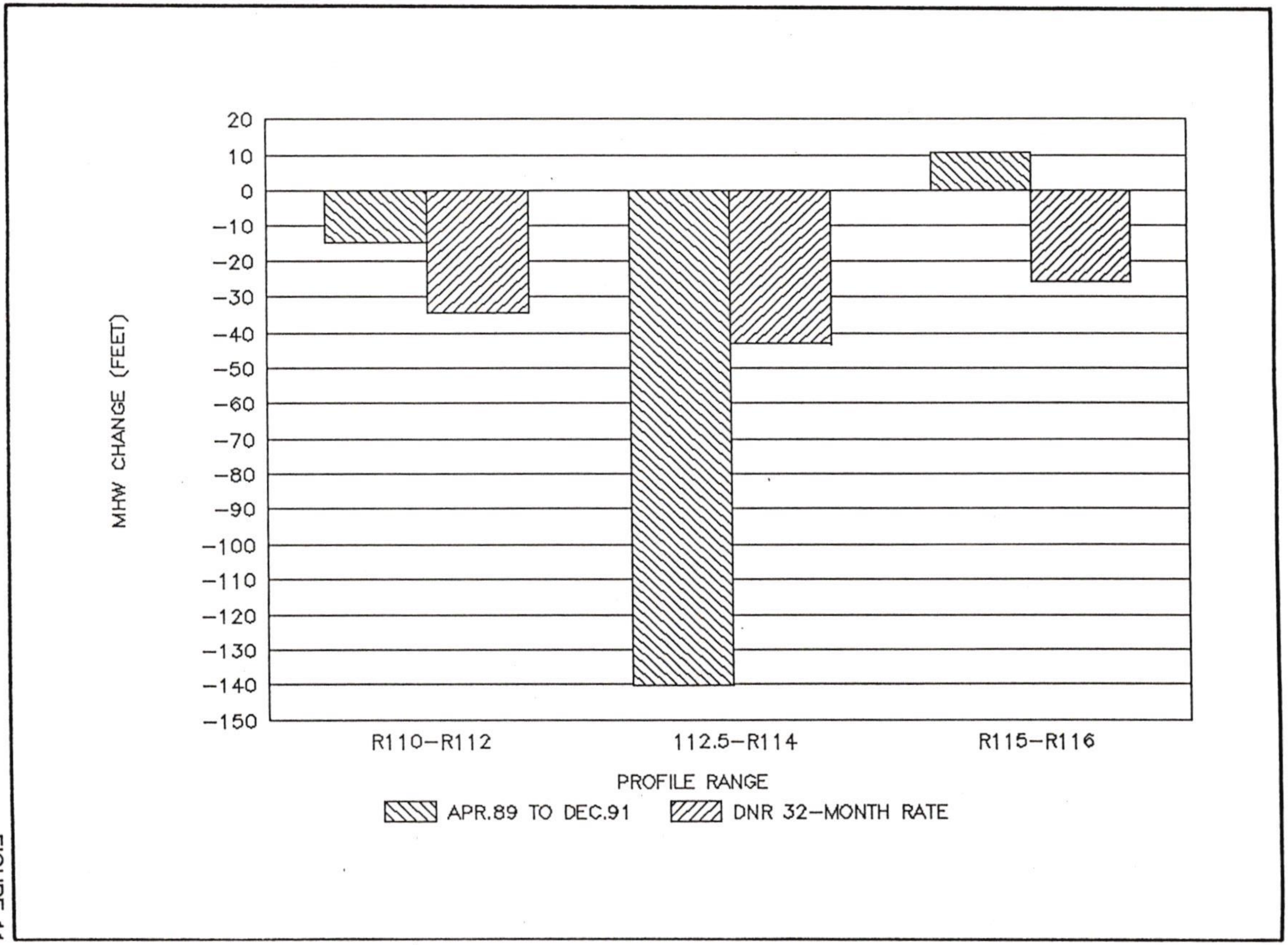
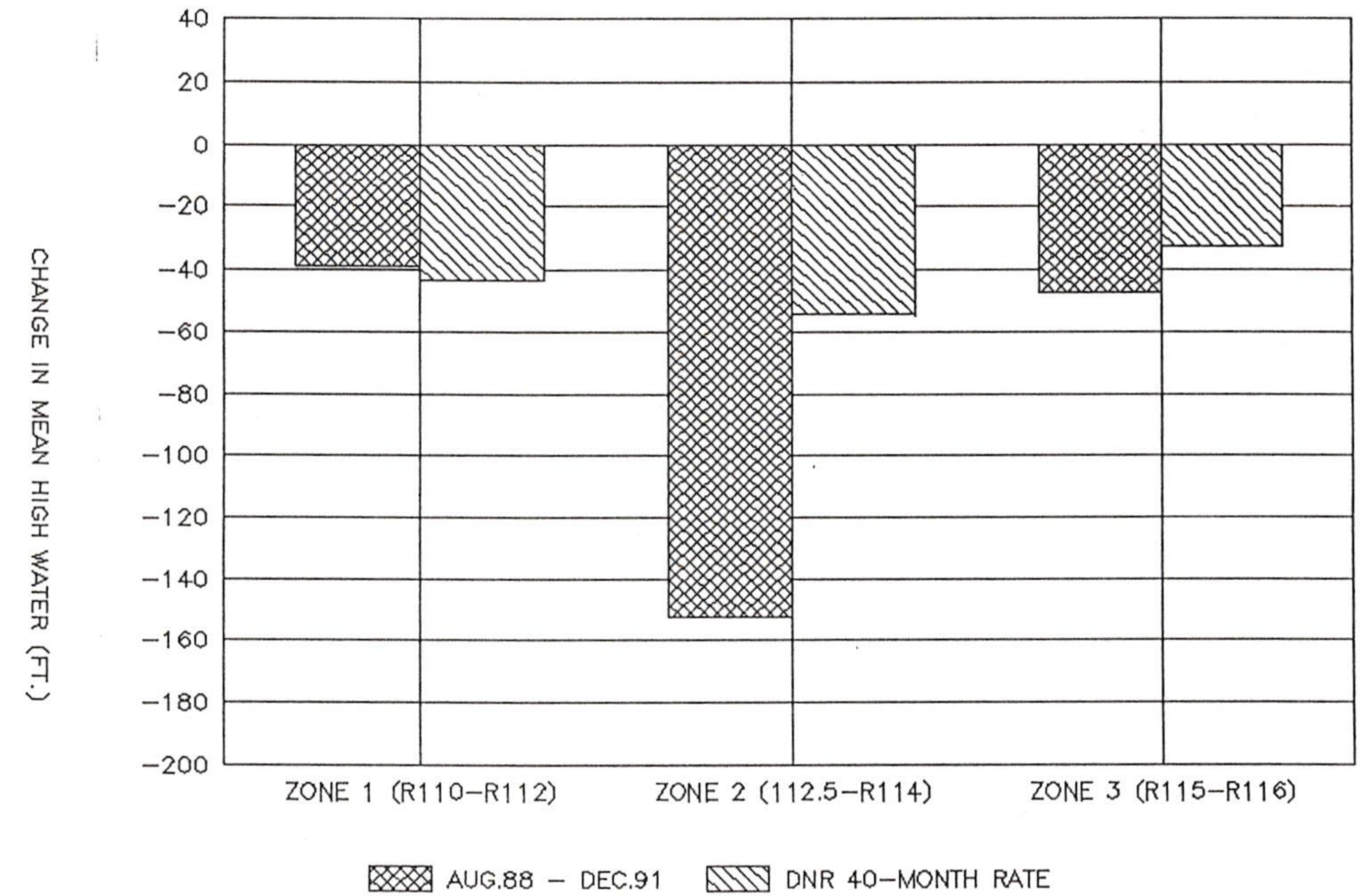


FIGURE 11

SANIBEL MHW CHANGES
APRIL 1989 TO DECEMBER 1991

FIGURE 12

SANIBEL ISLAND MEAN HIGH WATER CHANGES
AUGUST 1988 – DECEMBER 1991



Based on bathymetric survey comparison of 1960 and 1989 data, the flood shoal appears to be impounding approximately 2200 cubic yards/year from the littoral system. This value is reached by averaging a 61,800 cy volume change over 28 years. These two surveys were digitized and the volume comparison was completed using both a Trapezoidal Rule and a Simpson's Rule approximation. A topographic plot of the 1989 survey and the 1960-1989 contour change chart are presented in Figures 13 and 14.

A significant ebb shoal apparently exists at Blind Pass, but not offshore of the current inlet position. The shoal, an area of approximately 6000' x 1000' exhibits a pattern of contours 1000 feet offshore that appears to be the remnant of a previous ebb shoal. A topographic plot (Figure 15) of the nearshore region depicts this shoal. Volume calculations yield a quantity of approximately 890,000 cy that may be a viable borrow source in the future.

The inlet channel at the Department of Transportation bridge connecting Sanibel and Captiva Island has shoaled considerably as a natural response to hydraulic forces (see Section II. G. - Stability and Hydraulic Characteristics). The channel shoals shift position regularly providing considerable hazards to vessel navigation.

The groin on Captiva Island borders the inlet channel. This is the only consistent feature of the inlet. Because of the existence of the groin, current scouring of the seabed occurs, holding the deepest part of the channel to the north side of the inlet.

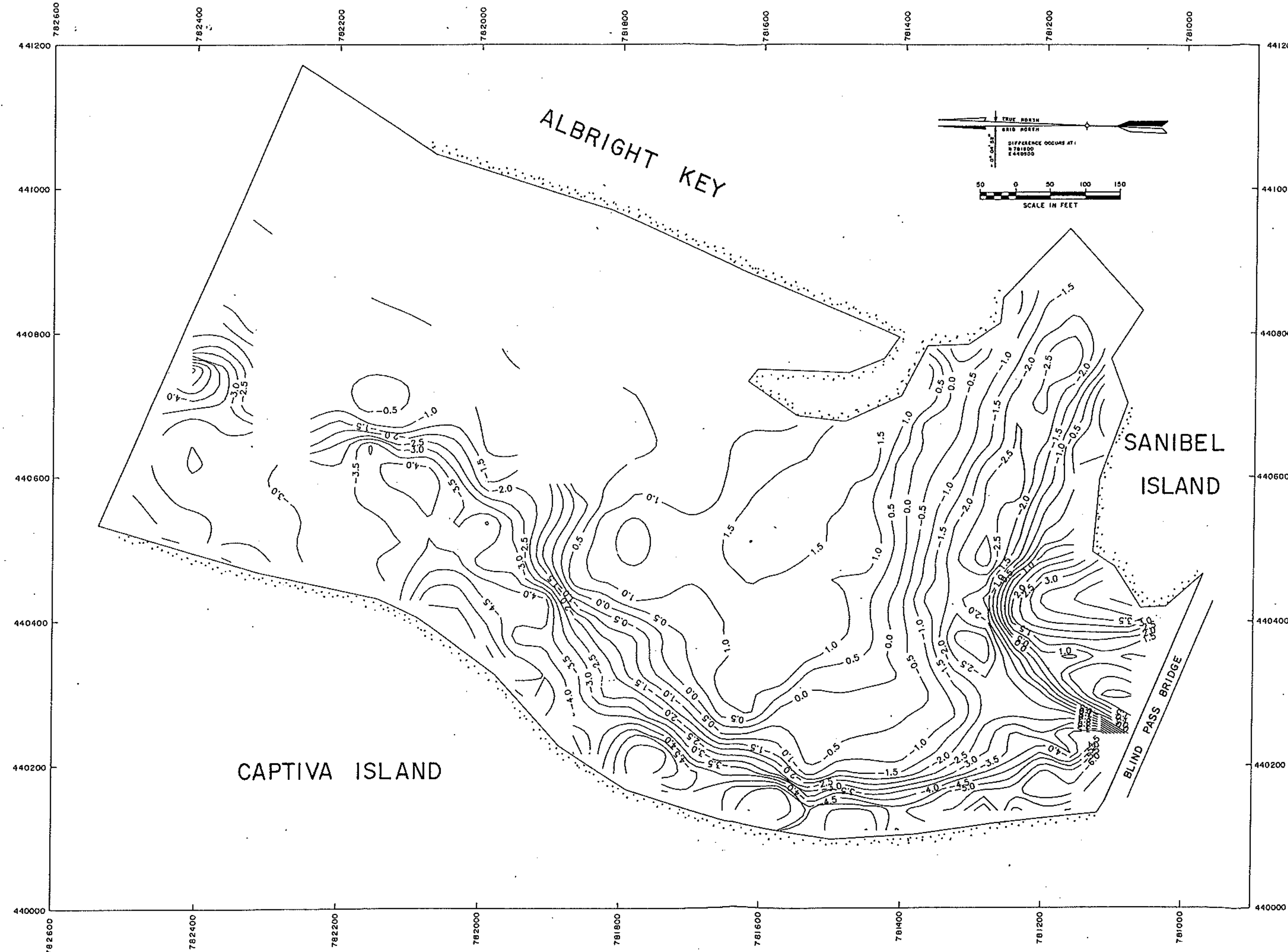
E. Littoral Budget Analysis

The littoral budget is a balance of sand movement during specific time periods over discrete segments of coast. It is generally accepted that the net littoral drift is south on Captiva and Sanibel Islands as is evidenced by the creation of Captiva and Sanibel Islands through southerly sand migration over the past 5000 years (Missimer). The erosion response of Captiva Island to the opening of Redfish Pass is further indication of a strong net south drift.

The southern boundary of the littoral budget is the south end of Sanibel Island where net littoral drift is assumed to be zero. No assumptions are made concerning sand movement at the northern boundary except as indicated.

The shoreline evolution along the southern 8 miles of Sanibel Island provides important information on the rate of sand movement from northern Sanibel Island. Based on shoreline changes we find that southern Sanibel has been actively accreting (building up) since 1941.

The rate of buildup in southern Sanibel is faster than the rate of loss from Captiva Island and northern Sanibel, because sand is coming in from offshore (see Table 11). From 1941 through 1955, the rate of accretion in southern Sanibel was a rapid 139,000 cubic yards per year (see Table 11). In the later time periods (1955-1974 and 1974-1989), the



NOTES:

1. 1989 BATHYMETRIC SURVEY CONDUCTED NOVEMBER 29, 1989 BY COASTAL PLANNING & ENGINEERING, INC.
2. 1960 BATHYMETRIC SURVEY CONDUCTED BY UNITED STATES COAST & GEODETIC SURVEY.
3. POSITIVE CONTOUR DESIGNATIONS INDICATES ACCRETIONS.
4. NEGATIVE CONTOUR DESIGNATIONS INDICATE EROSION.
5. CONTOURS ARE SHOWN IN FEET.
6. COORDINATES AS SHOWN HEREON ARE BASED ON THE FLORIDA STATE PLANE COORDINATE SYSTEM, WEST ZONE.

COASTAL PLANNING & ENGINEERING, INC.
BOCA RATON SARASOTA JACKSONVILLE FLORIDA

PROJECT: CAPTIVA ISLAND BLIND PASS, FLOOD TIDAL SHOAL CONTOUR CHANGE CHART 1960 vs. 1989

DRAWN BY: Computer / Mr

CHECKED BY: J.A.

DATE: 5/9/90

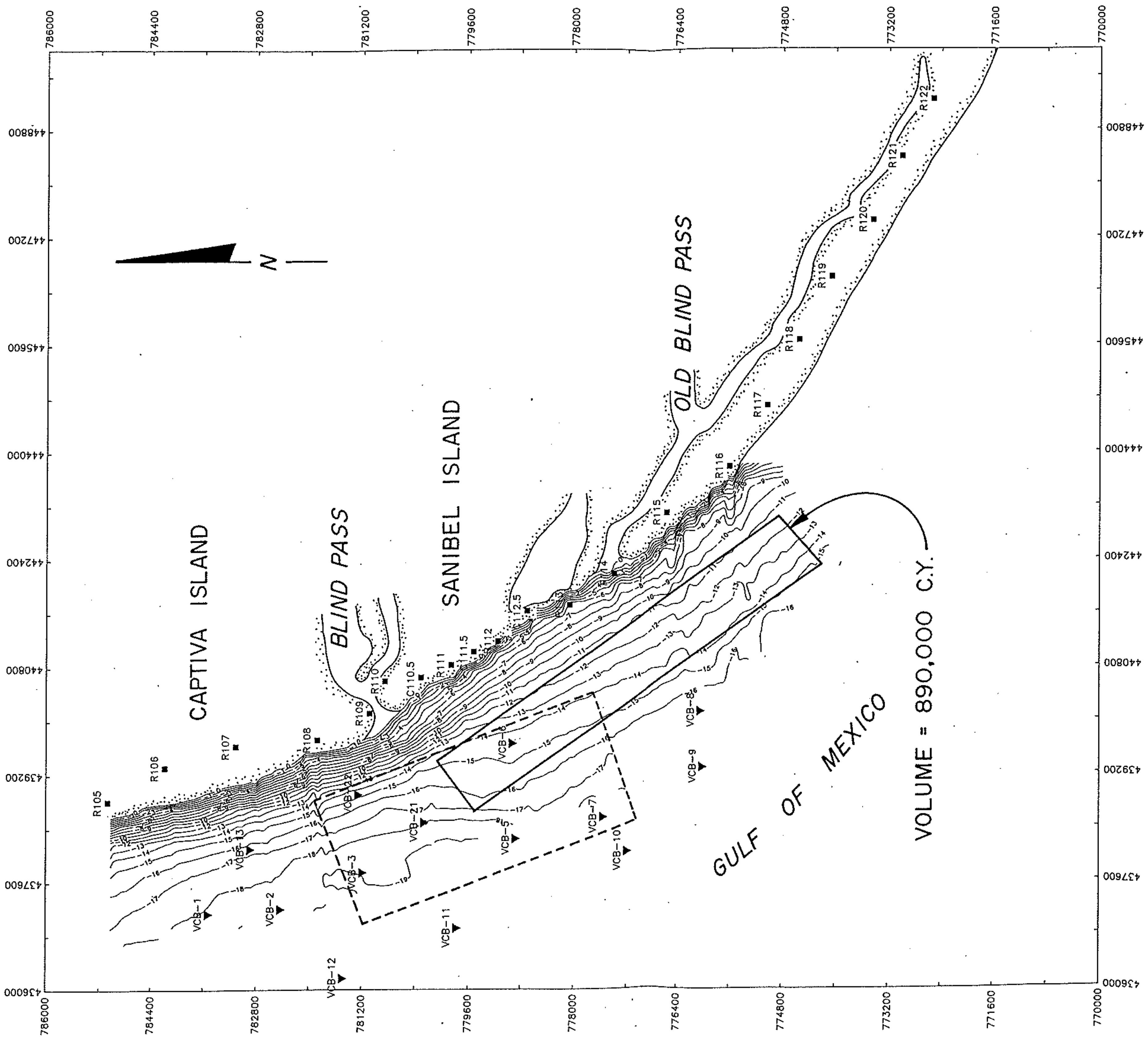
COMM. NO.: 8401.54

SCALE: AS SHOWN

SHEET: 1 OF 1

REVISION DATE:

FIGURE 14



LEGEND:

- VCB-10 – 1980 VIBRACORES
- R116 – D.N.R. MONUMENTS
- G.F. YOUNG OCT., 1987 SURVEY AREA
- AREA OF VOLUME COMPUTATION

NOTES:

1. BATHYMETRIC CONTOURS WERE GENERATED FROM THE OCTOBER, 1989 BEACH PROFILES SURVEY CONDUCTED BY COASTAL PLANNING & ENGINEERING, INC.
2. SHORELINE AND BLIND PASS CHANNEL SHOWN WERE SCALED FROM THE DECEMBER, 1988 D.N.R. AERIAL PHOTOGRAPHS.

COASTAL PLANNING & ENGINEERING, INC.
BOCA RATON SARASOTA JACKSONVILLE FLORIDA

PROJECT: BLIND PASS EBB TIDAL SHOAL

DRAWN BY: Computer /
CHECKED BY:
DATE: 5/9/90
COMM. NO.: 8401.54
SCALE: 1" = 800'
SHEET: 1 OF 1
REVISION DATE:

FIGURE 15

accretion rate of southern Sanibel slowed to 76,000 and 79,000 cubic yards/year, respectively. Because the total buildup of sand exceeds the supply of sand from the north, we conclude that the buildup on Sanibel is partially due to onshore movement of sand. At the north end of the island the onshore sand movement comes partially from the historic ebb shoal of Blind Pass.

Table 11 and Figure 16 were used to estimate the rate of onshore transport. We assumed that the amount of transport linearly decreases with time and that transport into Redfish Pass was negligible during the later two time periods. Figure 16 shows through extrapolation that the estimated onshore transport at Sanibel for the 1941-1955 time period was 87,000 cubic yards/year. Based on this analysis, the onshore transport would be 35,000 cubic yards/year for the August 1988 through December 1991 time period.

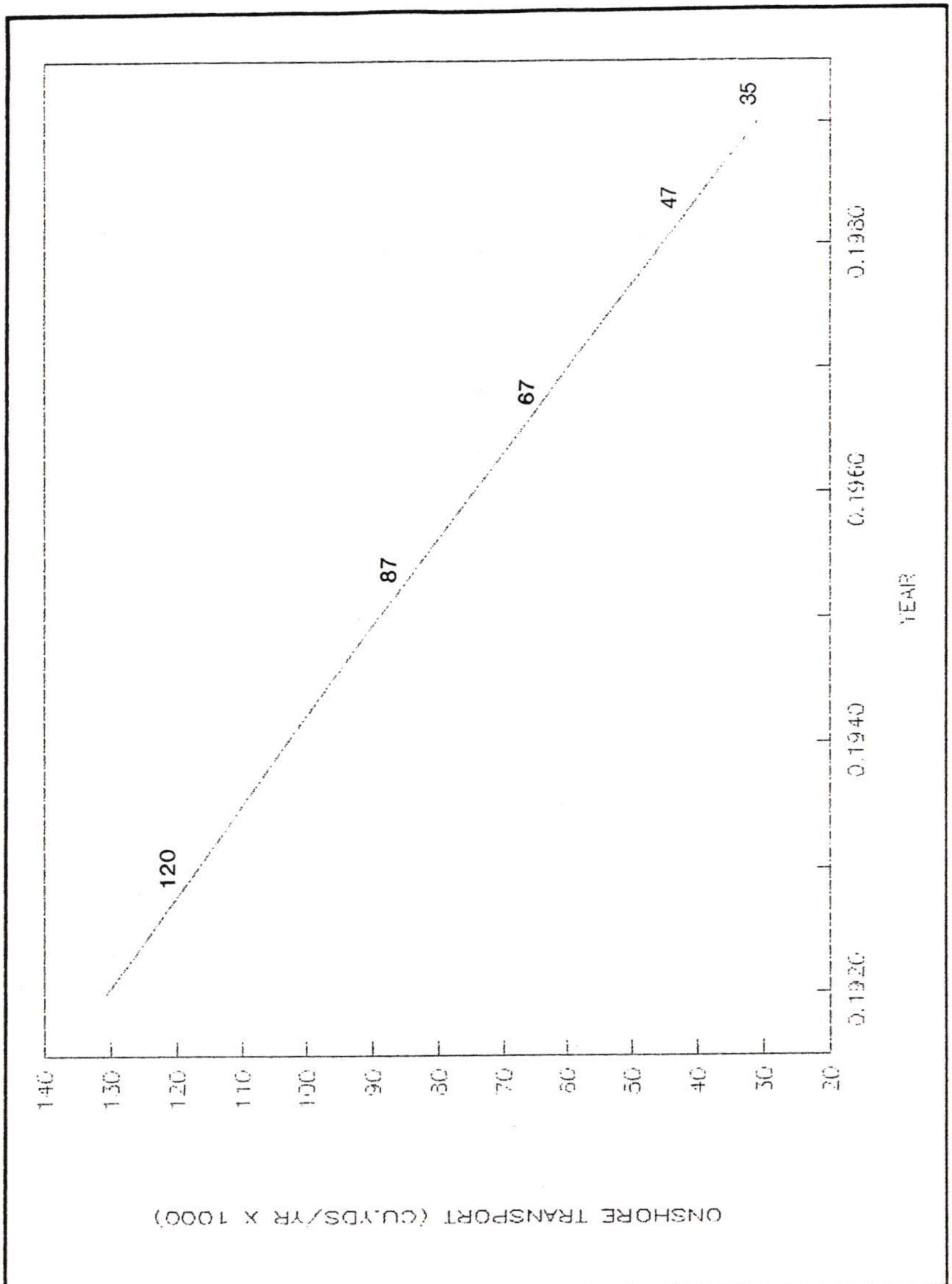
Table 11

Annual Volumetric Changes on Captiva and Sanibel
(cu. yds. x 1000/yr.)

	1941-1955	1955-1974	1974-1988
Captiva	-165	-67	-42
N. Sanibel (4 miles)	+79	+59	+10
S. Sanibel (8 miles)	+139	+75	+79
Totals	+53	+67	+47

The relationship depicted in Figure 16 can be confirmed as follows: If the graph is extended to the date of Redfish Pass opening (1921), the total amount of material to move from the ebb shoal between 1921 to 1988 can be calculated to be 5.3 million cubic yards. The pre-1921 ebb shoal size can then be calculated by adding losses (5.3 million c.y.) and the current ebb shoal size (approximately 890,000 c.y.) to give 6.2 million c.y. Using historic data, Professor A. J. Mehta (Personal Communication 20 March, 1992) was able to calculate the theoretical ebb shoal size from 1888 inlet geometry. From a throat size of 10,800 square feet, an ebb shoal volume of 6.6 million c.y. is calculated, based upon methods in Walton & Adams (1976). Both methods suggest a historic Blind Pass ebb shoal size, prior to Redfish Pass opening, of approximately 6.4 million cubic yards.

Sediment budgets for the 1941-1955, 1955-1974 and 1974-1988 time periods are presented in Figure 17. A composite sediment budget for the years 1941-1988 is shown on Figure 18.



EBB SHOAL SAND MIGRATION

TO NORTHERN SANIBEL

FIGURE 16

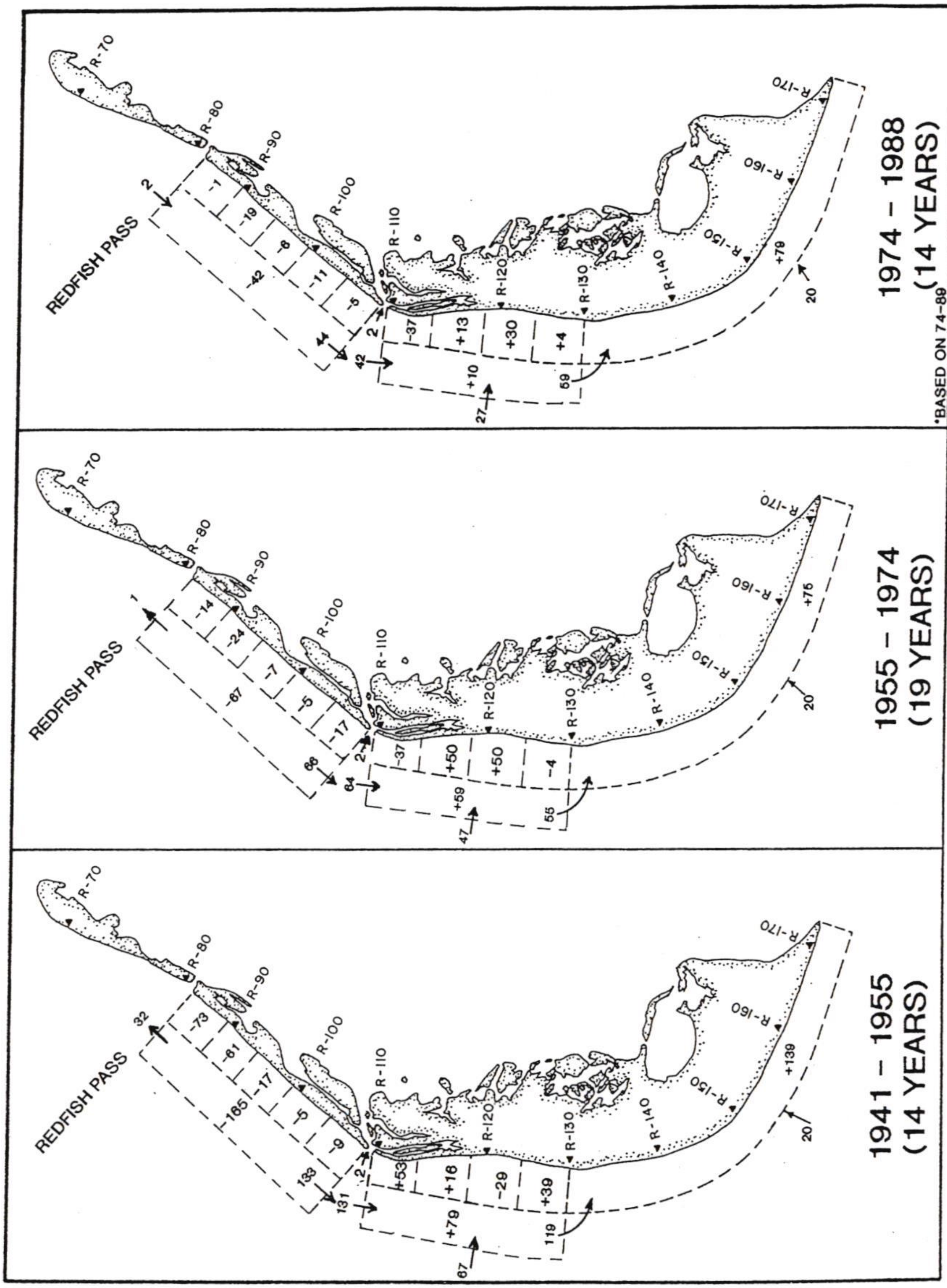


FIGURE 17

CAPTIVA – SANIBEL SEDIMENT BUDGET

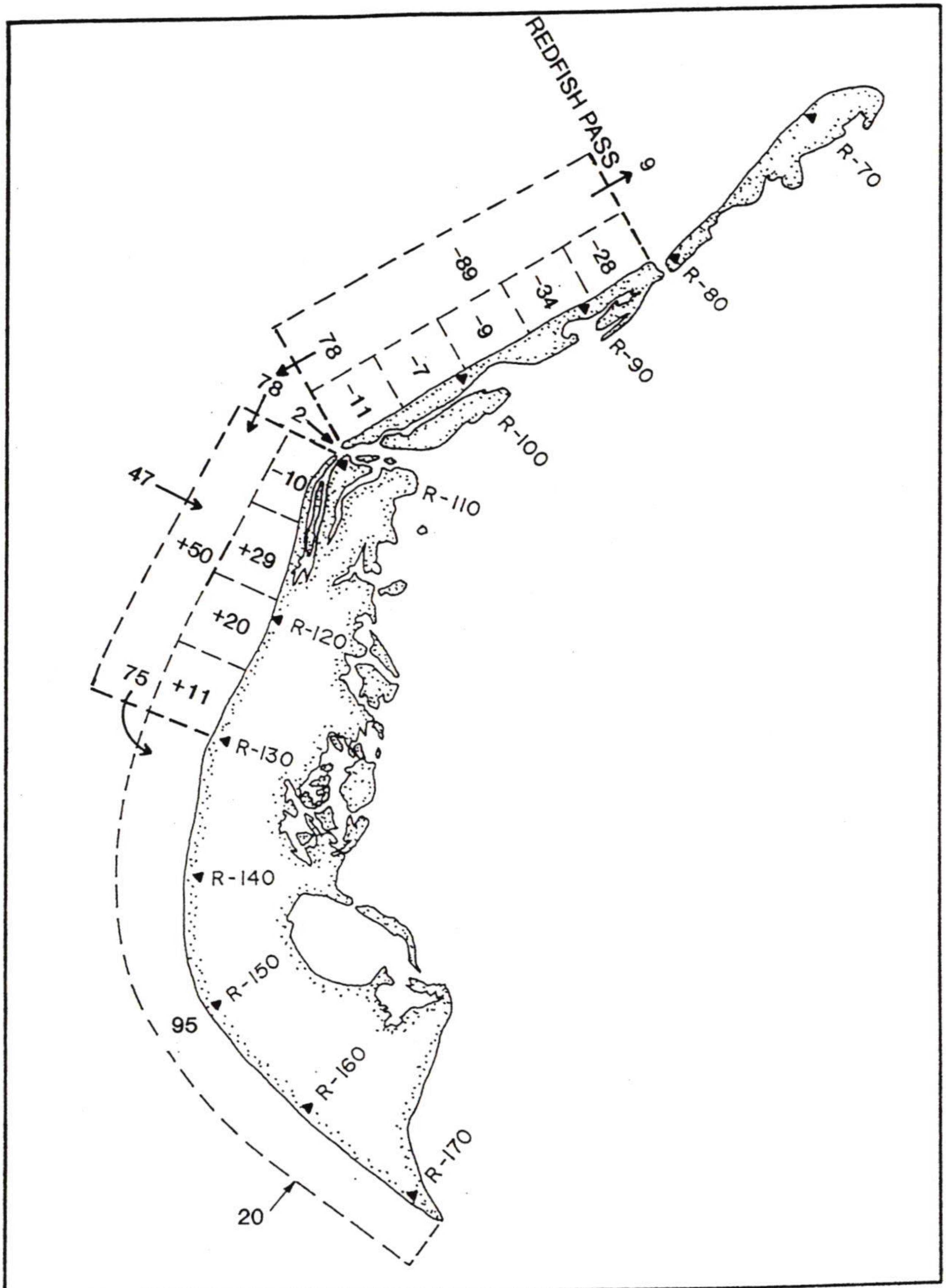


FIGURE 18

CAPTIVA – SANIBEL COMPOSITE SEDIMENT BUDGET

1941 – 1988

During the 1941 through 1955 time period, we can assume that the Redfish Pass shoals had not fully developed and were not providing protection for the northern shore of Captiva Island. This would partially account for the high total erosion rates of Captiva Island. During this time period, 32,000 cubic yards was being lost into Redfish Pass annually and 133,000 cubic yards was leaving the island to the south.

During the next time period, 1955 to 1974, the erosion rate of Captiva Island reduced by more than half from 165,000 cubic yards/year to 67,000 cubic yards/year. The reduced erosion can be partially explained by a more developed ebb shoal of Redfish Pass, which limited the losses into Redfish Pass.

The movement of sand to Sanibel Island from Captiva Island reduced by 50% during this period (from 133,000 to 66,000 cubic yards/year). During this time, 134 permeable groins were installed on Captiva Island (including 2 long wooden groins) and portions of the road revetment were constructed. It is likely that these structures slowed north and south littoral drift along Captiva Island. The most likely reason for the reduction in south drift was the reorientation of segments of the island as a result of major recession of the northern beaches. The northern segment was pinned by the wooden groins and revetment at the north bend of Captiva Drive. The southern segment was first pinned by the county terminal groin at Blind Pass (1972), then by a revetment built 1200 feet north of the groin during the 80's. The northern 4 miles of Sanibel accreted 59,000 cubic yards from 1955 through 1974.

The movement of sand from Captiva to Sanibel Island further reduced between 1974 and 1988 from 66,000 to 44,000 cubic yards/year. This represents a reduction of 22,000 cubic yards/year. This reduction in transport was partially due to the terminal groin constructed by Lee County in 1972. The groin was constructed to protect the approach road to the bridge and evacuation route. Further hardening of the island combined with erosion of shore segments that are updrift of the structures also served to reduce drift during the 1974-1988 time period.

To estimate the groin's impact on Sanibel Island, an odd-even analysis was conducted for the area 1 mile either side of Blind Pass. This method assumes that there are two modes of erosion occurring; one due to background erosion (even) which would be the same north and south of the inlet, and a second mode where the accretion on the updrift side would be a mirror image of the erosion on the downdrift side (the odd component). The mirror image or odd component of the erosion is one of the inlet effects. This odd-even method is also very helpful in reducing the error that is part of shoreline change interpretation. Error introduced by tides or wave runup would be approximately the same north and south of the inlet. These uniform errors become a part of the even analysis, leaving a more accurate determination of the odd erosion quantities which are the inlet effect. Table 12 shows the results of this analysis.

The analysis shows that the background erosion has been fairly consistent since 1974, while the inlet effect has reduced in the most recent time period. This drop most likely shows the effects of the 1988/89 beach restoration project, adding material to the natural bypass system. The odd-even analysis shows that inlet induced erosion averages 13,600 cubic yards per year.

Table 12

Odd/Even Analysis
(Thousands of Cubic Yards)

	1974-1988	1988-1991	1974-1991
Background	-21.0	-30.5	-22.7
Inlet Induced	-16.0	-2.5	-13.6

The present ebb shoal of Blind Pass, which extends from the inlet south along the first 2000 feet of Sanibel Island, has built up from August 1988 through December 1991. To estimate the quantity of sand in the shoal we compared surveys from August 1988 and December 1991. We found that approximately 79,000 cubic yards (24,000/year) of material built in the shoal area from the jetty extending 1400 feet down the beach (Table 13).

Table 13

Volume Change - Shoal Opposite Inlet 8/88-12/91
(cubic yards)

Profile Name	Volume Change Above -18 ft.	Volume Change Above 0 ft.	Shoal Buildup/ Loss	Effective Distance (ft.)
R110	40,913	43	40,870	620.8*
110.5	25,605	1,493	24,112	511.7
R111	11,701	-1,881	13,582	241.0
			78,564	1373.5

*Effective distance was extended north to the jetty.

During the post-construction time period, 1988 through 1991, the Captiva beaches lost 47,000 cubic yards/year while northern Sanibel's beaches (R-110 to R-130) lost 9,000 cubic yards/year of sand in the north 4 miles. During this same period of time, 24,000 cubic yards/year built up in the ebb shoal of Blind Pass. The total change of volume in northern Sanibel including the ebb shoal build-up is 15,000 cubic yards/year accretion from 1988/1991.

A littoral budget was established based on these findings assuming that south Sanibel accreted as it had in the previous time period (Figure 19(a) 1988-1991). If we hold this assumption, then 17,000 c.y. per year would have come from Redfish Pass and deposited on the beach of Captiva Island. Since this is unlikely, an alternate littoral budget was developed.

An alternate littoral budget for 1988-91 was developed based on observations and surveys. The 1989/91 time period was an atypical period of stronger north littoral drift. As evidence of this, the beach was eroded north of the Blind Pass groin (on southern Captiva Island) for the first part of 1991, contrary to what would be expected during the winter months. An alternate littoral budget was established for this time period (see Figure 19(b). This littoral budget suggests a stronger north drift and higher losses of sand into Redfish Pass. Based on this alternate budget, 10,000 cubic yards was transported to Sanibel Island. This budget better represents the conditions experienced on Captiva and Sanibel Islands during the 1988-1991 time period.

During a more typical time period the littoral drift will move south from Captiva Island to Sanibel Island at a higher rate. Figure 20 shows an estimate of the future littoral budget during average wave conditions.

F. Discussion of Littoral Budget

Before 1921 Blind Pass was a larger inlet, similar in size to Redfish Pass. At that time the inlet contained large ebb tidal shoals commensurate with the amount of water going in and out of the inlet, the tidal prism. Since the inlet was relatively old (more than 300 years old), the ebb shoals were probably well developed and sand that was moving down from Captiva was bypassing the inlet.

When Redfish Pass opened in the early 1920's, it captured a large portion of the tidal prism from Blind Pass. Subsequent to 1921, sand from the ebb shoal of Blind Pass started to migrate to the beach and attach itself to the beach within the northern four miles of Sanibel Island.

Redfish Pass also stopped the flow of sand from North Captiva Island to Captiva Island creating an erosional condition on Captiva, especially focused on the northern beaches. The littoral drift deficiency created by Redfish Pass was concentrated primarily on Captiva Island through 1955, as evidenced by the high erosion rate from 1941 through 1955, when the island lost 165,000 cubic yards per year.

The littoral budget suggests that during the period (1941-1955) as much as 133,000 cubic yards was leaving the south end of Captiva Island with 131,000 cubic yards going to

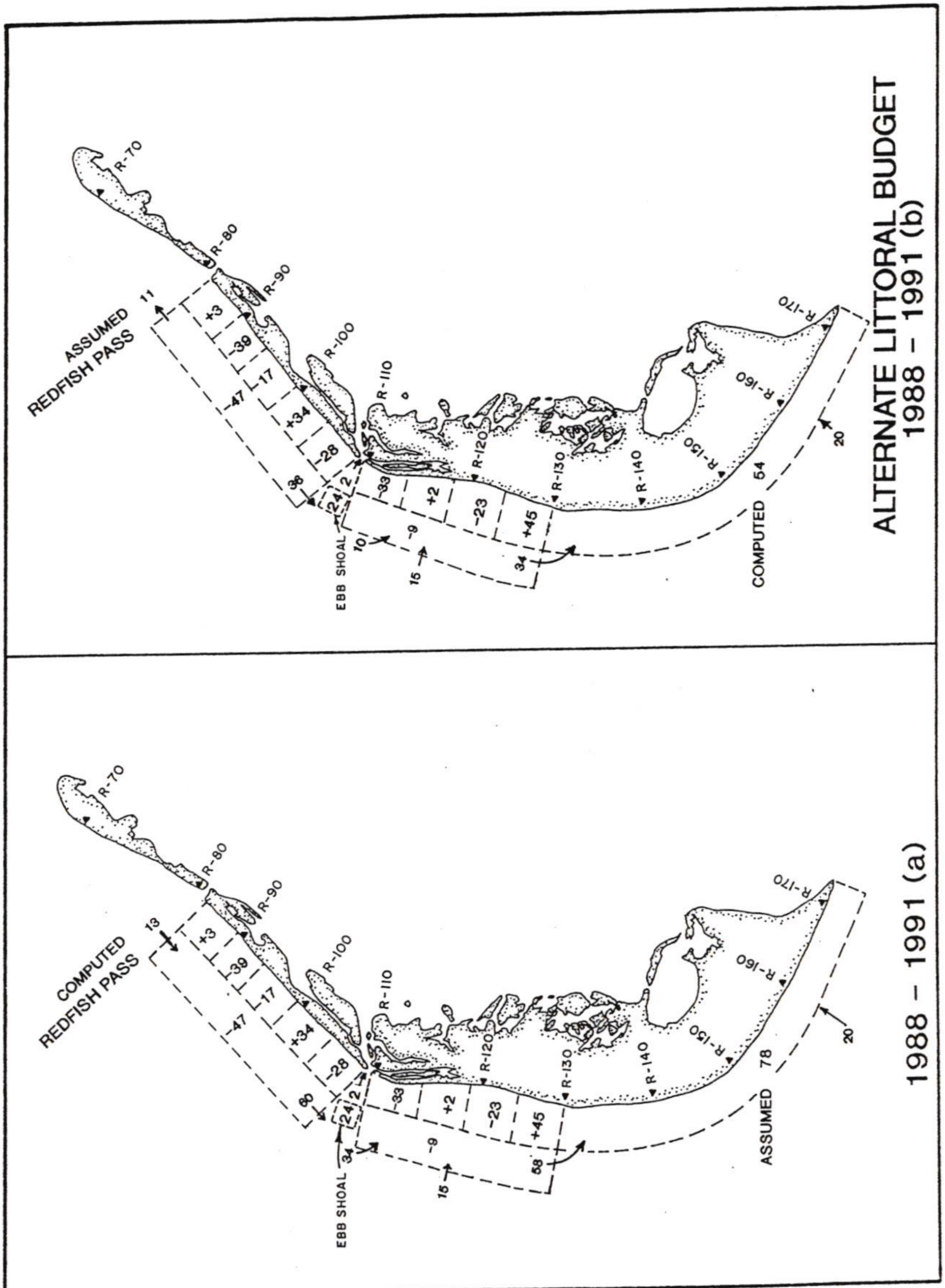


FIGURE 19

CAPTIVA - SANIBEL SEDIMENT BUDGET

1988 - 1991
(3 YEARS)

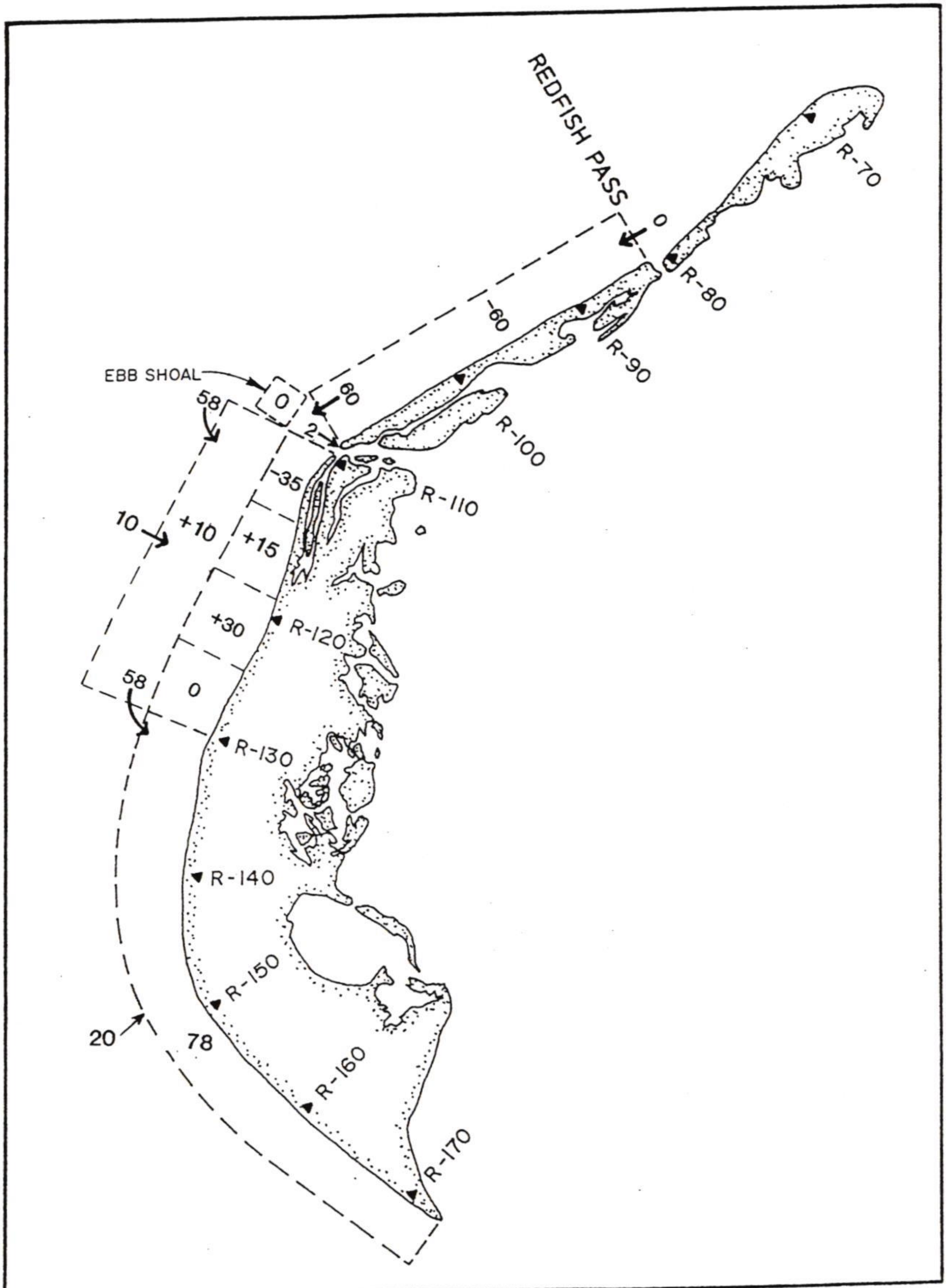


FIGURE 20

CAPTIVA – SANIBEL FUTURE SEDIMENT BUDGET

northern Sanibel. At the same time, ebb shoal sand migrating to the shore at the rate of 67,000 cubic yards created a strong accretional trend along the northern four miles of the island. This was especially true in the first mile where the beaches built up at a rate of 53,000 cubic yards per year.

From the late 1950's through the early 1970's the erosion rate of Captiva Island reduced. Some of that reduction was due to the ebb shoal building at Redfish Pass which limited or eliminated the losses at the north end of the island. The remaining reduction was due to reorientation of shoreline segments along the island and the hardening of portions of the island. The amount of sand leaving Captiva Island at the south reduced from 133,000 cubic yards in the 1940's and early 1950's to 66,000 cubic yards per year, a reduction of almost 67,000 cubic yards per year. At the same time, onshore movement of sand from the ebb shoal to northern Sanibel Island reduced from 67,000 to approximately 47,000 cubic yards per year.

Although the northern 4 miles was still accreting from 1955-1974, the northern mile of Sanibel Island went from a strongly accretional trend to an erosion trend, losing 37,000 cubic yards per year during the 1955-1974 time period. This is probably due to a combination of two effects. One is that the loss of protection from the ebb shoal in the immediate vicinity of Blind Pass did not allow that portion of the island to sustain its seaward position. Secondly, the reduction of sand quantity moving from Captiva and from the ebb shoal contributed to the strong erosional trend.

After 1974, sand availability again reduced for northern Sanibel. Sand from Captiva reduced from 66,000 to 44,000 cubic yards. Offshore-onshore movement reduced from 47,000 to 27,000 cubic yards per year. During this period southern Sanibel Island (the last 8 miles) continued to accrete at 79,000 cubic yards per year. The northern 4 miles of Sanibel Island went from a strong accretional trend of 59,000 cubic yards per year to an accretional trend of +10,000 cubic yards per year.

A groin was built by Lee County in 1972 to protect the evacuation route and the bridge approach road. This structure was also partially responsible for the 22,000 c.y. reduction in drift from Captiva to Sanibel after 1972. Part of that reduction in drift was also due to continued hardening of the shorelines on Captiva. It is estimated that the County structure, built in 1972, accounted for a littoral drift reduction of 13,600 cubic yards per year.

Blind Pass was closed between 1977 and 1982. When it reopened in 1982, the erosion rates of Captiva Island increased from 1982 through 1985. Surveys from 1985 through 1988 indicate an erosion rate of almost 85,000 c.y./yr. on Captiva Island. It is probable that the deterioration of the County groin during the post groin construction period allowed a higher erosion rate on Captiva Island during that period.

In 1988 and 1989, the beaches of Captiva Island were restored and the groin at the south end of Captiva Island was rebuilt and extended 100 feet. The purpose of the groin extension was to prevent rapid loss of material at the south end of the nourishment project. The groin was also constructed to provide further protection for the evacuation route by holding larger amounts of sand on the Turner Park public beach in front of the Captiva Road approach to the Blind Pass bridge.

Subsequent to the construction of the Captiva project, monitoring has shown that the shorelines of northern Sanibel have retreated faster than the historical trend through December of 1991, but that the erosion rate of the area has been slower from a volumetric standpoint.

A review of the profiles indicates a substantial flattening of the upper beach portion of the profile and the very nearshore portion of the profile especially in the vicinity of Clam Pass Bayou/Old Blind Pass. In the Clam Pass Bayou and Old Blind Pass area, significant overwash has occurred and a large volume of sand (approximately 47,000 c.y.) has built up on the landward portion of the profile in the pass.

It has also been noted that during the 3.3 year data set (1988-1991), two unusual weather events occurred. The first was Tropical Storm Keith which significantly altered the shoreline south of Blind Pass by causing extensive overwash and lowering of the barrier island in the vicinity of Clam Bayou and Old Blind Pass. In the shoreline analysis the effects of this storm have been discounted and only the shoreline retreat rates after Keith have been counted.

The second event that should be noted is that during the winter of 1990-1991, there appeared to be an atypical northward sand movement, as evidenced by the lack of buildup of sand north of the Blind Pass jetty during that winter period. This may have affected the rate of erosion that has been measured on both islands.

After the 1988/89 beach nourishment of Captiva Island, an ebb shoal feature formed seaward of Blind Pass which was not present in 1988. The ebb shoal extends from the mouth of the inlet south, approximately 1400 feet. The shoal contains approximately 80,000 cubic yards and has built up over the 3.3 year time period subsequent to the beach nourishment project. Most of the building of the shoal occurred in the first two years after nourishment. Recent surveys indicate that the shoal building process has slowed or reversed in the last 6-month time frame.

It is not clear at this time whether the shoal represents a permanent feature or will move in and attach itself to the beach as has happened in the past. The building of the shoal at this seaward location is probably an effect of the groin extension and additional sand made available from the beach nourishment project.

The existence of the shoal has caused a shadow and wave refraction effect at the very north end of Sanibel Island. This has caused a littoral drift reversal and a nodal point to be established at or about Clam Bayou. The nodal point creates a zone of high erosional stress at this location.

The high shoreline retreat rate in the Clam Bayou area is also the result of overwash. The combination of overwash and the existence of a nodal point has resulted in a retreat of 257 feet since the beach nourishment project. This high retreat rate has distorted the average shoreline retreat rates.

We can conclude from the above analysis that presently the groin is bypassing as much or more sand than it had bypassed before the nourishment and groin extension project. Physical changes of the shoreline planform have occurred in response to an ebb tidal shoal building. The combination of the ebb shoal and persistent overwash of some areas have resulted in higher shoreline retreat rates along the first mile of Sanibel.

It can be concluded that these higher rates are related to the beach nourishment and groin extension project, but are affected by other physical parameters. The most important is the rollover and rapid retreat of the beach near Clam Pass and Old Blind Pass.

Shoreline retreat has been faster than the historical annual average of 13.3 feet set by the DNR permitting process prior to the 1988/89 beach nourishment project. Mitigation for retreat attributable to "the extension of the terminal groin on Captiva Island" is a requirement of the DNR permit.

Once the condition stabilizes at Clam Pass and Old Blind Pass, the lower erosion rates of northern Sanibel should moderate the retreat rate to below the historical retreat rate of 13.3 feet. Until that happens, however, the retreat in the vicinity of Clam Pass will be rapid and the average shoreline retreat rate will be higher than the historical rate.

There is some uncertainty about the amount of overwash at Clam Pass and Old Blind Pass. Recent retreat rates (1988-91) in that area have been significantly higher than the historical trend (1974-88). It has been assumed that this is due to the post-storm effects of Tropical Storm Keith which appear to have lowered the Barrier Island and made the beach more vulnerable to overwash. Similar conditions were observed in northern Sanibel in 1972 after Hurricane Agnes when the northern 2000 feet of Sanibel retreated over 200 feet in the 9-month period following that storm.

A review of aerials shows that Clam Pass is open and closed about as much as it was prior to Keith. This suggests that the barrier island fronting the Clam Pass area has not been affected as much by Keith as is indicated above. This further suggests that the high retreat rate may be caused by a deficiency of sand moving to the Clam Pass area.

G. Stability and Hydraulic Analysis

Background

Blind Pass is one of many inlets that punctuate the southwest coast of Florida facing the Gulf of Mexico. Located in Lee County, it separates the Captiva Island to the north and Sanibel Island to the south and connects a part of Pine Island Sound to the Gulf. The inlet was first opened naturally around three hundred years ago and for quite a while behaved as a tide-dominated inlet with a prograding ebb-tidal shoal. Since the opening of Redfish pass to the north in 1926, the inlet has gravitated toward a wave-dominated one, and is less stable. The capture by Redfish Pass of a substantial portion of the tidal prism that had kept Blind Pass active since its inception is evidenced by the alternate closure and opening that has typified its existence up to at least the middle 1980's. Its ephemeral existence is also evidenced by the disintegration of the once stable ebb tidal shoal to relative insignificance.

This section is confined to the physical inlet response using both analytical and numerical approaches to inlet hydraulics. The report consists of the collation and review of all the available study reports on Blind Pass in order to reconstruct the morphological development of the inlet and collection and analysis of current and bathymetric data.

The numerical model used is a one-dimensional code that describes the response of a Keulegan-type inlet-bay system to sinusoidal tidal forcing (Lin, 1988).

Morphological Changes

Available reports and aerial photographs were collected from the Coastal Engineering Archives and monitoring reports associated with the Captiva Island Beach Nourishment Project. This store of documented and photographic information was converted into a chronology of events to facilitate better understanding of the morphological development of the inlet as summarized in Table 14.

It is apparent from Table 14 that Blind Pass has undergone a series of closures and reopenings as a consequence of the predominant southerly drift. The alternate inlet closure and opening represent an efficient pathway whereby sediments are fed to the south, i.e., Sanibel Island. Prior to 1921, the inlet section at Blind Pass measured 200 m across by 5 m deep due to the appreciable water surface area it commanded in the Pine Island Sound. Following the opening of Redfish Pass in 1921, the tidal prism that had maintained Blind Pass shrunk considerably due to flow diversion through Redfish Pass, which grew to a size about twenty times that of Blind Pass with significant development of the ebb-tidal shoal. Subsequently, there have been at least three episodes of downdrift migration, closure, and reopening.

Longshore Sediment Transport

A relatively simple way of computing littoral drift along the coastline of Florida based on visually observed waves from ships has been presented by Walton (1973). The method uses the SSMO (Summary of Synoptic Meteorological Observations) wave data, which are a compilation of meteorological and sea state observations made from ships plying through "Data Squares" defined by their longitudes and latitudes, as input in computing longshore energy flux and consequent littoral drift based on linear wave theory. The results of the monthly estimates of littoral drift are shown in Table 15.

Table 14

A Chronology of Events, Blind Pass

Year	Event
955 BP - 655 PB	Original pass opened.
300 BP	Pass broke through barrier island.
1883	Inlet broke through near the current position.
1888	Inlet @ throat - 200 m x 5 m. Downstream offset of 250 m.
1921	Opening of Redfish Pass.
1941	New inlet opened near current position. Possibly the result of hurricane.
1953	Inlet width at throat = 60 m.
1958	Inlet width at throat = 20 m.
8/29-9/13/60	Hurricane Donna reopened pass.
1961	Direct inlet closed. Flow exit further south.
1962	Gulf entrance reportedly closed by storm action.
1964	Inlet closed by spit.
1966	Historical flow area = 95 m^2.
1970	Historical flow area = 160 m^2.
1972	Hurricane Agnes reopened pass.
1972	Short rip-rap jetty constructed on the north side.
1974	Historical flow area = 140 m^2.
1975	Historical flow area = 42 m^2.
11/76	Gradual inlet narrowing in the past several months closed inlet to boat traffic.
May 1977	Inlet closed by tidal accretion.
1979	Inlet closed.
6/82	Subtropical "No-Name" storm reopened pass. Minimum cross-sectional area = 56 m^2.
1986	Opened again.
12/87	Inlet closed.
1988	Inlet open.
11/88	Terminal groin lengthened by 31 m.
8/91	Throat cross-section below NGVD = 64 m^2

Field Data Analysis

The following field data collected in July/August 1991 were analyzed to obtain geometric and hydraulic data required for the analysis portion of the study:

1) cross-sectional survey covering the inlet and a substantial part of the flood shoal;

2) one continuous point current measurement;
3) two surface current measurements using drogues; and
4) spot tidal elevation measurements at selected locations and times.

Currents

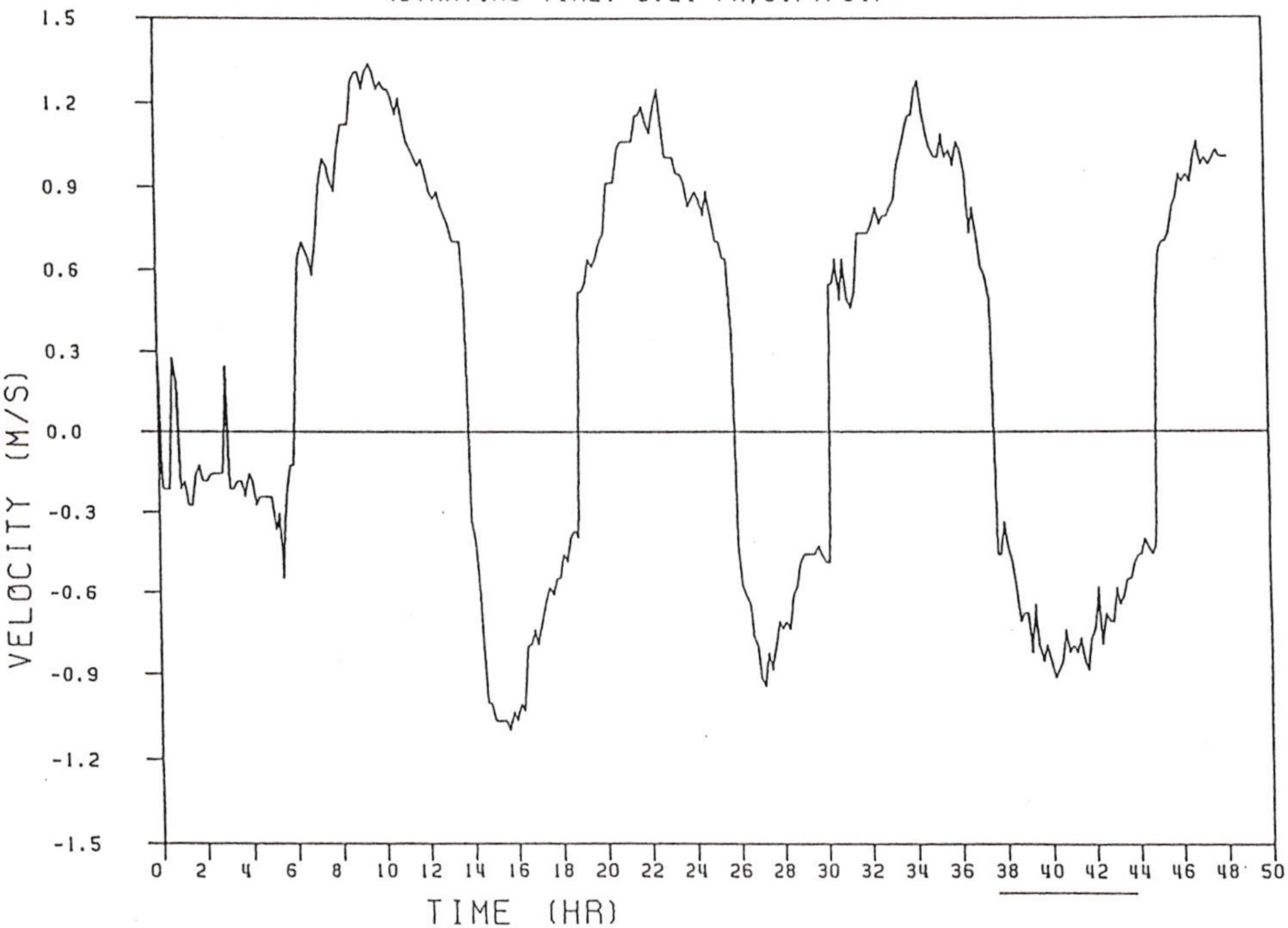
The measured current, which is mainly tide-driven and shown in Figure 21, shows a similar pattern of change to the tidal variation. Current deflection from the inlet axis is apparent from Figure 22, where the ebb and flood flow directions are each modified by the inlet exit and entrance geometry. The peak ebb current is stronger than the peak flood current, being about 1.3 m/s and 0.9 m/s respectively. The corresponding peak surface currents are about 1.6 m/s and 1.3 m/s based on surface drogue measurements. Assuming a theoretical logarithmic velocity distribution and accounting for variation in the transverse direction, the mean cross-sectionally averaged velocity is taken to be about 1.1 m/s for calibration purposes.

Table 15

Longshore Transport Rate at Blind Pass

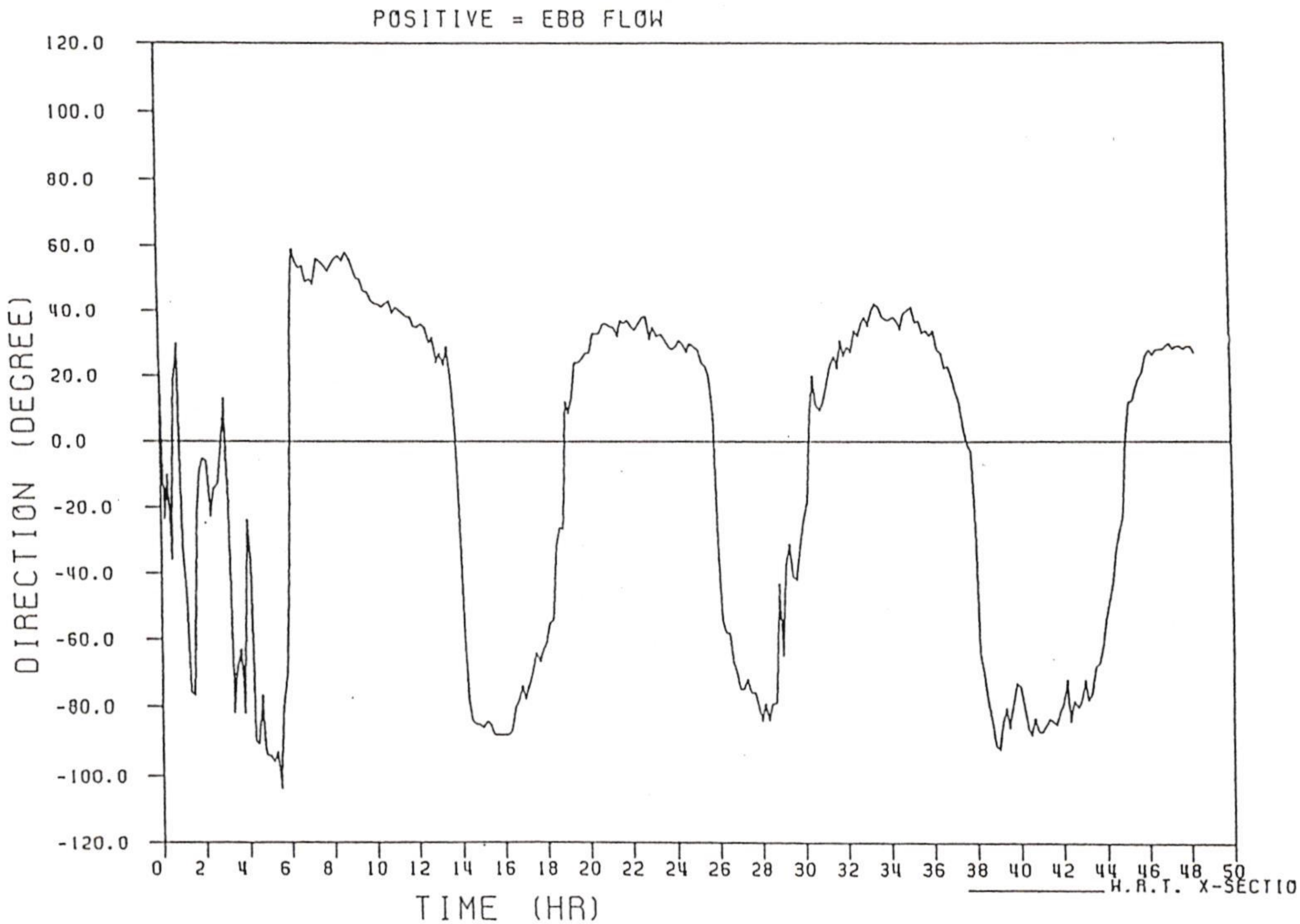
Month	Transport South $\Theta_n = 255°$ N (m^3/day)	Transport North $\Theta_n = 220°$ N (m^3/day)	Gross (m^3/day)	Net (m^3/day)
Annual	350	230	580	120 S
January	840	90	920	750 S
February	750	150	900	600 S
March	410	250	660	160 S
April	50	400	450	350 N
May	80	240	320	160 N
June	20	300	320	280 N
July	100	120	220	20 N
August	50	170	220	120 N
September	90	250	340	160 N
October	220	160	380	60 S
November	320	100	420	220 S
December	240	210	450	30 S

FIGURE 21 MEASURED POINT VELOCITY AT BLIND PASS
(STARTING TIME: 3.21 PM, 31/7/91)



SOURCE: MEHTA, ET. AL., 1991

FIGURE 22 MEASURED POINT VELOCITY AT BLIND PASS



SOURCE: MEHTA, ET. AL., 1991

Geometric Data

The survey data were analyzed to yield the geometric data as summarized in Table 16. It is noted that while the throat flow depth, h_c, occurs at Section 4, the throat flow area, Ac, occurs at section 10 (Figure 23). The inlet channel is considered to be stretching from Sections 1 to 7, and the water area thereafter is considered part of the bay area. Confining the analysis to the first seven sections, the throat depth and cross-section h_c and A_c, are found to be 2.1 m and 64 m^2, respectively.

Tidal Prism

The bathymetric and hydraulic data were analyzed to determine the flood and ebb tidal prisms for Blind Pass. The average flood tidal prism was 43.90 x 10^6 ft^3 while the average ebb tidal prism was 9.13 x 10^6 ft^3. Both of these values exceed the previous measured prism of 7.6 x 10^6 ft^3 (University of Florida, 1974). The 1991 measurements indicate that a significant net circulation of water was occurring in Pine Island sound since the volume of water that entered Blind Pass was 4.8 times the volume that exited.

Since overall inlet stability increases with the tidal prism, it would be expected that the stability would improve between 1974 and 1991. The indeed has been the case.

Inlet Hydraulics and Long Term Stability

The first part of the analytical study entails using the one dimensional model equation developed for the Keulegan-type bay to obtain parameters that characterize the hydraulic and stability behavior of the inlet.

The second part of the analytical study involves computation of the relation between the cross-sectional area, A_c, and the maximum flow velocity at the throat u_{max}, which enables a qualitative assessment of the hydraulic stability of the inlet to be made. This is followed by the use of the O'Brien relationship linking the tidal prism, Ω, and the minimum flow area, A_c, from which the sedimentary regime of the inlet can be derived.

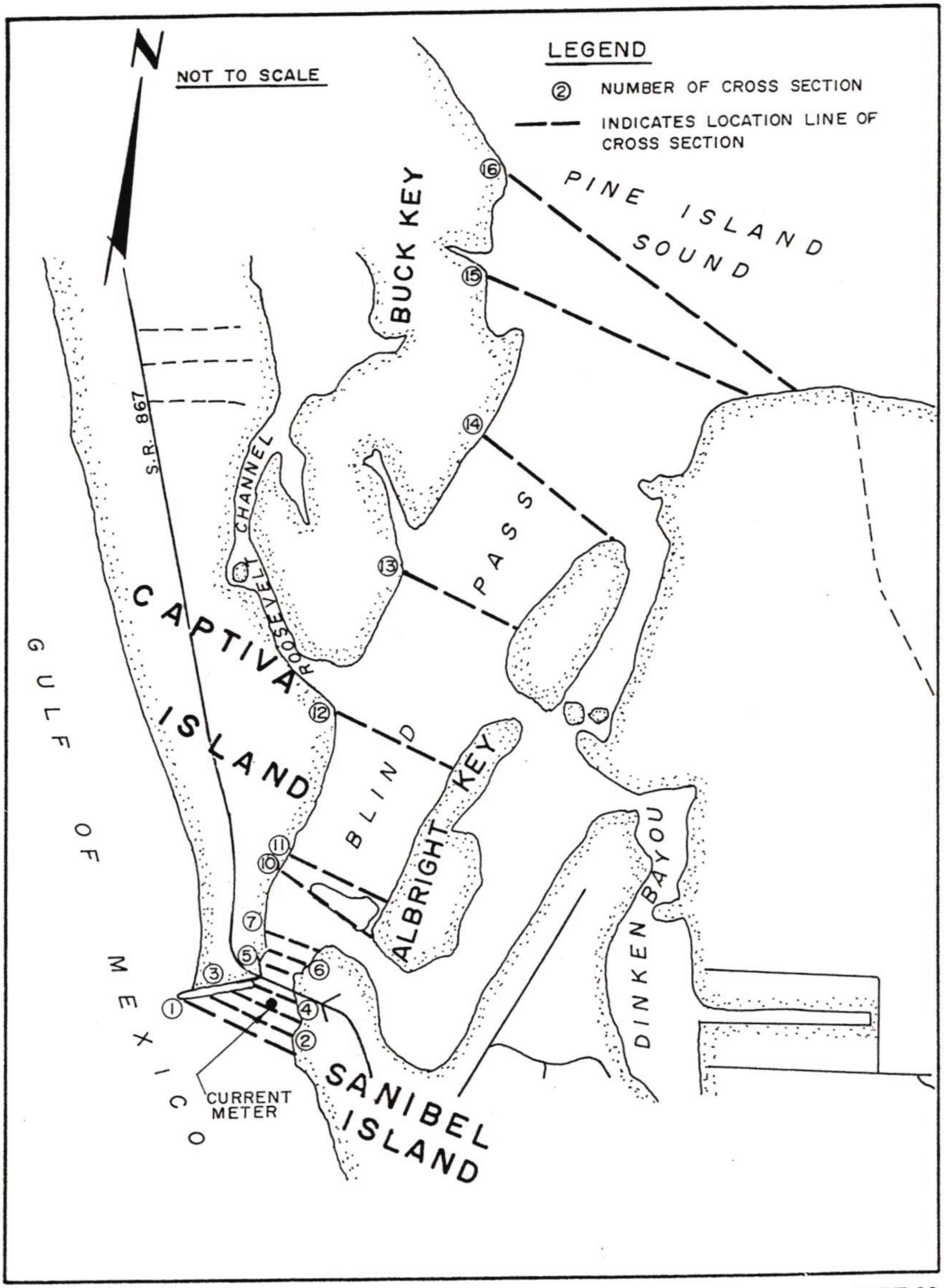


FIGURE 23

BLIND PASS LOCATION MAP

Table 16

Geometric Data for Blind Pass

Cross-section No.	Distance (m)	Cross-section Area (m^2)	Mean Depth (m)
1	0	125	0.8
2	29	91	1.0
3	60	64	1.5
4	76	64	2.1
5	116	94	1.8
6	134	74	1.2
7	163	78	0.9
10	259	52	1.4
11	312	57	1.2
12	648	76	0.8
13	984	189	0.7
14	1296	313	0.9
15	1548	234	0.7
16	1747	275	0.5

The superposition of the hydraulic and sedimentary stability criteria then yields the inlet stability diagram for Blind Pass.

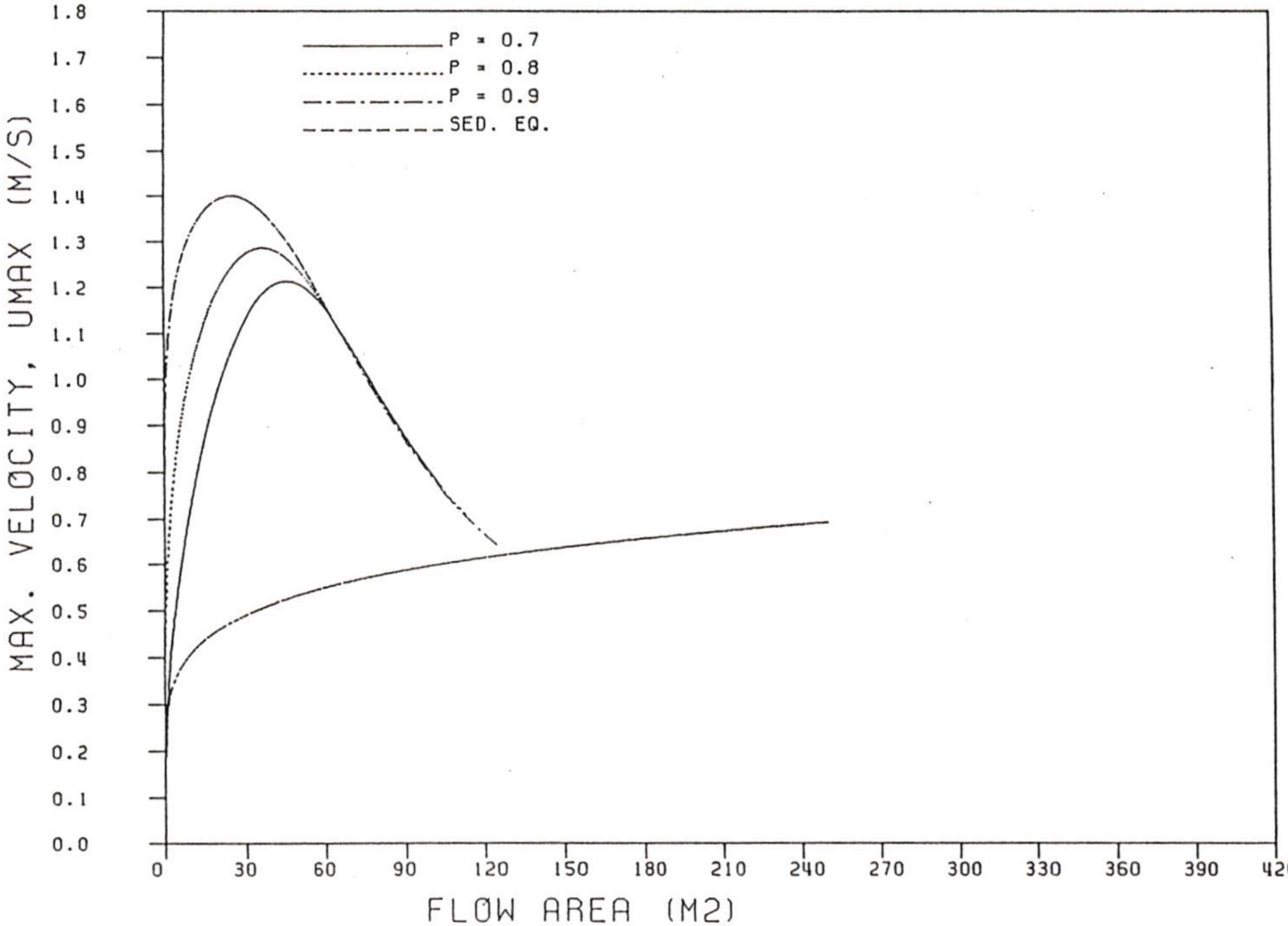
Since the tides at Blind Pass are mixed, two stability diagrams were developed. For the semidiurnal tides (T = 12.4 hrs., a = 0.25 m) Figure 24 shows the stability diagram. For the diurnal tide (T = 24.9 hrs., a = 0.30 m) Figure 25 shows the stability diagram.

Figure 24 shows that the critical cross-sectional area is approximately 45 m^2 for the semidiurnal tides. Since the existing throat cross-section is 64 m^2, the inlet is stable. The equilibrium cross-section is approximately 125 m^2 for the semidiurnal tide conditions. Based on the strong velocities, an increase in the cross-sectional area could be expected.

Figure 25 shows the critical cross-sectional area is approximately 50 m^2 for diurnal tides which is smaller than the existing cross-sectional area. This indicates that during diurnal tides the inlet is only marginally stable. The diurnal equilibrium cross section is approximately 160 m^2.

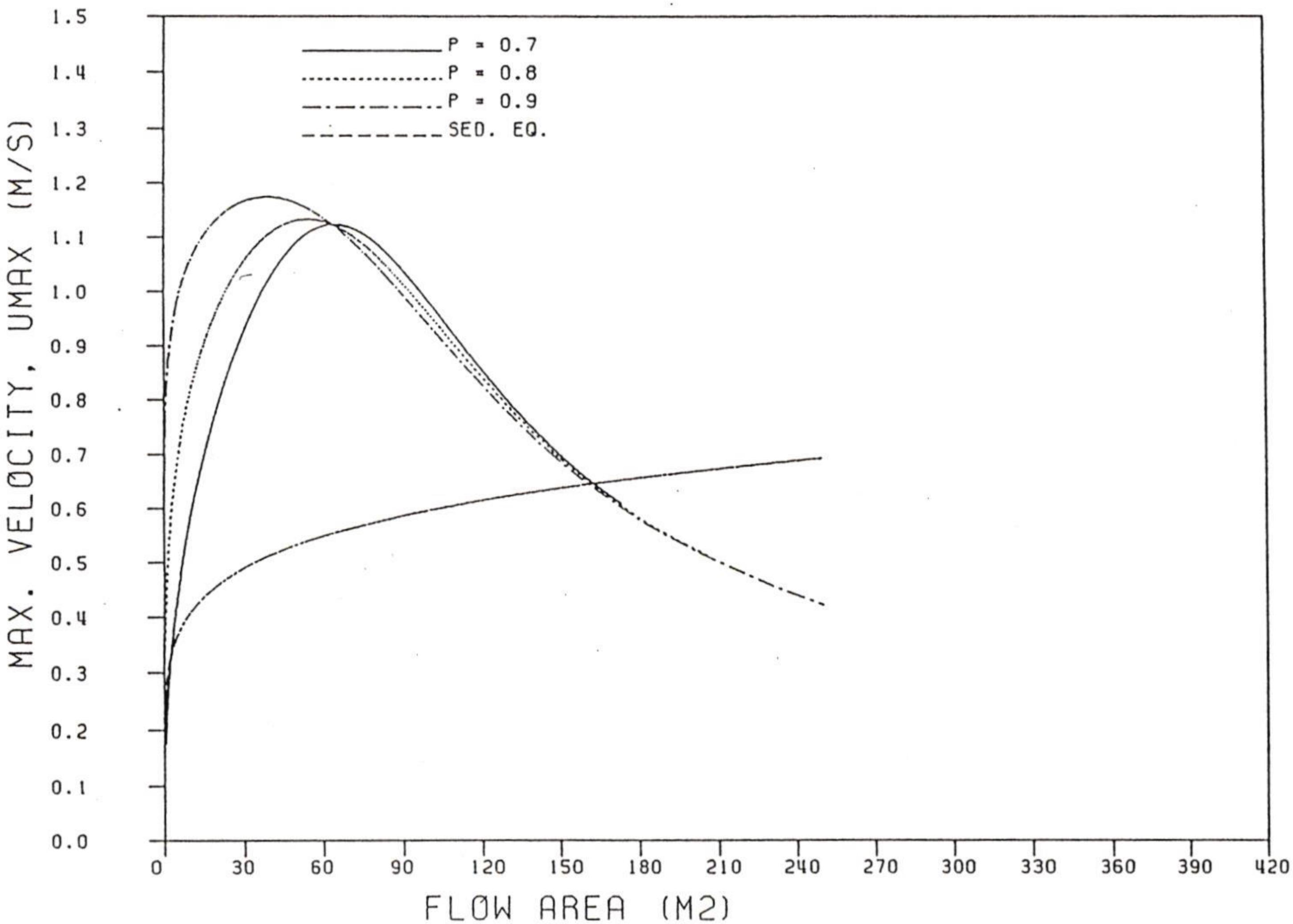
FIGURE 24

STABILITY DIAGRAM, BLIND PASS
SEMIDIURNAL TIDE CONDITION



SOURCE: MEHTA, ET. AL., 1991

STABILITY DIAGRAM, BLIND PASS
DIURNAL TIDE CONDITION



SOURCE: MEHTA, ET. AL., 1991

FIGURE 25

Short Term Stability

In the literature on inlet stability, a distinction between long term and short term stability is frequently made. The former refers to the gradual deterioration of the inlet due to shoaling and may occur over several months or even decades. On the other hand, short term stability is associated with storm events, which can result in inlet closure. Hence, while the former considers average conditions, the latter is necessarily linked to the intensity and duration of storm events.

Short term stability was analyzed using an integrated one dimensional inlet flow model coupled with a sediment transport equation. By varying the littoral drift rate along the beach, the duration of inlet stability can be determined.

The results of the numerical runs are shown in Figure 26 for littoral drift rates, M, ranging from 200 to 2000 m^3/day, a ten-fold increase. The length of run duration was chosen such that it would encompass an entire spring-neap tidal cycle, a period of approximately a month. Since the model was run each time with a constant M value, the duration of about a month more or less fits in with the strong monthly variation in littoral transport exhibited in Table 15.

It is seen that up to about M = 600 m^3/day, the inlet exhibits either stable or slight accreting conditions. From M = 700 m^3/day to 800 m^3/day, the shoaling trend is clearly noticeable, but the inlet still remains open at the one-month cut-off point. The inlet closes in about a month for M = 900 m^3/day and thereafter the time of closure is more rapid as the M value increases to 2000 m^3/day where the inlet closes in twelve days. These outputs, therefore, are in qualitative agreement with the expected behavior of Blind Pass under increasing sediment loading.

H. Wind and Wave Climate

Wind data (USACE 1989) were compiled for the hindcast station #42, positioned 26.5° north and 82.5° west, or approximately 20 miles west of Blind Pass. Figure 27 reflects data collected between 1956 and 1975. The most prevalent wind directions recorded were from the northeast through southeast followed by west winds. These winds are typically generated by one of three mechanisms.

Lee County is located in the sub-tropical climatic band and thus is affected by prevailing trade winds. These winds shift from the northeast to southeast between winter and summer seasons. The trade winds have minimal effect on wave development in nearshore areas since they blow primarily from onshore.

Daily differential solar heating of land and water masses creates diurnal onshore-offshore breezes. Land masses heat faster during the day causing the air to rise forming cumulus clouds. The offshore air then moves onto the land, and a west wind develops. After sunset, an east wind predominates as the land cools. This sea-land breeze cycle is

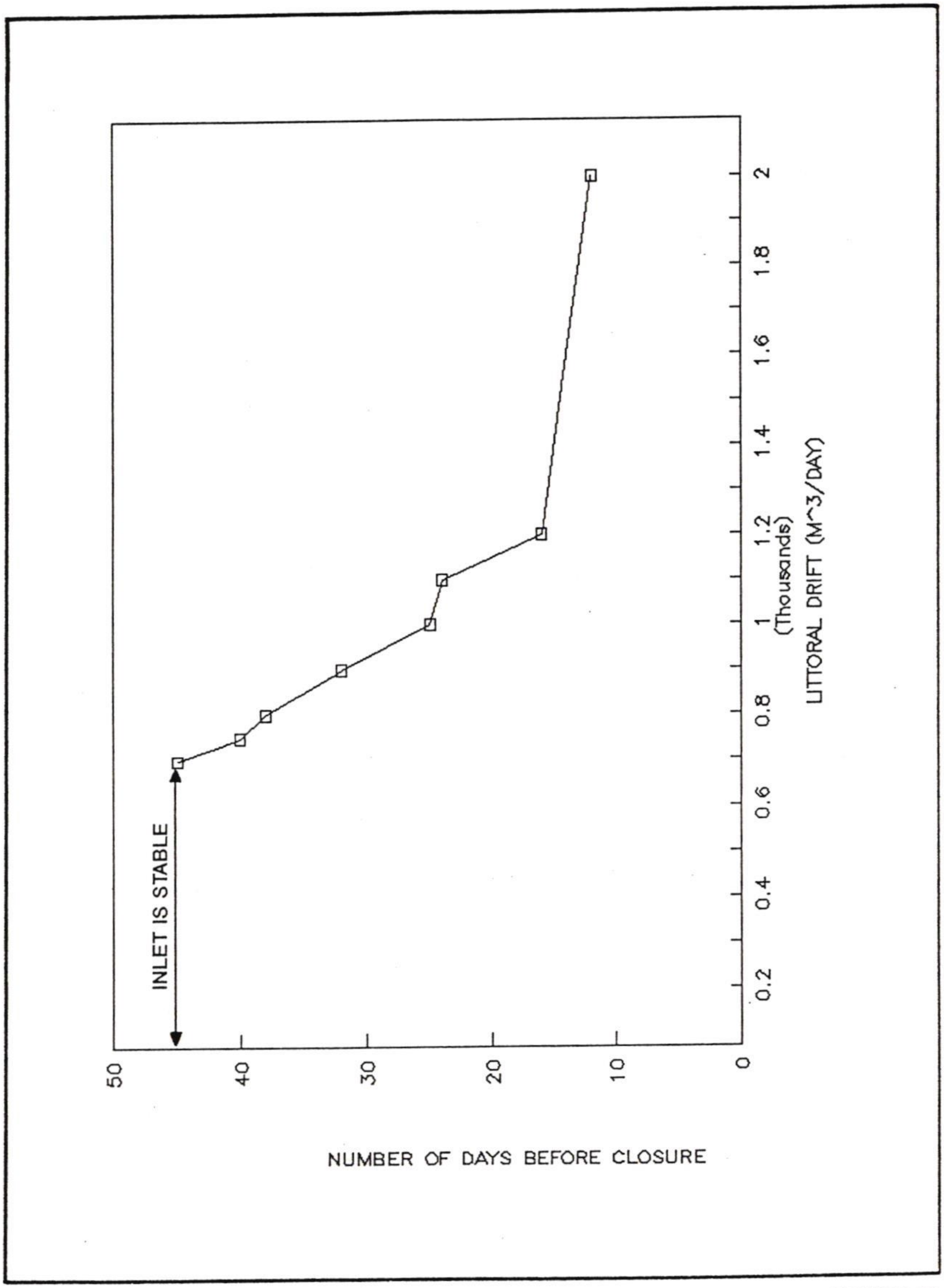


FIGURE 26

SHORT TERM STABILITY AT BLIND PASS

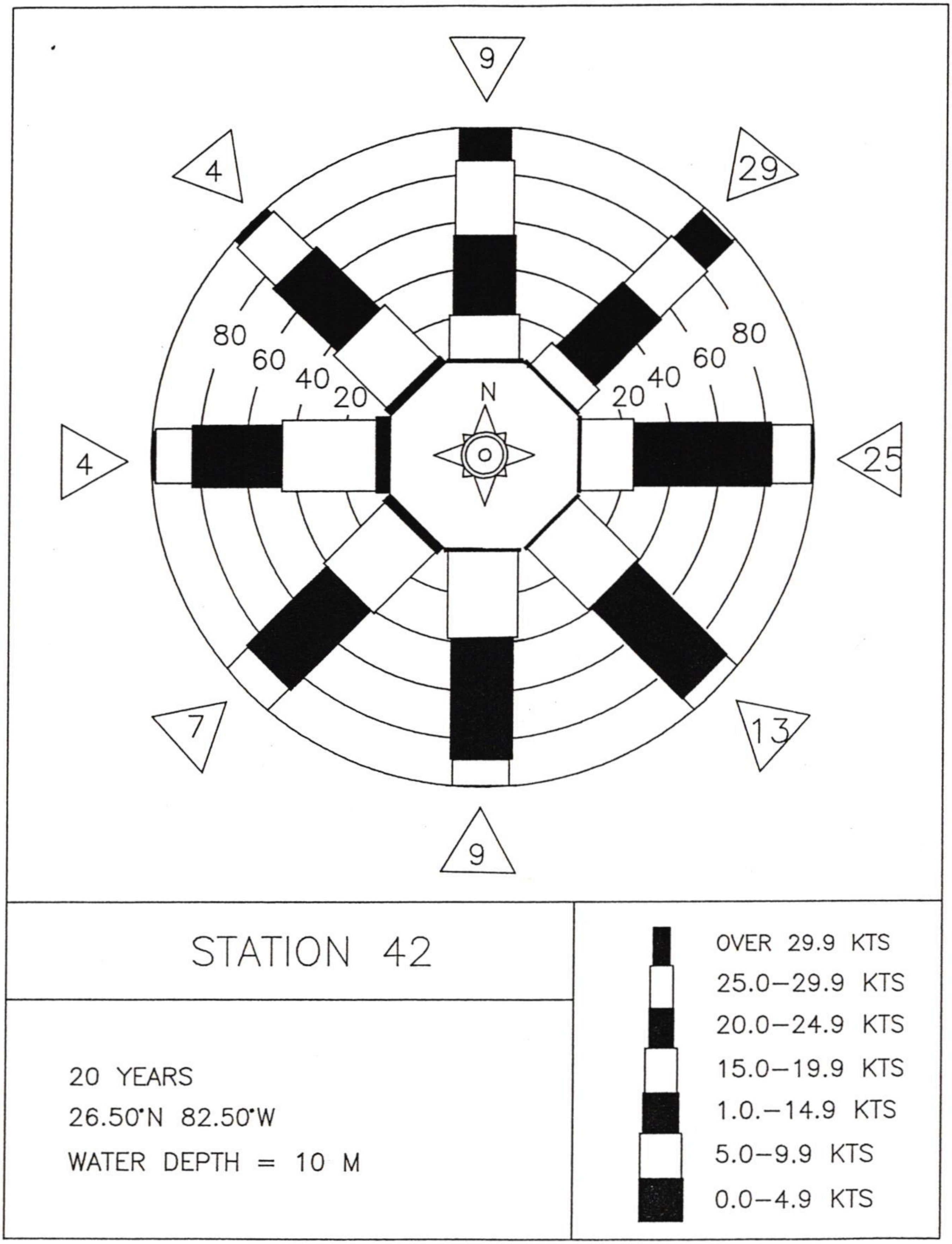


FIGURE 27

AVERAGE WIND DIRECTION,
SPEED AND DURATION
BLIND PASS AREA

localized to within several miles of the coast, but does develop waves which ultimately contribute to sediment movement.

Frontal weather pattern activity generates winds which vary from south through northeast as "fronts" approach and pass through the area. Typically, frontal winds become important during winter months when northern weather patterns can extend well south of Lee County. Although the Gulf Coast Shoreline is not as susceptible to severe frontal weather erosion as the east coast of the state, occasional "Northeasters" have caused noticeable shoreline erosion.

Winds from tropical storms or hurricanes can blow from any direction (depending on the track of the storm) and cause severe damage. Significant storm events affecting the Blind Pass area are compiled in Section I.F. - History of the Inlet.

Because of the geographic orientation of the Gulf Coast in the study area, hurricane impact is less severe than other coastal areas, from the standpoint of wave-induced beach erosion. Cyclonic storms that pass east of the study area generate northwest backing through southwest winds. While these directions are potentially most damaging, wind speeds are lessened as these storms pass over land. Storms passing offshore the study area typically produce winds from northeast through southeast with high wind speed potential. While these are the strongest winds in the storm, the offshore direction has decreased wave-induced erosional potential.

Waves generated by local wind phenomena and distant weather disturbances are responsible for beach erosion, longshore sand transport and formation of sand bars in nearshore regions. Historical wave records in the area of Blind Pass are presented in Figure 28. This wave data was generated by hindcast models (USACE 1989) and compiled for a position approximately 20 miles west of Blind Pass.

The predominant offshore winds produce waves that travel away from land, and these waves are most common in the study area. These waves form offshore and travel out into the Gulf, leaving the region relatively free of wave activity; for this reason, the northeast, east and southeast waves are eliminated from this analysis.

It should be noted, however, that offshore winds will tend to smooth and flatten the wave progressing toward shore generated outside the local area. The smaller of these onshore waves are lost through shear friction to the opposing wind, leaving only the larger, distantly-generated waves to continue to the beach. This effect is seen in the days following prolonged strong east winds, as long period swells appear causing powerful longshore currents and sediment movement.

The most frequently occurring waves along the beach in the study area were from the west with a mean height of 1.0 - 1.1 m (3.2 - 3.5 ft.) and a period of 5.2 - 5.6 seconds. The southwest waves, while as frequent as the northwest set, carried less energy and hence, less potential for littoral movement.

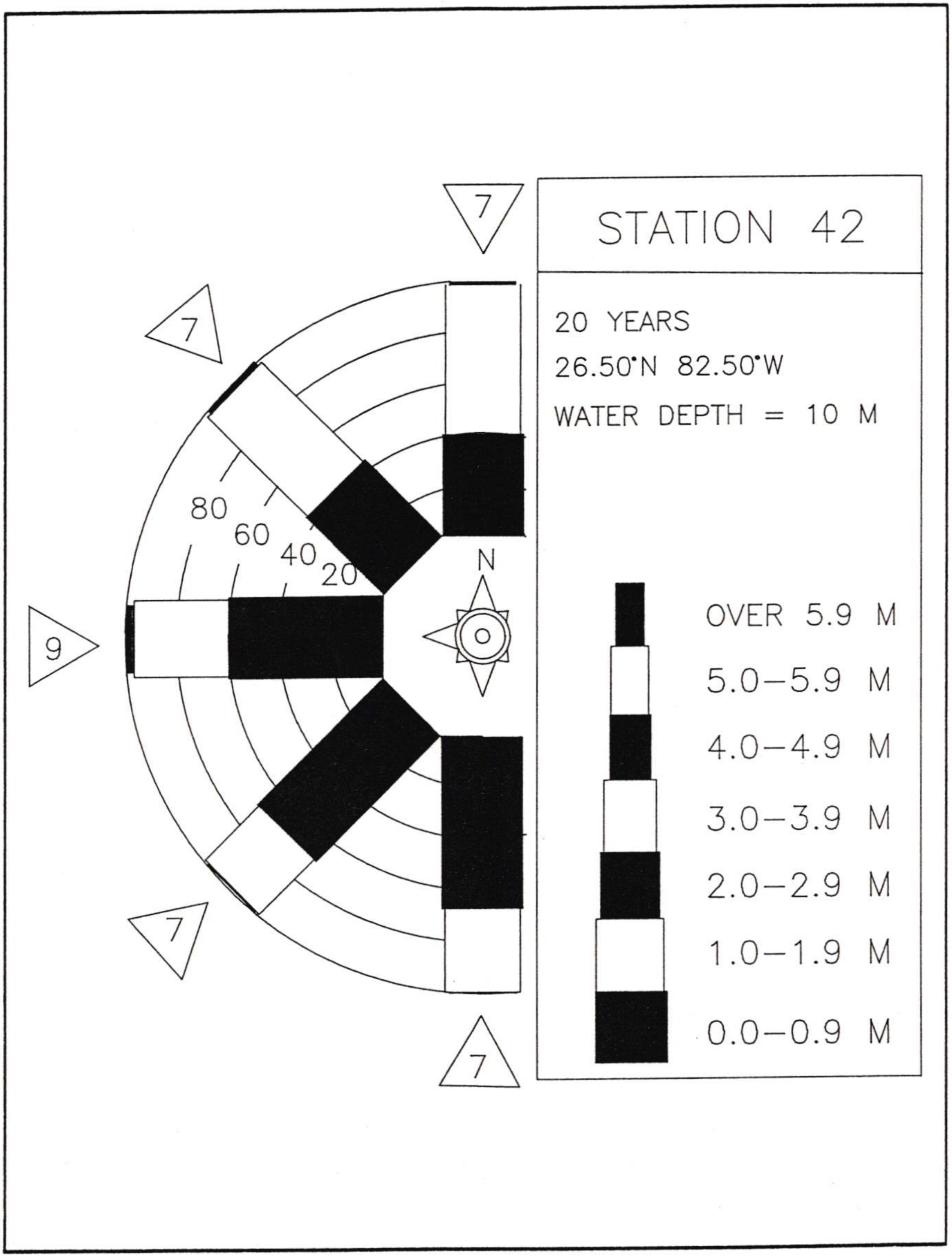


FIGURE 28

AVERAGE WAVE DIRECTION,
HEIGHT AND DURATION
BLIND PASS AREA

The largest onshore waves recorded were 3.1 m (9.9 ft.) from the west; occurring in February, indicative of winter northeaster activity. This wave data supports the littoral drift analysis presented in Section E. Wave action drives the transport of sand along the beach, primarily from north to south with a lesser counter-drift in the opposite direction.

I. Currents

Wave energy and solar-lunar tides are the primary factors generating currents in the nearshore zone. Oblique waves induce longshore currents along the sea bed that move large quantities of material (sand, pebbles, shells, shell fragments and debris) within the surf zone to the depth of closure or approximately 12 feet deep. These currents can reach velocities of 4 - 5 feet per second, depending on the depth, wave energy and wave crest angle with the shoreline. Longshore currents are sustained as long as waves continue to impact the beach.

Solar-lunar tides are capable of current generation as well. Tides along the Gulf Coast are both diurnal and semi-diurnal. During part of the monthly cycle the tide reaches a high and low twice daily while the remainder of the month experiences one high and one low per day.

At Blind Pass the normal tide range is approximately 2.3 feet while the spring tide range is approximately 3.4 feet. The tides produced by 10-year and 50-year storms are estimated at 6.4 feet and 12.3 feet, respectively (USACE 1985).

The tidal current in the inlet is a function of both channel geometry and tidal prism. Tidal prism is the actual volume of water flowing through the inlet during one tide cycle. In a sand-bounded channel, this current has a theoretical limit before scouring will occur (see Section G. - Stability and Hydraulic Characteristics).

Blind Pass, along with Redfish Pass and the San Carlos Channel provide tidal flushing for Pine Island Sound. Blind Pass carries a proportionally smaller share of the total prism for the Sound (see Section II. G. - Stability and Hydraulic Characteristics of Blind Pass). The flood tidal prism is approximately 43.90×10^6 ft^3 and the ebb tidal prism is approximately 9.13×10^6 ft^3. The tidal prism is affected by the length of the inlet channel, obstructions to flow in the Sound, general positioning of the land masses in the area and other factors.

The resulting tidal current, measured as part of a Coastal Planning & Engineering, Inc., survey in July 1991, was 4.4 fps (265 fpm) and 3.6 fps (215 fpm) on the flood and ebb tide respectively. These velocities were measured by an anchored current meter placed in the channel of Blind Pass and were confirmed by drogue measurements.

These measurements were taken on the semi-diurnal tide and are higher than expected. The currents during the diurnal tide cycle will be substantially lower than the measured values due to the longer tidal period and minimal tide range characteristic of the diurnal tide.

J. Structures

Since the Captiva Erosion Prevention District was established in 1959 by an act of the Florida Legislature, several types of structures and beach fill have been utilized to control erosion. A description of the previous measures that were sponsored by the CEPD and local interests to control erosion along the shores of Captiva Island is provided in Table 17. The positions of structures in the vicinity of Blind Pass are noted in Figure 29. All of the structures listed in Table 17 were designed to abate erosion of the shoreline.

Several of the structures shown in Figure 29 south of Blind Pass, such as the wooden bulkhead, were not constructed originally for full coastal exposure. They were originally intended to be inland waterway structures, as those positions were originally on protected inland canals (see Section I.F. - History of Blind Pass).

The impact on the littoral processes by the Captiva structures has been discussed. The Sanibel structures, shown in Figure 29, also impact the littoral processes. When these structures are exposed to the open Gulf, they interrupt littoral drift and impound sand. Because of their location in the inlet region, it is difficult to quantify this impact.

Table 17

Year	Protective Measure
1961	134 "dog-bone" groins were installed along the length of Captiva Island.
1962	7,000 cubic yards of sediment from Roosevelt Channel on the bayside were placed on the center portion of Captiva Island.
1963	50,000 cubic yards of sediment were pumped to the area of Post Office Road on Captiva.
1964	Extensive rock revetments and seawalls were installed by private owners on Captiva Island.
1965	Two timber groins were installed by CEPD near the center of Captiva Island and 50,000 cubic yards of sediment was pumped from the bayside between the two groins.
1964-1967	50,000 - 100,000 cubic yards of sand were trucked in by Lee County for the Post Office Road area. 17,000 cubic yards was brought in to repair the County highway after Hurricane Gladys.
1972	Lee County installed the terminal groin at Blind Pass.
Pre 1974	Sanibel records prior construction of revetment and bulkhead in vicinity of Blind Pass.
1981	South Seas Plantation, a privately-held development, funded a beach nourishment project for the northern 1.8 miles of the island. The project consisted of 760,000 cubic yards of material from the Redfish Pass ebb tidal shoal.
1986	Six experimental perpendicular stabilizers were installed at the north bend of Captiva Road.
1987-1988	Lee County repaired rock revetment after road washouts caused by several storms.
1988-1989	The terminal groin at Blind Pass was extended 100 feet between October and November 1988. A beach nourishment project was constructed along the entire length of the island and consisted of placement of 1,600,000 cubic yards of material from the Redfish Pass ebb tidal shoals. The six experimental perpendicular stabilizers and two timber groins were removed prior to beach placement. Dune vegetation was planted along the entire island between August and October 1989.
1991	Private seawall constructed 1/3 mile south of Blind Pass.

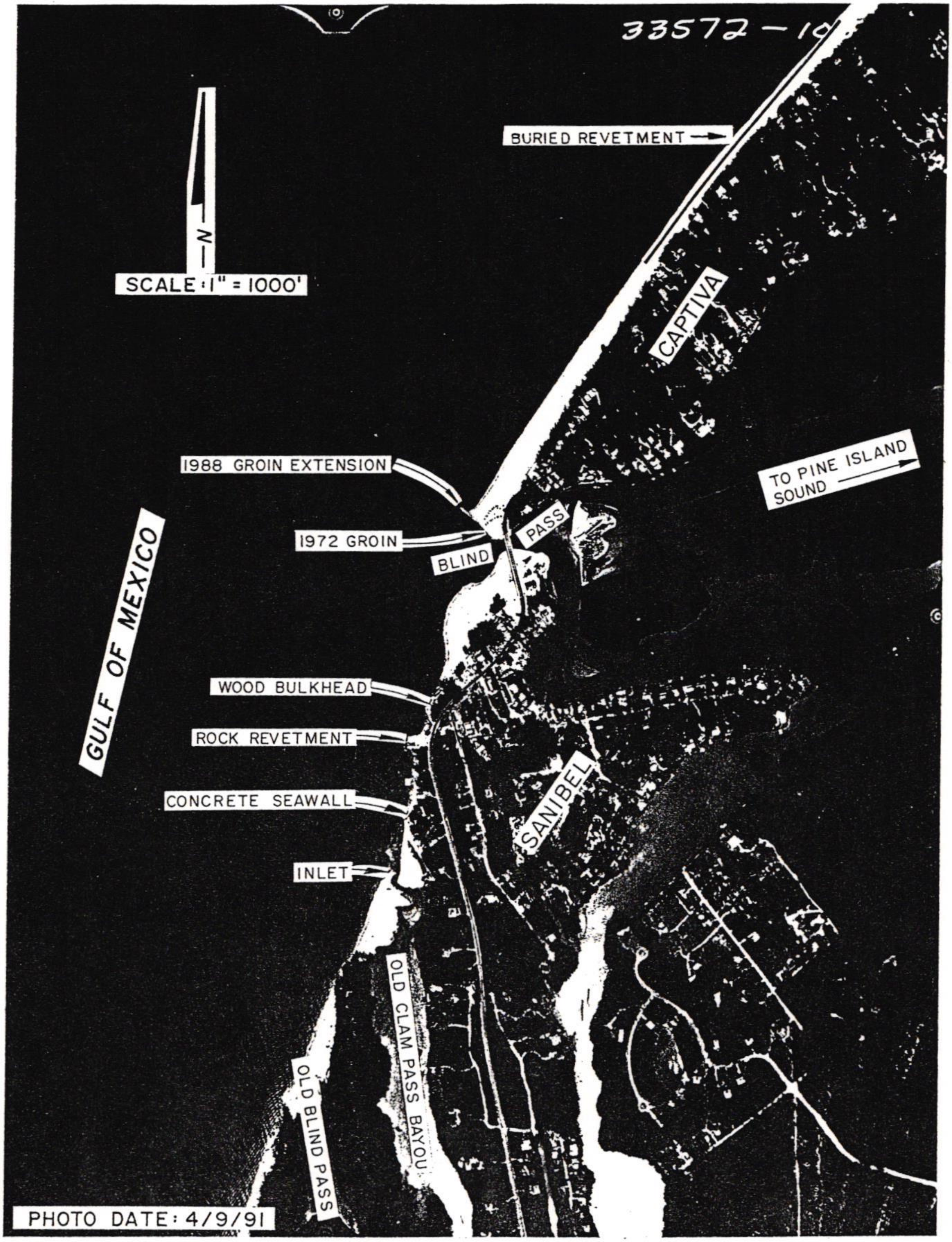


FIGURE 29

COASTAL STRUCTURES ADJACENT
TO BLIND PASS

III. NATURAL RESOURCES

A. General

Blind Pass, which has a long history of southerly migration and hydraulic instability, greatly influences the surrounding estuarine and marine environment. It is clear that the methods used to maintain the pass in the future will affect the surrounding environment.

The natural resources surrounding Blind Pass are comprised of three major resource classifications. These are the beach and dune system, and upland areas; estuarine wetlands; and the nearshore Gulf of Mexico.

The following description of the natural resources surrounding Blind Pass was developed from available reference materials, aerial photographs and limited onsite environmental investigations. Preliminary field investigations of the natural resources surrounding Blind Pass were conducted in conjunction with flood shoal bathymetric and topographic surveys on July 30, 1991. More detailed onsite inspections of the specific resources likely to be impacted by the recommended management plan were conducted on April 1, 1992. Figure 30 illustrates the natural resources in the vicinity of Blind Pass.

B. Beach, Dune System and Upland Areas

Most of the dune and upland areas within the study area have been developed. Development along the northern third of Captiva Island consists of a planned resort community. Development along the remainder of Captiva Island and the western portions of Sanibel Island consists of low-density single-family residences, along with some commercial and multi-family uses. In contrast, a majority of the development along the southeastern portion of Sanibel Island consists of higher-density mid-rise, resort and commercial structures.

Although most upland areas adjacent to Blind Pass have been developed, some native vegetation still remains. The most commonly observed native upland species include sea grape (Coccoloba uvifera), gumbo limbo (Bursera simaruba) and cabbage palm (sabal palmetto). In addition, narrow fringes of mangroves still line the undeveloped portions of the estuarine shoreline adjacent to the pass.

Both upland development and beach erosion have eliminated a majority of the native dune system in the vicinity of Blind Pass. Nevertheless, portions of the dune on Captiva Island have recently been re-established. A sea oat community was established on the northern end of Captiva Island as part of the 1981 South Seas Plantation beach restoration project. Additional dune vegetation (80% sea oats, 20% other) was planted along the entire island, between October and December 1989. In 1990, the CEPD removed Australian pine seedlings from the new vegetation and replanted sea oats at the southern end of the 1988 Captiva Island beach restoration project. Commonly observed dune species on Captiva Island now include sea oats (Uniola paniculata), sea purslane

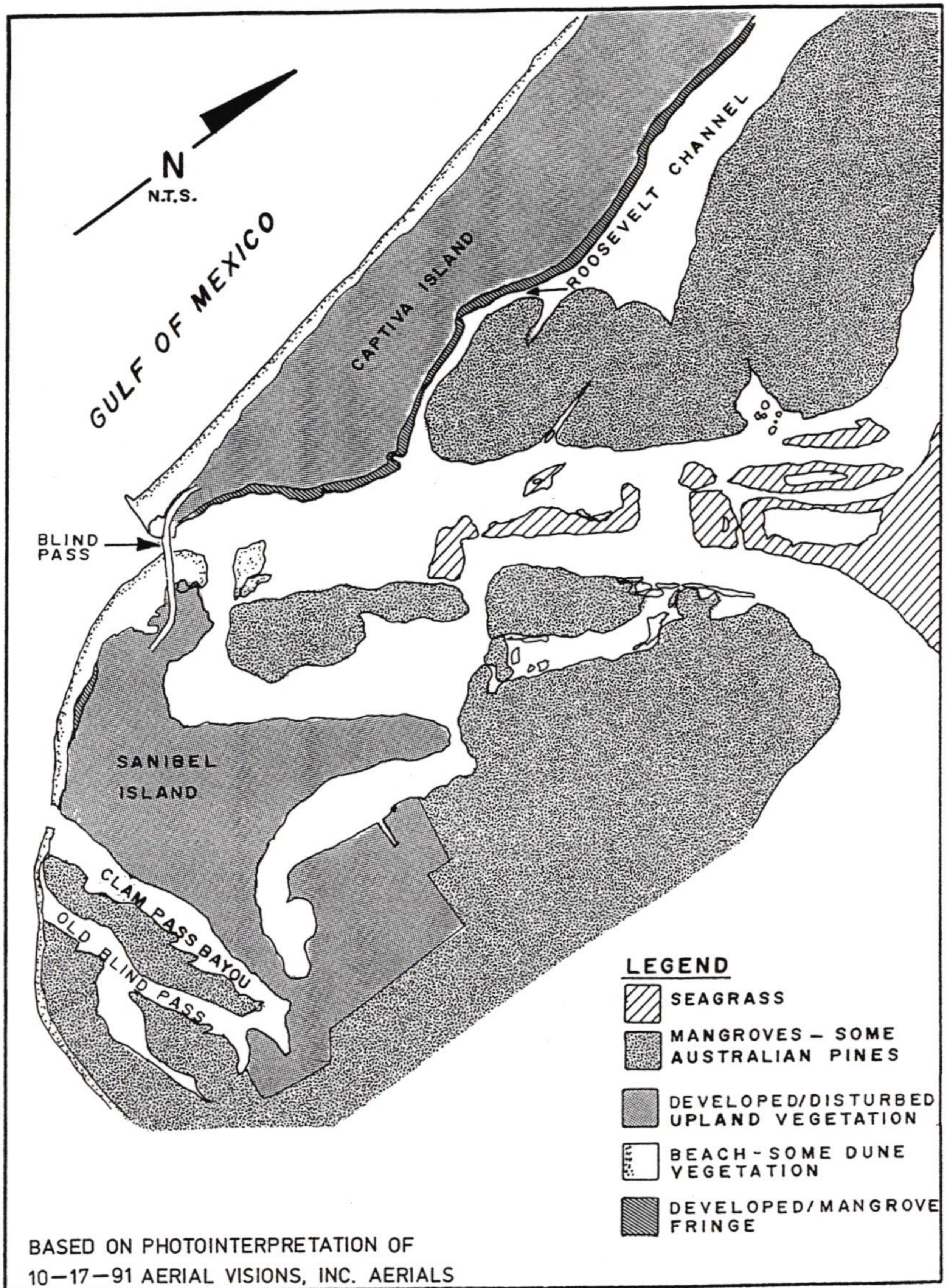


FIGURE 30

HABITATS ADJACENT TO BLIND PASS

(Sesuvium portulacastrum), sea grape (Coccoloba uvifera), railroad vine (Ipomoea pes-caprae), Scaveola sp., salt grass (Distichlis spicata), dune sunflower (Helianthus debilis) and prickly pear cactus (Opuntia compressa).

Dune vegetation has also recently become established on the upland portion of the flood tidal shoal. Dune species observed on the shoal include sea purslane (Sesuvium portulacastrum), railroad vine (Ipomoea pes-caprae), fringe rush (Fimbristylis spathacea), salt grass (Distichlis spicata), sea blite (Suaeda linearis), saltwort (Batis maritima) and seashore dropseed (Sporobolus virginicus). In addition, several small red mangroves, black mangroves, white mangroves and buttonwood trees have become established along the southwestern edge of the flood shoal. Several newly established white and red mangroves are also present along the southeastern portion of the shoal.

Due to the extensive development of the islands, the remaining upland and newly established dune vegetation provide only limited habitat for wildlife. Nevertheless, a few adaptable species, such as raccoons and squirrels, are common on the islands. A list of the mammals which are reported to occur in the vicinity of Blind Pass is presented in Table 18.

The beach ecosystem provides habitat for a variety of organisms. Common beach organisms include a variety of polychaetes, amphipods and crabs, including the common ghost crab. Other wildlife, including rodents, snakes, birds, lizards, and insects, may inhabit the beach for all, or a portion of their lives.

In addition, many species of birds are known to forage at the flood tidal shoal, and at the beaches and nearshore waters adjacent to the pass. Shorebirds, including gulls, terns, sandpipers, plovers, and stilts, use the intertidal beach for foraging, while other birds, such as the eastern brown pelican (Pelecanus occidentalus carolinensis) and the double-crested cormorant (Phalacrocorax auritus), forage in the nearshore waters (Continental Shelf Associates, 1987). Table 19 lists some of the most common bird species reported to occur in the vicinity of Blind Pass.

The beaches adjacent to Blind Pass also provide nesting habitat for the Atlantic loggerhead turtle (Caretta caretta). Other sea turtles reported to occur in the vicinity of Blind Pass include the Atlantic green turtle (Chelonia mydas), Atlantic hawksbill turtle (Eretmochelys imbricata), Atlantic Ridley turtle (Lepidochelys kempi) and Atlantic leatherback turtle (Dermochelys coriacea).

Table 18

Mammals Reported in the Vicinity of
Blind Pass

Common Name
Armadillo
Atlantic bottlenose dolphin
Black rat
Bobcat
Cotton mouse
Eastern cottontail
Eastern fox squirrel
Eastern mole
Eastern yellow bat
Evening bat
Florida longtail weasel
Florida water rat
Florida mink
Florida mouse
Gray fox
Hispid cotton rat
House mouse
Least shrew
Marsh rabbit
Mexican freetail bat
Opossum
Raccoon
Sanibel Island rice rat
River otter
Shorttail shrew
Southeastern big-eared bat
Spotted skunk
Striped skunk
West Indian manatee
Whitetail deer

Source: J.N. "Ding" Darling National Wildlife Refuge - Mammal List. 1 pg.

Table 19

Birds Commonly Observed in the Vicinity of Blind Pass

Common Name	Scientific Name
Pied-billed grebe	Podilymbus podiceps
American white pelican	Pelecanus erythrorhynchos
Brown pelican	Pelecanus occidentalis
Double-crested cormorant	Phalacrocorax auritus
Anhinga	Anhinga anhinga
Least bittern	Ixobrychus exilis
Great blue heron	Ardea herodias
Great egret	Casmerodius albus
Snowy egret	Egretta thula
Little blue heron	Egretta caerulea
Louisiana heron	Egretta tricolor
Reddish egret	Egretta rufescens
Cattle egret	Bubulcus ibis
Green-backed heron	Butorides striatus
Black-crowned night-heron	Nycticorax nycticorax
Yellow-crowned night-heron	Nycticorax violaceus
White ibis	Eudocimus albus
Mottled duck	Anas fulvigula
Northern pintail	Anas acuta
Blue-winged teal	Anas discors
Northern shoveler	Anas clypeata
American wigeon	Anas americana
Lesser scaup	Aythya affinis
Red-breasted merganser	Mergus serrator
Black vulture	Coragyps atratus
Turkey vulture	Cathartes aura
Osprey	Pandion haliaetus
Red-shouldered hawk	Buteo lineatus
American kestrel	Falco sparverius
Clapper rail	Rallus longirostris
King rail	Rallus elegans
Common moorhen	Gallinula chloropus
Black-bellied plover	Pluvialis squatarola
Snowy plover	Charadrius alexandrinus
Wilson's plover	Charadrius wilsonia

Table 19

Birds Commonly Observed in the Vicinity of Blind Pass

(Continued)

Common Name	Scientific Name
Semipalmated plover	Charadrius semipalmatus
Piping plover	Charadrius melodus
Killdeer	Charadrius vociferus
Greater yellowlegs	Tringa melanoleuca
Lesser yellowlegs	Tringa flavipes
Willet	Catoptrophorus semipalmatus
Sanderling	Calidris alba
Short-billed dowitcher	Limnodromus griseus
Laughing gull	Larus atricilla
Ring-billed gull	Larus delawarensis
Royal tern	Sterna maxima
Sandwich tern	Sterna sandvicensis
Black skimmer	Rynchops niger
White-winged dove	Zenaida asiatica
Mourning dove	Zenaida macroura
Common ground-dove	Columbina passerina
Mangrove cuckoo	Coccyzus minor
Smooth-billed ani	Crotophaga ani
Common barn-owl	Tyto alba
Eastern screech-owl	Otus asio
Great horned owl	Bubo virginianus
Red-bellied woodpecker	Melanerpes carolinus
Common flicker	Colaptes auratus
Pileated woodpecker	Dryocopus pileatus
Great crested flycatcher	Myiarchus crinitus
Gray kingbird	Tyrannus dominicensis
Blue jay	Cyanocitta cristata
Fish crow	Corvus ossifragus
Carolina wren	Thryothorus ludovicianus
American robin	Turdus migratorius
Gray catbird	Dumetella carolinensis
Northern mockingbird	Mimus polyglottos
European starling	Sturnus vulgaris
White-eyed vireo	Vireo griseus
Prairie warbler	Dendroica discolor

Table 19

Birds Commonly Observed in the Vicinity of Blind Pass

(Continued)

Common Name	Scientific Name
Common yellowthroat	Geothlypis trichas
Northern cardinal	Cardinalis cardinalis
Rufous-sided towhee	Pipilo erythrophthalmus
Red-winged blackbird	Agelaius phoeniceus
Boat-tailed grackle	Quiscalus major
Common grackle	Quiscalus quiscula
House sparrow	Passer domesticus

Compiled from: Emerson, K.C., ed. Check-list of Birds for the area of Sanibel, Captiva and adjacent islands. Published by Sanibel - Captiva Audubon Society, Sanibel - Captiva Conservation Foundation, and Ding Darling Wildlife Society. 1984. 2 pg.

Robbins, C.S., B. Bruun and H.S. Zim. Birds of North America: A Guide to Field Identifiation. Golden Press, New York, N.Y. 1983. 360 pg.

Prior to the 1988 Captiva Island beach restoration project, continuing beach erosion and the construction of shoreline protection structures had resulted in the loss of most of the sea turtle nesting habitat north of Blind Pass (LeBuff, 1990). Following the 1988 Captiva Island beach restoration project, both the number of nests and the number of nests/emergence, or nesting success, increased (LeBuff, 1990). Studies prior to the beach project documented an average of 19 nests/year for the 5 mile beach, with an average nesting success of 36.5% (Table 20). In contrast, the average number of nests from 1988 to 1990 was 52 nests, or a 174% increase over pre-restoration averages. This was in spite of the fact that the data for 1989 were incomplete (collection of the 1989 sea turtle nesting data did not begin until July 1, almost two months after nesting began). Nesting success for the 1988 and 1990 nesting seasons were 39.6% and 46.2%, respectively. Nesting success data were not available for the 1989 nesting season. Historical sea turtle nesting densities for Sanibel Island are provided in Table 21.

C. Estuarine Wetlands

A majority of the estuarine wetlands adjacent to Blind Pass are located within the Pine Island Sound Aquatic Preserve. Limits of the Pine Island Sound Aquatic Preserve range from just east of the Blind Pass bridge, north to Boca Grande Pass, south to southern tip of Sanibel Island and east to Pine Island. In addition, the north central portion of Sanibel Island and the adjacent mangrove islands are located within the J. N. "Ding" Darling National Wildlife Refuge.

Estuarine wetland communities adjacent to Blind Pass include seagrass and algal beds, mangrove forests, salt marshes and oyster beds. These communities provide both habitat and food for a variety of organisms. In addition, these communities function in nutrient and sediment recycling.

The submerged aquatic vegetation within Pine Island Sound consists of seagrass beds, attached algae and drift algae. The seagrass beds contained with the sound are made up primarily of shoalgrass (Halodule wrightii), turtlegrass (Thalassia testudinum), and manatee grass (Syringodium filiforme). These seagrass beds serve as important nursery grounds for snappers, groupers, drum, shrimp, blue crab (Callinectes sapidus), and Florida spiny lobster (Panulirus argus) (Continental Shelf Associates, Inc., 1987). The endangered West Indian manatee also utilizes seagrasses as an important food source. Terns, egrets, ibises, gulls, pelicans and herons forage upon the small crustaceans, gastropods, annelids and fishes found in the tidal flats surrounding Blind Pass.

Mangrove forests fringe much of the undeveloped shoreline east of Blind Pass. Areas frequently inundated by normal tidal action are generally inhabited by red (Rhizophora mangle) and black (Avicennia germinans) mangroves. White mangroves (Laguncularia racemosa) and buttonwood (Conocarpus erectus) are found in areas where inundation is less frequent. These mangrove communities serve as habitat and food source for fiddler crabs, mangrove snapper, and a variety of wading birds, such as herons and egrets.

Table 20

Sea Turtle Nesting Data
For
Captiva Island
(5 Miles)

	1975	1976	Nourished 1988	1989*	1990
Nests	26	12	44	39	73
False Crawls	45	21	67	Not Available	85
% Nesting Success	36.6	36.4	39.6	Not Available	46.2

* incomplete data (only July 1 - August 31)

Compiled from: "Sea Turtle Conservation - Captiva Style" by Mr. Charles R. LeBuff, Jr., of Caretta Research, Inc. 1990.

Table 21

Sea Turtle Nesting Data
For
Sanibel Island
(11.5 miles)

	1979	1980	1981	1982	1983	1984	1985
Nests	86	65	72	70	92	134	128
False Crawls	Not Available	15	32	30	28	Not Available	58
% Nesting Success	Not Available	81.3	69.2	70	76.7	Not Available	68.8

Compiled from: "Lee County Beach Management Plan Environmental Analysis" by Continental Shelf Associates, Inc. March 30, 1987. p. 14.

These mangroves also act as a nursery habitat for a wide variety of marine and estuarine fishes and invertebrates.

The last two estuarine communities found within Pine Island Sound include the salt marshes and oyster beds. Salt marsh plants such as black needlerush (Juncus roemerianus) and cordgrass (Spartina alterniflora) are also found along portions of the undeveloped estuarine shoreline. Oyster (Crassostrea virginica) bars are commonly found throughout the sound, especially near freshwater sources (Continental Shelf Associates, Inc., 1987). Figure 30 delineates the estuarine habitats adjacent to Blind Pass.

Other estaurine waters within the study area include Clam Pass Bayou and Old Blind Pass (Figure 30). Located south of Blind Pass, these estaurine waters are not located within the Pine Island Sound Aquatic Preserve (Brooks, personal communication). At present, Clam Pass Bayou is directly connected to the Gulf of Mexico by way of a narrow tidal entrance. Old Blind Pass, on the other hand, is not directly connected to the Gulf, but is indirectly flushed through Clam Pass Bayou.

Both Clam Pass Bayou and Old Blind Pass are bordered to the west by a narrow, sparsely vegetated strip of sand. The vegetation along this strip of sand includes sea purslane, salt grass, Panicum sp., seashore dropseed, railroad vine and Australian pines. Numerous terns, gulls, pelicans and other shore and wading birds forage and rest on the sand west of Clam Pass Bayou and Old Blind Pass.

The dominant vegetation on the island which divides these two bodies of water includes buttonwood, and red, black and white mangroves. In addition, several sea grape, Australian pines and Joe wood (Jacquinia keyensis) are also present.

Both Clam Pass Bayou and Old Blind Pass provide habitat for a variety of estuarine and estaurine-oceanic species. Vegetation along the undeveloped shoreline is dominated by red, white and black mangroves. Based on limited field investigations, the aquatic vegetation within the bayou and old pass consists of detached and attached algae. Several species of fishes and invertebrates spend all or a portion of their lives within the bayou and old pass. And finally, wading and shorebirds forage on the invertebrates and fishes within Clam Pass Bayou and Old Blind Pass.

D. Nearshore Gulf of Mexico

Based on aerial photographs and field investigations, no significant hardbottom formations exist in proximity to Blind Pass. The gulf floor surrounding Blind Pass consists of unconsolidated sediments, primarily sand.

The nearshore Gulf of Mexico resource classification includes biotic communities mainly associated with two zones: littoral (intertidal) and sublittoral (offshore). The littoral, or intertidal, zone is inhabited by several species of polychaete worms, sand bugs, isopods, amphipods. Large numbers of wedge shells, mole crabs and coquina clams are also found in the intertidal zone. On the other hand, the sublittoral, or offshore, zone contains the largest variety of species. Organisms common to the sublittoral zone include sand dollars, sea urchins, scallops and other pelecypod mollusks, sea hairs, spider crabs, hermit crabs, and various species of shrimps and mollusks.

The offshore gulf waters also provide habitat for adult and juvenile fishes (Table 22). Estuarine-dependent species which use the offshore and pass waters for spawning include red drum (Sciaenops ocellatus), spotted seatrout (Cynoscion nebulosus), snook (Centropomus undecimalis), Atlantic croaker (Micropogonias undulatus), southern flounder (Paralichthys lethostigma), Florida pompano (Trachinotus carolinus), striped mullet (Mugil cephalus), Gulf menhaden (Brevoortia patronus), tarpon (Megalops atlanticus) and bonefish (Albula vulpes) (Continental Shelf Associates, Inc., 1987). Reef fishes in the area include red grouper (Epinephelus morio), jewfish (Epinephelus itajara), gag grouper (Myceteroperca microlepis), scamp (Mycteroperca phenax), red snapper (Lutjanus campechanus) and mangrove snapper (Lutjanus griseus) (Continental Shelf Associates, Inc., 1987).

The coastal waters offshore of Captiva and Sanibel islands also contain a variety of commercial and sport fishes. The major species, in addition to those previously listed, include king mackerel (Scomberomorus cavalla), Spanish mackerel (Scomberomorus maculatus) and little tunny (Euthynnus alletteratus) (USACE, 1978). A review of recent marine fisheries annual landing summaries indicates that significant commercial fisheries for mullet, red grouper, spotted sea trout, blue crab and pink shrimp exist in Lee County (DNR, 1990). Although some commercially valuable fishes do frequent the waters adjacent to the study area, commercial fisheries in the vicinity of Blind Pass are generally limited to seasonal mullet fisheries (Listowski, personal communication). No known commercial concentrations of scallops or shrimp exist in the immediate project area (Listowski, personal communication).

E. Endangered Species

A list of the endangered, threatened, rare or species of special concern which are reported to occur in the vicinity of Blind Pass is presented in Table 23. Additional threatened, endangered or rare species which are reported to occur in the waters adjacent to Blind Pass include the Atlantic bottlenosed dolphin, short-finned pilot whale, right whale, blue whale, sei whale, fin whale, humpback whale and sperm whale.

Table 22

Fish Species Reported to Occur
in the Vicinity of Blind Pass

Scientific Name	Common Name
Ginglymostoma cirratum	nurse shark
Carcharhinus limbatus	blacktip shark
Sphyrna tiburo	bonnethead shark
Rhinobatos lentiginosus	Atlantic guitarfish
Narcine brasiliensis	lesser electric ray
Raja eglanteria	clearnose skate
Dasyatis sp.	stingray
Dasyatis sayi	bluntnose stingray
Gymnura micrura	smooth butterfly ray
Aetobatus narinari	spotted eagle ray
Rhinoptera bonasus	cownose ray
Elops saurus	ladyfish
Brevoortia sp.	menhaden
Etrumeus teres	round herring
Opisthonema oglinum	Atlantic thread herring
Harengula jaguana	scaled sardine
Sardinella aurita	Spanish sardine
Anchoa hepsetus	striped anchovy
Anchoa mitchilli	bay achovy
Synodus foetens	inshore lizardfish
Bagre marinus	gafftopsail catfish
Hyporhamphus unifasciatus	halfbeak
Strongylura marina	Atlantic needlefish
Tylosurus crocodilus	houndfish
Membras martinica	rough silverside
Menidia sp.	silverside
Hippocampus erectus	lined seahorse
Centropomus undecimalus	snook
Pomatomus saltatrix	bluefish
Rachycentron canadum	cobia
Caranx hippos	crevalle jack
Chloroscombrus chrysurus	Atlantic bumper
Oligoplites saurus	leatherjacket
Selene vomer	lookdown
Trachinotus carolinus	pompano
Trachinotus falcatus	permit
Decapturus punctatus	round scad
Eucinostomus sp.	mojarra

Table 22

Fish Species Reported to Occur
in the Vicinity of Blind Pass
(continued)

Scientific Name	Common Name
Lagodon rhomboides	pinfish
Archosargus probatocephalus	sheepshead
Cynosion arenarius	sand seatrout
Leiostomus xanthurus	spot
Menticirrhus littoralis	gulf kingfish
Menticirrhus saxatilis	northern kingfish
Pogonias cromis	black drum
Chaetodipterus faber	Atlantic spadefish
Mugil cephalus	striped mullet
Mugil curema	white mullet
Scomberomorus cavalla	king mackerel
Scomberomorus maculatus	Spanish mackerel
Peprilus alepidotus	harvestfish
Paralichthys albigutta	gulf flounder
Chilomycterus schoepfi	striped burrfish

Source: Phillips, T.D., and J. M. Sprinkel, Mote Marine Laboratory, 1989.

Table 23

List of Endangered, Threatened, Rare or Species of Special Concern which are Reported to Occur in the Vicinity of Blind Pass

Common Name	Scientific Name	Status FGFWFC	Status USFWS
BIRDS			
Arctic peregrine falcon	Falco peregrinus tundrius	E	T
Brown pelican	Pelecanus occidentalis	SSC	
Bald eagle	Haliaeetus leucocephalus	T	E
American oystercatcher	Haematopus palliatus	SSC	
Least tern	Sterna antillarum	T	
Reddish egret	Egretta rufescens	SSC	
Roseate spoonbill	Ajaia ajaja	SSC	
Little blue heron	Egretta caerulea	SSC	
Snowy egret	Egretta thula	SSC	
Louisiana heron	Egretta tricolor	SSC	
Wood stork	Mycteria americana	E	E
Grasshopper sparrow	Ammondramus savannarum	E	E
Marsh wren	Cistothorus palustris	SSC	
Piping plover	Charadrius melodus	T	T
Sandhill crane	Grus canadensis pratensis	T	
REPTILES			
Atlantic green turtle	Chelonia mydas mydas	E	E
Atlantic hawksbill turtle	Eretmochelys imbricata imbricata	E	E
Atlantic ridley turtle	Lepidochelys kempi	E	E
Atlantic loggerhead turtle	Caretta caretta	T	T
Leatherback turtle	Dermochelys coriacea	E	E
American alligator	Alligator mississippiensis	SSC	T (S/A)
American crocodile	Crocodylus acutus	E	E
Eastern indigo snake	Drymarchon coracis couperi	T	T
MAMMALS			
West Indian manatee	Trichechus manatus latirostris	E	E
Sanibel Island rice rat	Oryzomys palustris sanibeli	SSC	
Florida mouse	Podomys floridanus	SSC	

Table 23

List of Endangered, Threatened, Rare or Species of Special Concern which are Reported to Occur in the Vicinity of Blind Pass (Continued)

Common Name	Scientific Name	FGFWFC	USFWS
FISHES			
Common snook	Centropomus undecimalis	SSC	

T = Threatened
SSC = Species of special concern
E = Endangered
T (S/A) = Threatened due to similarity of appearance

Compiled From:

Florida Game and Fresh Water Fish Commission. Official Lists of Endangered and Potentially Endangered Fauna & Flora in Florida. 1 April 1991. D.A. Woods, compiler. 23 pg.

Emerson, K.C., ed. Check-list of Birds for the Area of Sanibel, Captiva and Adjacent Islands. Published by Sanibel - Captiva Audubon Society, Sanibel - Captiva Conservation Foundation, and Ding Darling Wildlife Society. 1984. 2 pg.

J. N. "Ding" Darling National Wildlife Refuge - Mammal List. 1 pg.

Alternatives are evaluated as to technical feasibility and environmental permittability. The effects on the Clam Pass Bayou system (currently open) are discussed.

Alternatives:

A. Close the Inlet.

1. Remove the jetty.

This alternative involves the removal of the 1988 jetty extension and the 1972 jetty constructed by the County on the north side of Blind Pass. This would allow nature to move sand from Turner Beach into Blind Pass. Blind Pass should close over a period of weeks or months. The south end of Captiva will recede until a new equilibrium shoreline is established (Figure 31).

During storms, it is expected that some sand will be overwashed at the Blind Pass bridge area and result in sand lost from the active littoral zone. There is also the possibility that a storm could reopen Blind Pass in the future. If beach erosion is severe, the north end of the bridge could be undermined. The cost of this alternative involves the removal of all rock and filter fabric associated with the jetty. The cost is estimated at $473,000. The annual cost over the project life is $18,000 per year. Because this alternative would threaten the road and bridge and fails to maintain water quality within Blind Pass, this alternative is not recommended.

2. Remove the jetty and fill the inlet.

This alternative is similar to alternative 1 in that the 1988 jetty extension and 1972 jetty are removed. Blind Pass is then intentionally closed and protected by constructing a rock revetment in front of the bridge. Initial closure of the pass would be accomplished by driving a temporary sheet pile wall to interrupt the flow while a sand core and the rock revetment are constructed (Figure 32). Sand will erode off of Turner Beach which will result in the loss of public beach area and deposit on Sanibel.

The advantage of this option over Alternative 1 is that by creating a rock revetment in front of the bridge, loss of sand from the littoral system by overwash is prevented and the bridge itself will be protected. The initial cost of this alternative is $879,000. The annual cost of this alternative is $34,000 over the life of the project. While this option will bypass the full amount of littoral drift to Sanibel, water quality problems may result in Blind Pass and a public beach will be eroded. The north bridge approach would become vulnerable to storm impact as the sand north of the pass would erode. The storm evacuation route from Captiva Island would be threatened by this option. Therefore, this alternative is not recommended.

IV. ENGINEERING ALTERNATIVES

INTRODUCTION

This section of the management plan involves the evaluation of engineering alternatives that achieve the goals listed on page 1. The design of alternatives is preliminary and sufficient to develop an estimate of the cost of each alternative. The cost estimates include contingencies and engineering costs. For purpose of comparison, each alternatives' costs are annualized over a 50 year project life. Annualized costs are determined using an interest rate of 3%. Advantages and disadvantages of each system and their impact of the inlet-beach system are discussed.

The alternatives that are considered are classified as either relating to closing Blind Pass or sand bypassing (as required by the State format). The alternatives are described in detail in the following sections. The alternatives are:

A. Close the Inlet.

   1. Remove the jetty.
   2. Remove the jetty and fill the inlet.

B. Inlet Bypassing Systems.

   1a. Beach nourishment of northern Sanibel.
   1b. Beach nourishment with maintenance on Captiva Island's renourishment schedule.
   2. Restore northern Sanibel and stabilize with groin field.
   3. Restore northern Sanibel, remove the jetty extension and place extra fill on Captiva Island, renourish Captiva and northern Sanibel together.
   4. Restore northern Sanibel and overfill South Captiva Island.
   5. South jetty and beach nourishment on Northern Sanibel.
   6. Purchase homes and reroute road.
   7. Purchase homes and revet road.
   8. Dredge the flood shoal.
   9. No action.
   10. County builds road protective revetment (1992), maintain beach on north Sanibel (1800 ft.) (1993), and renourish with Captiva project.
   11. Beach nourishment and segmented offshore breakwater.

C. Experimental Systems

   1. Mobile jet pump system.
   2. Jet pump in ebb shoal with fluidizer collector.
   3. Restore northern Sanibel, maintain with dewatering system.

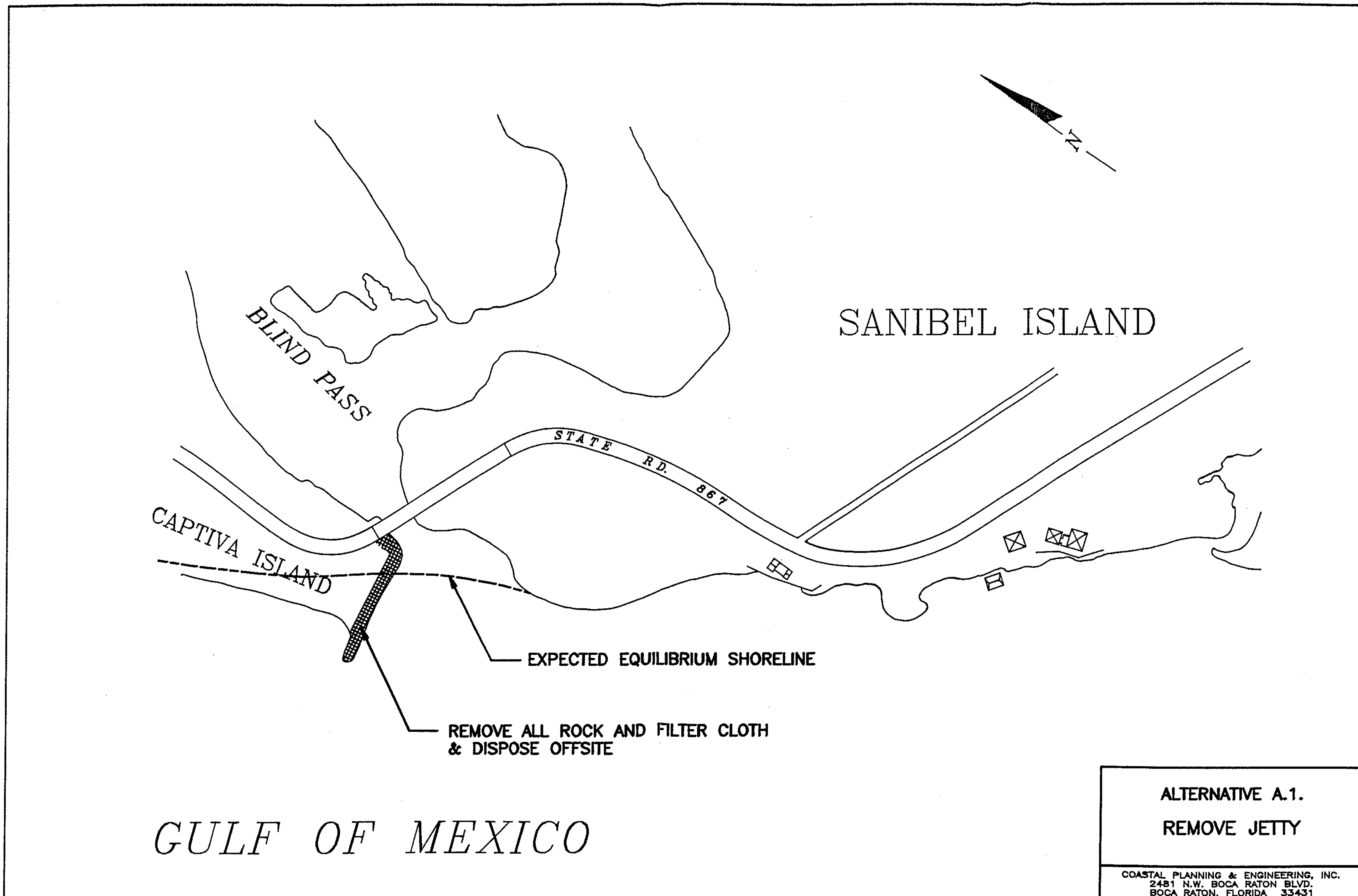

SANIBEL ISLAND
N
BLIND PASS
STATE RD. 867
CAPTIVA ISLAND
EXPECTED EQUILIBRIUM SHORELINE
REMOVE ALL ROCK AND FILTER CLOTH
& DISPOSE OFFSITE
GULF OF MEXICO
ALTERNATIVE A.1.
REMOVE JETTY
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 31

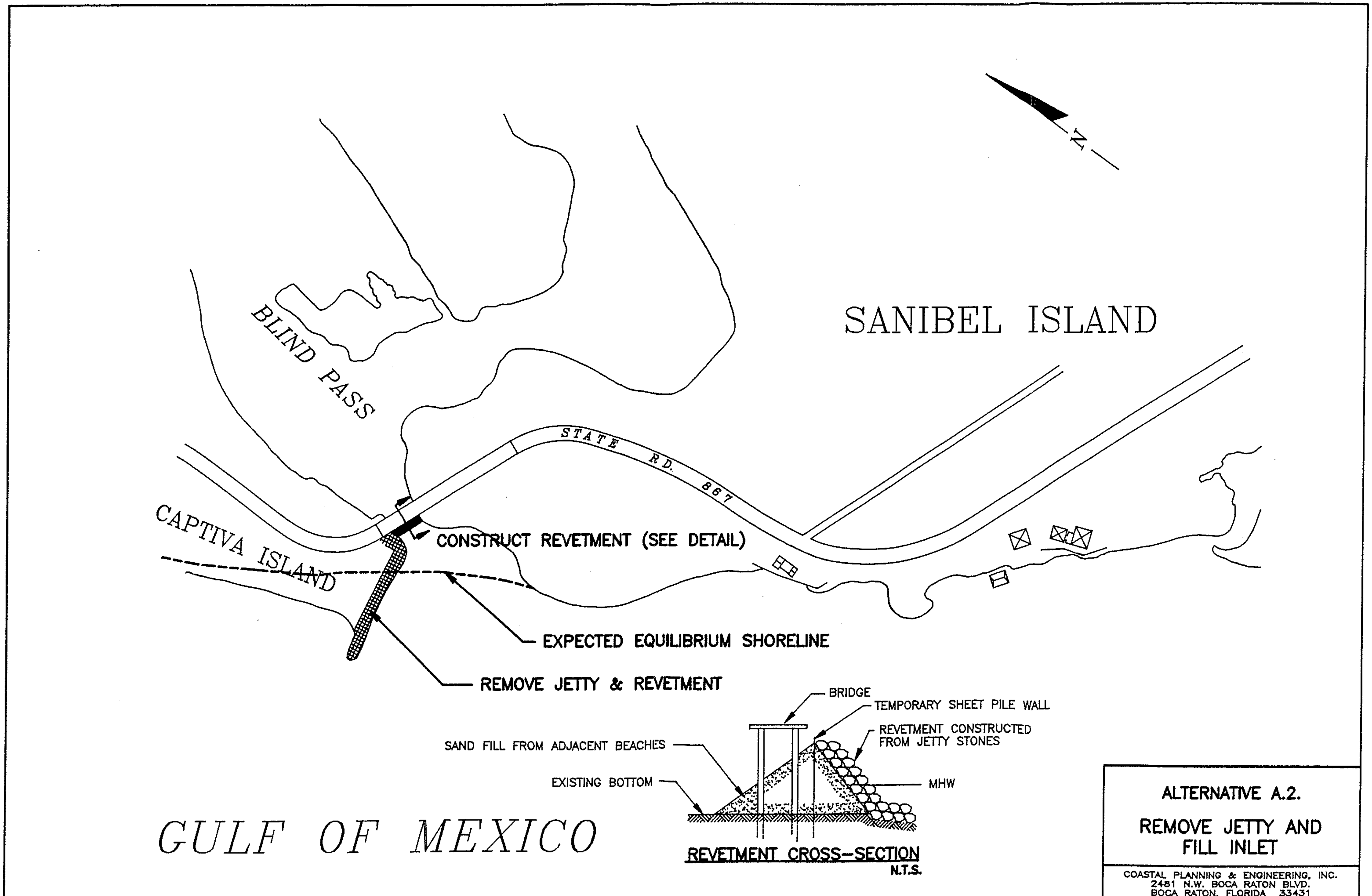

SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
STATE RD. 867
N
CONSTRUCT REVETMENT (SEE DETAIL)
EXPECTED EQUILIBRIUM SHORELINE
REMOVE JETTY & REVETMENT
GULF OF MEXICO
BRIDGE
TEMPORARY SHEET PILE WALL
REVETMENT CONSTRUCTED FROM JETTY STONES
SAND FILL FROM ADJACENT BEACHES
EXISTING BOTTOM
MHW
REVETMENT CROSS-SECTION
N.T.S.
ALTERNATIVE A.2.
REMOVE JETTY AND FILL INLET
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 32

B. Inlet Bypassing Systems

1.a. Beach Nourishment of Northern Sanibel.

This alternative involves the restoration of the beach along 3,600 feet of northern Sanibel (Figure 33). Fill would be placed in order to realign the shoreline between the pass and the beach south of Clam Bayou. It is estimated that 320,000 cubic yards of sand would be required to widen the beach an average of 130 feet. In addition, six years of advanced nourishment would be placed in order to protect the restored beach. The erosion rate of the project would be on the order of 35,000 cy/yr; 210,000 cubic yards would be placed as advanced nourishment.

A gap would be left in the fill in the vicinity of Clam Pass Bayou to allow for intermittent flushing of the water in the pass. It is likely that this gap will fill in with sand and reopen only after storm action. This is consistent with the historical performance of Clam Pass Bayou.

The total initial cost of this alternative is $4,655,000. The annual cost (@ 3% interest) including maintenance nourishments at six year intervals is $504,000.

1.b. Beach Nourishment with Maintenance on Captiva Island's Renourishment Schedule

This alternative contains the same components as alternative 1a. with the following exceptions. The volume of the initial advanced nourishment is reduced from six years to only three years. The placement of future advanced fill at northern Sanibel is then scheduled to coincide with the Captiva Island restorations. This reduces costs because separate mobilization charges are not incurred. The initial cost of this alternative is $3,858,000 and the annual project cost is $402,000. This represents a significant drop in annual cost if the dredging is scheduled to coincide with Captiva's renourishment.

2. Restore Northern Sanibel and Stabilize with Groin Field

This alternative involves the construction of three rubble mound groins along the road section of northern Sanibel (Figure 34). The groins are of variable length and would hold the same design shoreline that was assumed in the preceding alternatives. The groins would eliminate the need for advance fill.

No fill is placed south of the groins. As a result, Clam Bayou should remain open and the beach adjacent to Clam Bayou will continue to overwash. Significant changes in the shoreline south of the groin field could be expected. Unlike the other alternatives, this alternative attempts to protect a limited section of beach. Due to continued overwash, additional erosion may be experienced

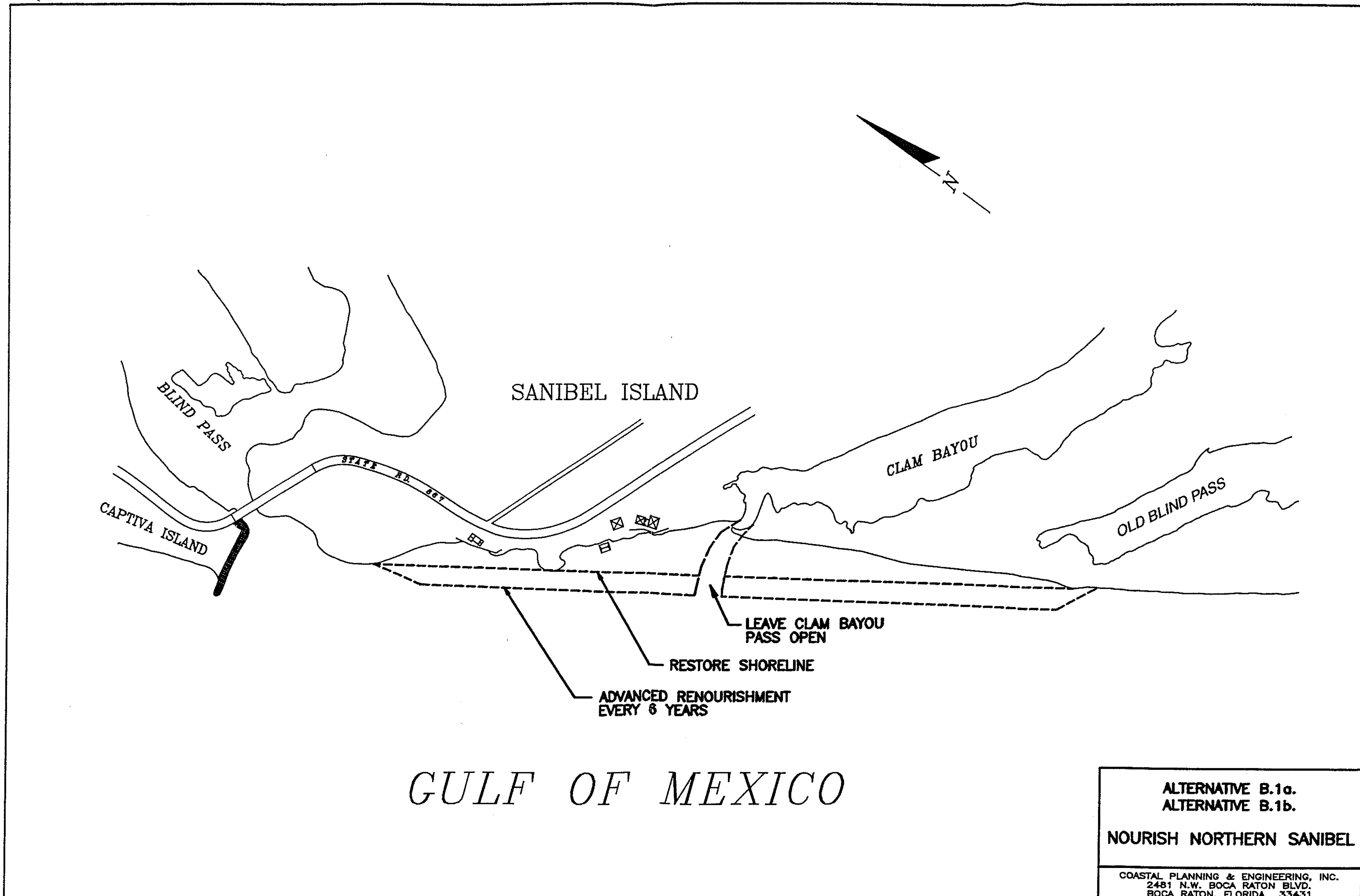

N
SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
STATE RD. 867
CLAM BAYOU
OLD BLIND PASS
LEAVE CLAM BAYOU PASS OPEN
RESTORE SHORELINE
ADVANCED RENOURISHMENT EVERY 6 YEARS
GULF OF MEXICO
ALTERNATIVE B.1a.
ALTERNATIVE B.1b.
NOURISH NORTHERN SANIBEL
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 33

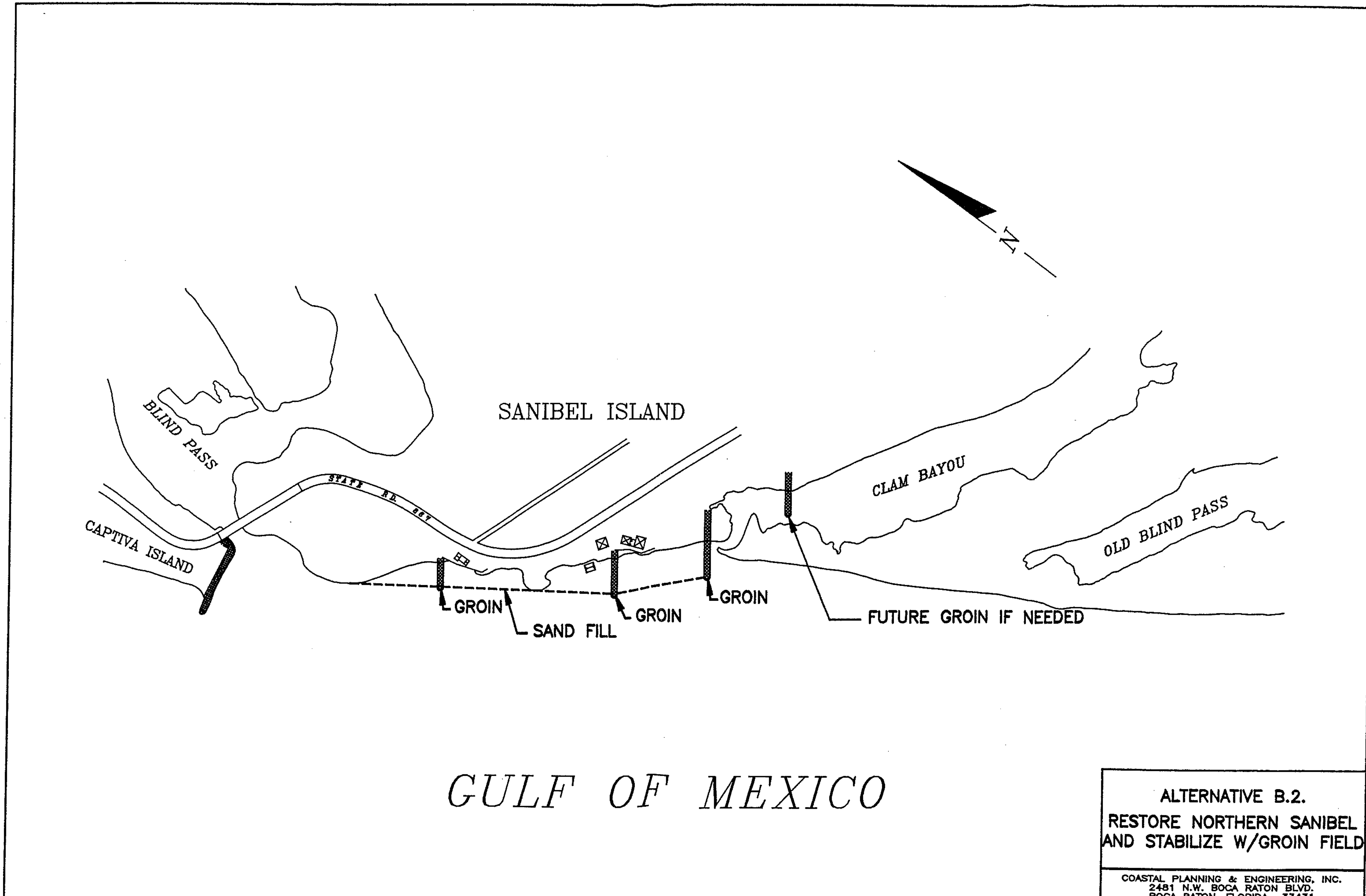

SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
STATE RD. 867
CLAM BAYOU
OLD BLIND PASS
N
GROIN
SAND FILL
GROIN
GROIN
FUTURE GROIN IF NEEDED
GULF OF MEXICO
ALTERNATIVE B.2.
RESTORE NORTHERN SANIBEL AND STABILIZE W/GROIN FIELD
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 34

along the developed section of Sanibel. A fourth groin would be constructed, if needed, in project year five.

The rubble mound groin design and cost estimates are based on the costs of the 1988 terminal groin extension. It is estimated that 140,000 cubic yards of sand would be needed to initially fill the groins. The initial cost of this alternative is $3,985,000. The annual cost of this alternative (@ 3% interest) is $171,000.

3. <u>Restore Northern Sanibel, Remove the Jetty Extension and Place Extra Fill on Captiva Island, and Renourish Captiva and Northern Sanibel Together</u>

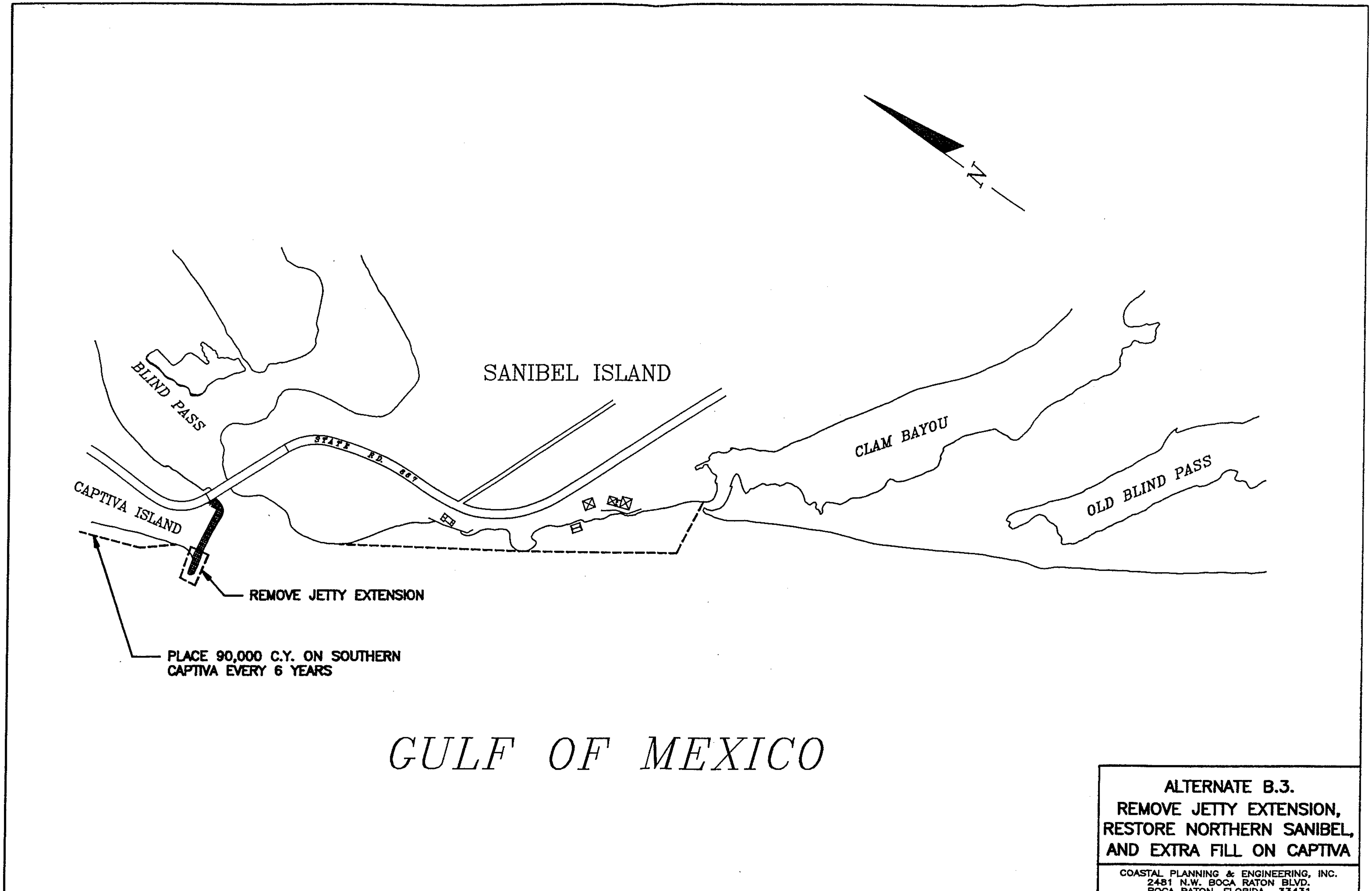
Under this option, the northern 1800 feet of beach on Sanibel would be restored in 1993 with 160,000 cubic yards (half of quantity placed in B.1.a.) of sand at the same time the 100 foot groin extension was removed from Blind Pass (Figure 35). When fill is placed on Sanibel, sand would also be placed on the southern beaches of Captiva Island to compensate for high erosion rates expected there.

When the groin is first removed, the beach adjacent to the groin would retreat by 100 feet in the first few months, with the beach losing about 30,000 cubic yards of sand. Subsequent losses of sand would be about 15,000 cubic yards/year higher than current rates. If we assume Captiva will be renourished in 1996, then the placement of sand on southern Captiva should be 75,000 cubic yards in 1993 to compensate for expected excess erosion before renourishment.

In 1996, both Captiva and Sanibel would be renourished. To account for expected losses at Blind Pass, an extra 90,000 cubic yards would be placed on Captiva (over and above expected renourishment quantities of 600,000 c.y.). Nourishment quantities on Sanibel would be 180,000 cubic yards in 1996, 150,000 cubic yards in 2002, and 120,000 cubic yards every 6 years thereafter. This is because Sanibel is expected to erode initially at a rate of 45,000 cubic yards/year less increased sand transfer from Captiva Island. If we subtract the 15,000 cubic yards increased sand coming from Captiva, we get 30,000 cy./yr. erosion rate on north Sanibel for 6 years, or 180,000. In the next 6 years, erosion is reduced to 40,000 c.y./yr., reducing nourishment to 150,000 c.y. Erosion will decrease to 35,000 c.y. thereafter, the same quantity as the longer project.

The initial cost of this option is $3,346,000. The annual cost at 3% interest would be $405,000.

Under this program the southern beaches of Captiva Island would lose all of the nourishment sand before the next nourishment. The county park at Turner Beach would be eroded during the end of the nourishment period. The approach road north of the Blind Pass bridge would be vulnerable to damage in a major storm.



ALTERNATE B.3.
REMOVE JETTY EXTENSION,
RESTORE NORTHERN SANIBEL,
AND EXTRA FILL ON CAPTIVA

COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 35

Northern Sanibel would erode at a slower rate and provide more protection to the evacuation route. The road would be vulnerable to storm damage at the end of the nourishment interval.

More sand would move into Blind Pass annually without the jetty extension. Blind Pass would be less stable than conditions that prevailed before 1988 and have more of a tendency to close and remain closed for longer periods of time.

Because this option does not meet the goals of erosion control or evacuation route protection, or Blind Pass stability, it is not recommended.

4. Restore Northern Sanibel and Overfill South Captiva Island

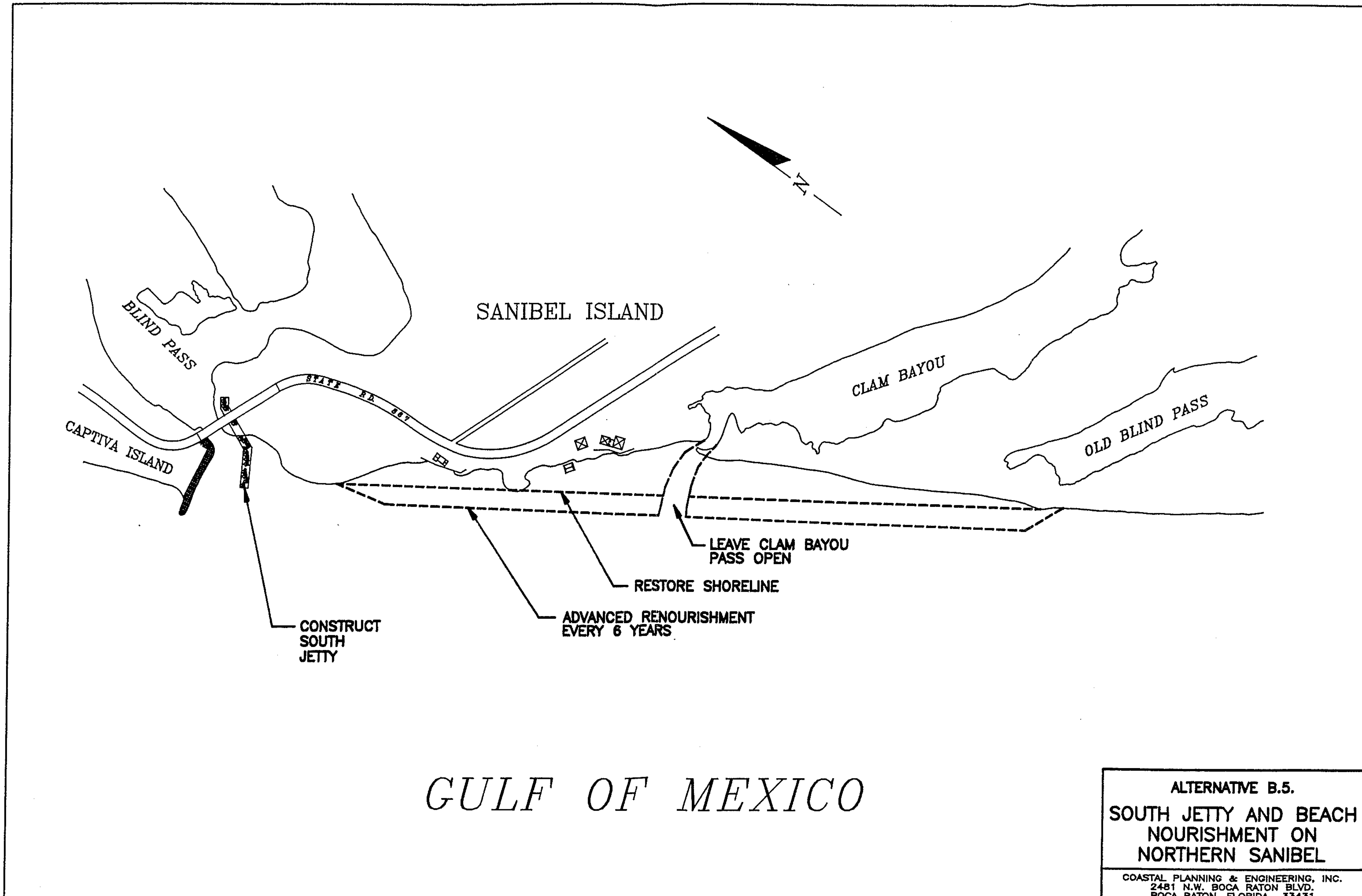
This alternative is a variation of Alternative B.1.b. The northern end of Sanibel is restored for a distance of 3,600 feet with 320,000 cubic yards of sand. The difference in this alternative is that the 210,000 cubic yards of advanced nourishment are placed on southern Captiva as a feeder beach. The alternative has the advantages of increasing sand bypass from Captiva Island while maintaining a wide protective beach at Turner Beach.

Potential disadvantages include the possibility of destabilizing Blind Pass with sand from the feeder beach. The other disadvantage is that the advanced nourishment is not placed directly to protect the restored beach. Since a delay could occur because the ebb shoal may store sand prior to bypassing, some of the restored Sanibel beach may periodically erode. This would not be unlike the historical performance of the northern Sanibel beaches. The initial cost of this alternative is the same as B.1.b., $3,858,000. The annual cost of this alternative is $402,000 (@ 3% interest).

5. South Jetty and Beach Nourishment on Northern Sanibel

This alternative includes the components of alternative B.1.b. and also includes the construction of a south jetty at Blind Pass (Figure 36). One purpose of the jetty would be to improve the inlet stability by reducing the amount of drift into Blind Pass from the south. A second purpose of the jetty would be to better direct currents in the vicinity of the pass. This would cause the sand bypass along the ebb shoal to be better behaved. Sand would move along a better defined ebb shoal as opposed to cyclical build-up and subsequent attachment of the shoal to the beach. The beach at Sanibel would be restored and renourished at a regular interval. The initial cost of this alternative is $5,195,000. The annual project cost is $453,000.

The south jetty would provide better protection for the road as it would moderate the cyclical nature of the erosion/accretion patterns to the inlet and provide for a more stable beach configuration.



ALTERNATIVE B.5.

SOUTH JETTY AND BEACH NOURISHMENT ON NORTHERN SANIBEL

COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 36

The ebb shoal would initially move further offshore as a result of the better directed currents. Sand would temporarily reside in the ebb shoal before it bypassed the inlet, potentially causing erosion of the beach.

The amount of sand needed to nourish the northern Sanibel beaches would not be significantly reduced by the south jetty. Studies have indicated that very little sand is currently entering the inlet.

6. Purchase Homes and Reroute Road

This alternative consists of purchasing the homes that are in most danger of storm damage or undermining and rerouting S.R. 867 to the east (Figure 37). This is a retreat type of option and involves allowing nature to continue to erode the shoreline.

For the optimal engineering solution, the cost of purchasing 4 homes on 7 parcels is in excess of $2,300,000. This figure is used to calculate the cost of this alternative. This cost includes the purchase and removal of the existing structures.

The cost of rerouting the road is approximately $625,000. This includes the repaving of a two lane road for a length of approximately one half mile (Figure 37). Since telephone, electric and water utilities run parallel to the existing road, they will have to be relocated as well. The utility cost accounts for an estimated $125,000 of the road relocation cost. The cost for this component of this alternative is preliminary and may increase depending on how much land, right of way, or easement is necessary.

The total initial cost of this option is $3,493,000. The annualized cost at 3% interest is $136,000 per year. This option allows the ongoing erosion problem to continue and the erosion would eventually get back to portions of the rerouted road and again threaten the access road. For this reason, this option, by itself, is not recommended. A less extensive purchase, which is the desire of local interests (Sanibel City Manager communications 12 March 1992), in combination with other alternatives is discussed in the recommended plan.

7. Purchase Homes and Revet Road

This alternative involves the purchase of the homes and construction of a revetment adjacent to S.R. 867 (Figure 38). This alternative has the advantage over rerouting the road because a fewer number of people are impacted. The revetment is to be built along 800 feet of road. As this solution does not mitigate the littoral drift deficit, additional sections of revetment may need to be added. For cost estimating purposes, an additional 100 feet of revetment is assumed to be constructed every five years until project year 10.

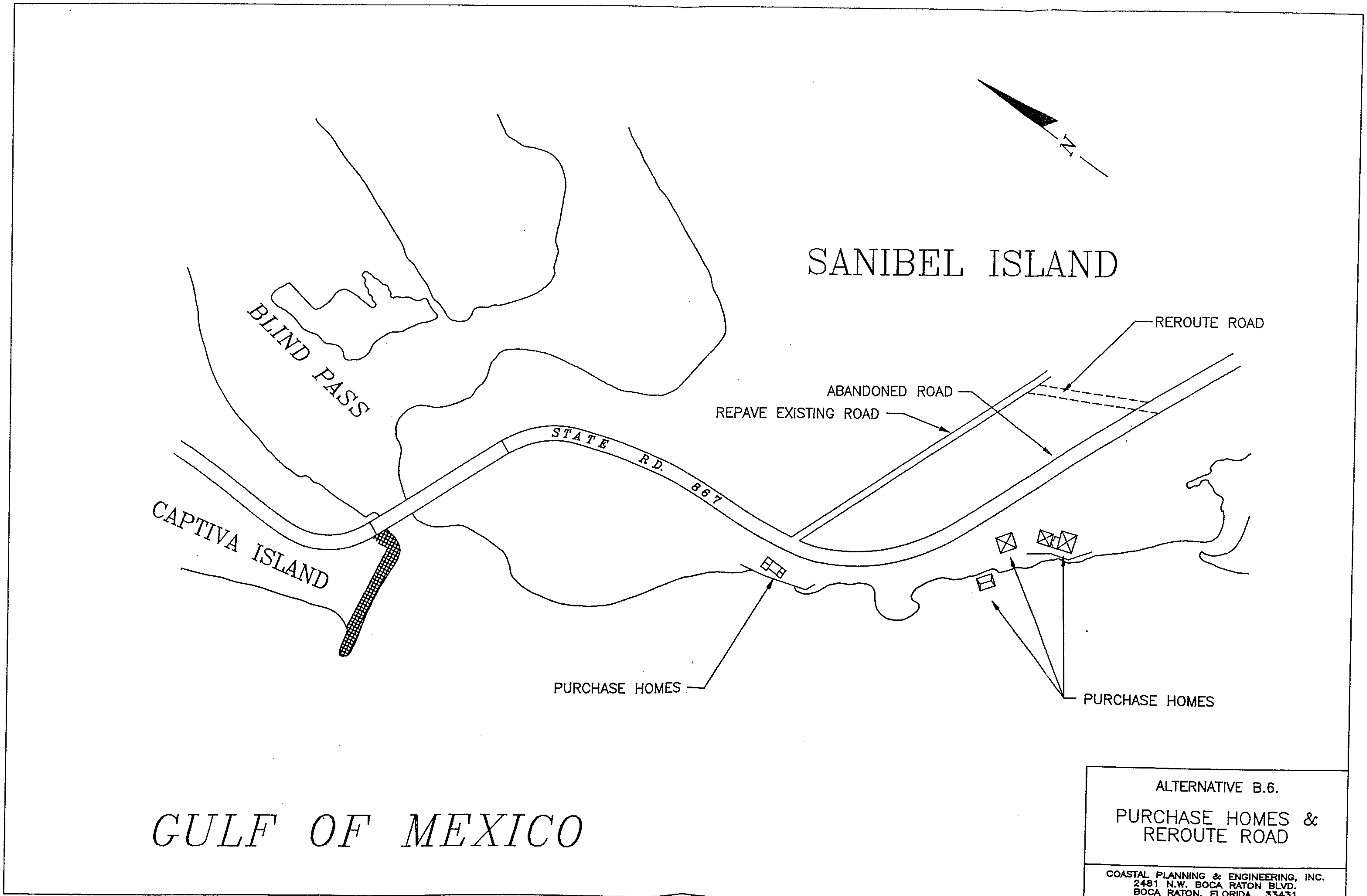

N
SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
STATE RD. 867
REROUTE ROAD
ABANDONED ROAD
REPAVE EXISTING ROAD
PURCHASE HOMES
PURCHASE HOMES
GULF OF MEXICO
ALTERNATIVE B.6.
PURCHASE HOMES & REROUTE ROAD
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 37

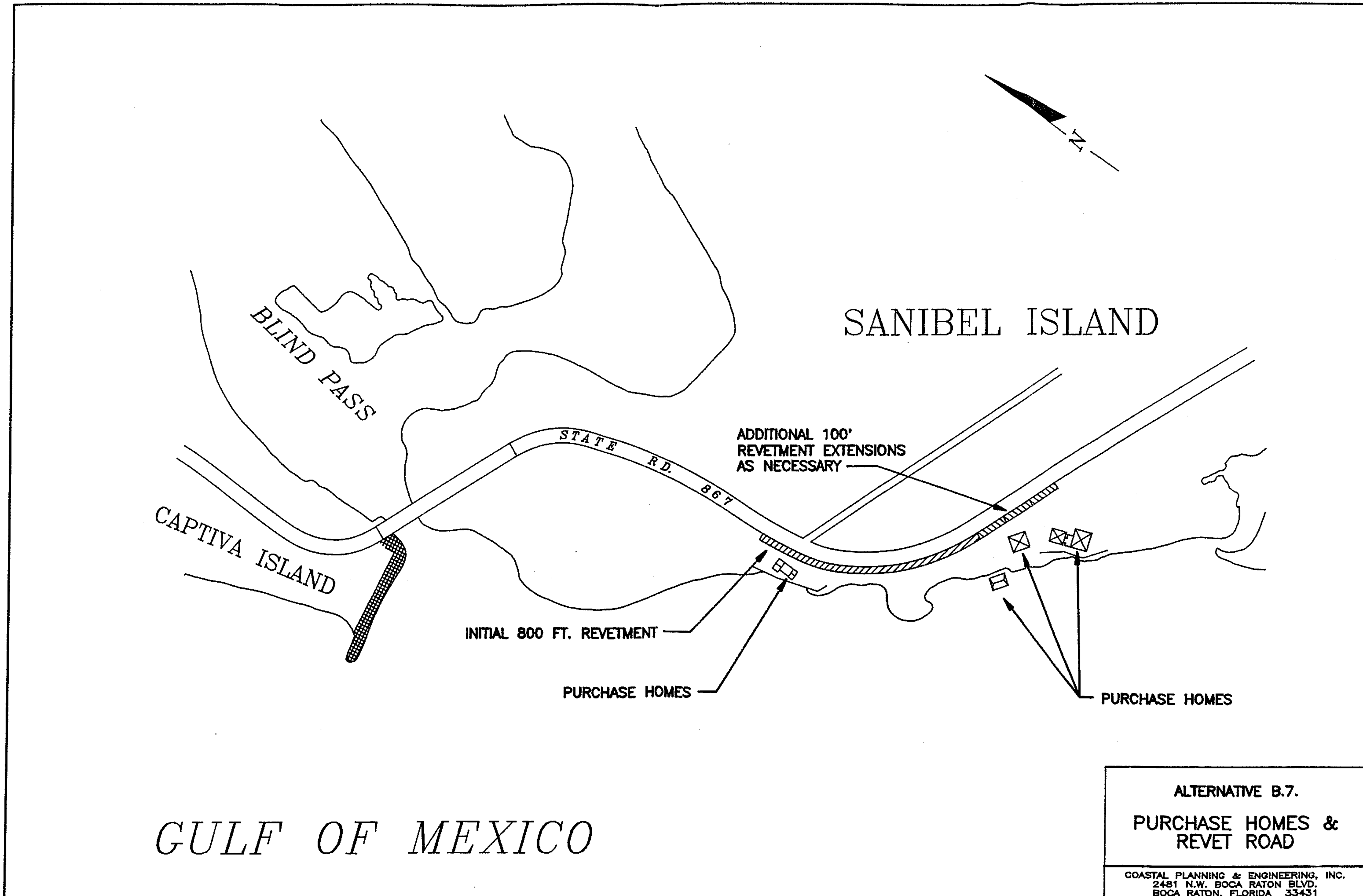

N
SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
STATE RD. 867
ADDITIONAL 100'
REVETMENT EXTENSIONS
AS NECESSARY
INITIAL 800 FT. REVETMENT
PURCHASE HOMES
PURCHASE HOMES
GULF OF MEXICO
ALTERNATIVE B.7.
PURCHASE HOMES &
REVET ROAD
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 38

Discussions with Lee County Department of Transportation and their consultants indicate that plans to revet the road have been deleted from their construction plans to raise the approaches. The reason given was the difficulty to permit revetments with the State and their concern about anti-shore hardening policies of the City of Sanibel. It may be possible for the County to re-include the revetment as part of a comprehensive approach to inlet management.

The initial cost of this alternative, including buying the houses/cottages is $3,715,000. The annual cost for this alternative is $152,000. The cost of removing abandoned shore protection structures is not included in the above estimates.

8. Dredge Flood Shoal

This alternative involves dredging available sand from the flood shoal of Blind Pass and placing it on the beach (Figure 39). According to CPE (1990), the flood shoal contains approximately 60,000 cubic yards of beach compatible sand. Both Dr. Mehta and Dr. Dean indicate that shoaling may be taking place along the inlet channel all the way back to Pine Island Sound. Additional material may be available from these areas. Dr. Mehta also feels that dredging a wider channel would make the inlet more stable and improve natural sand bypassing over time. The initial cost of this alternative is $379,500. The annualized project cost is $20,000.

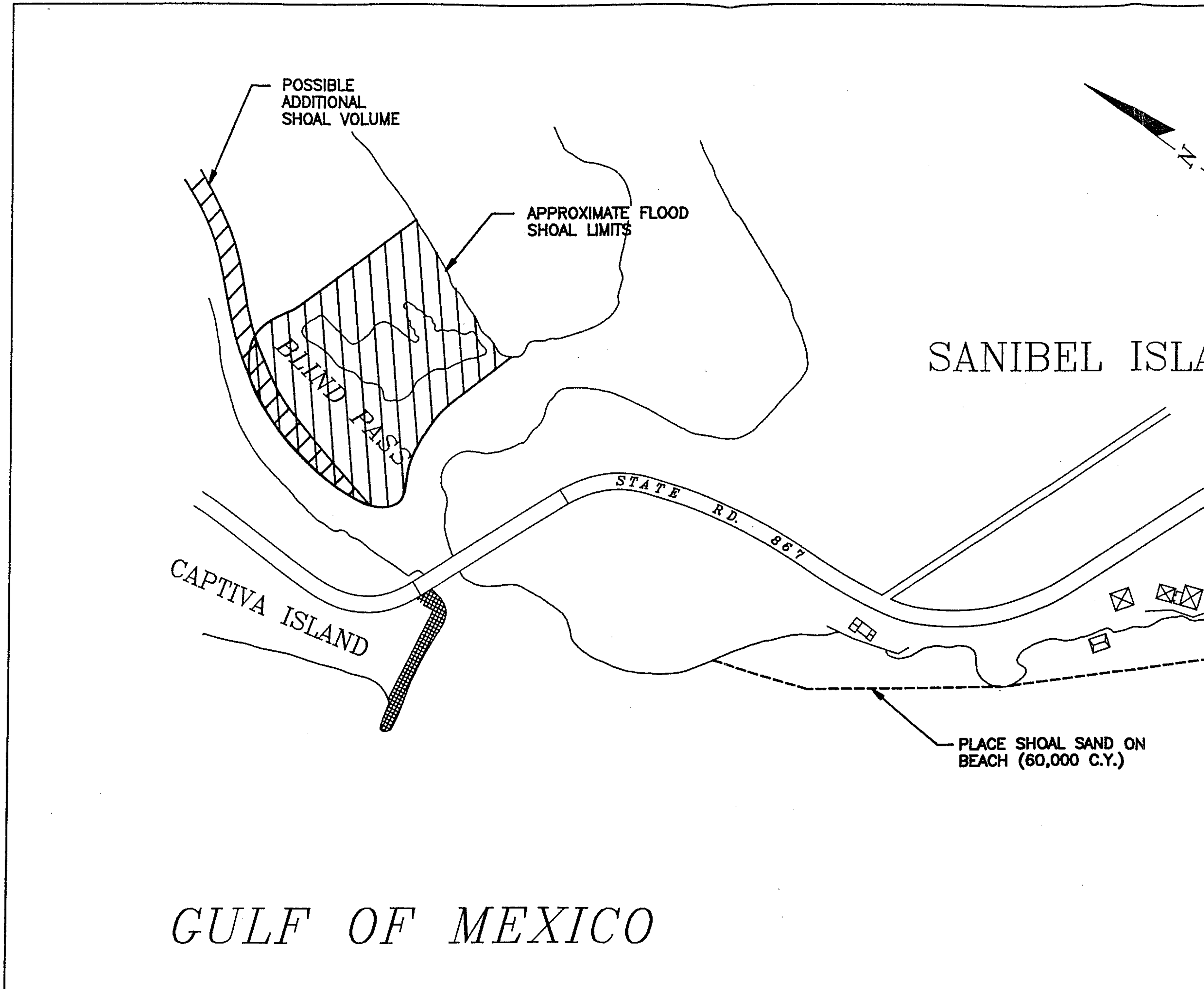
The disadvantage of this alternative is that dredging the shoal would be difficult. A small dredge would have to enter from Pine Island Sound in order to reach the site along the shallow channel. Environmental constraints, such as adjacent sea grass beds and nesting bird considerations, will probably make this alternative unpermittable by the state agencies. This alternative is not recommended.

9. No Action

This alternative is included for comparison with the other plans. Continued erosion of northern Sanibel is expected to continue. Additional hardening of the shoreline may be undertaken by private property owners. Clam Bayou will probably stay open due to the small supply of available sand. The overwash processes in the vicinity of Blind Pass are expected to continue. This option does not achieve the sand bypassing and erosion control goals. There is no construction cost associated with this alternative, but it is not recommended.

10. County Builds Road Protective Revetment, Maintain beach on North Sanibel (1800 ft), Renourish with Captiva Project.

This alternative is a storm protection plan for the evacuation route (Figure 40). Initially, the County will build an 800 foot road protective revetment; 135,000



ALTERNATIVE B.8.

DREDGE BLIND PASS FLOOD SHOAL

COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 39

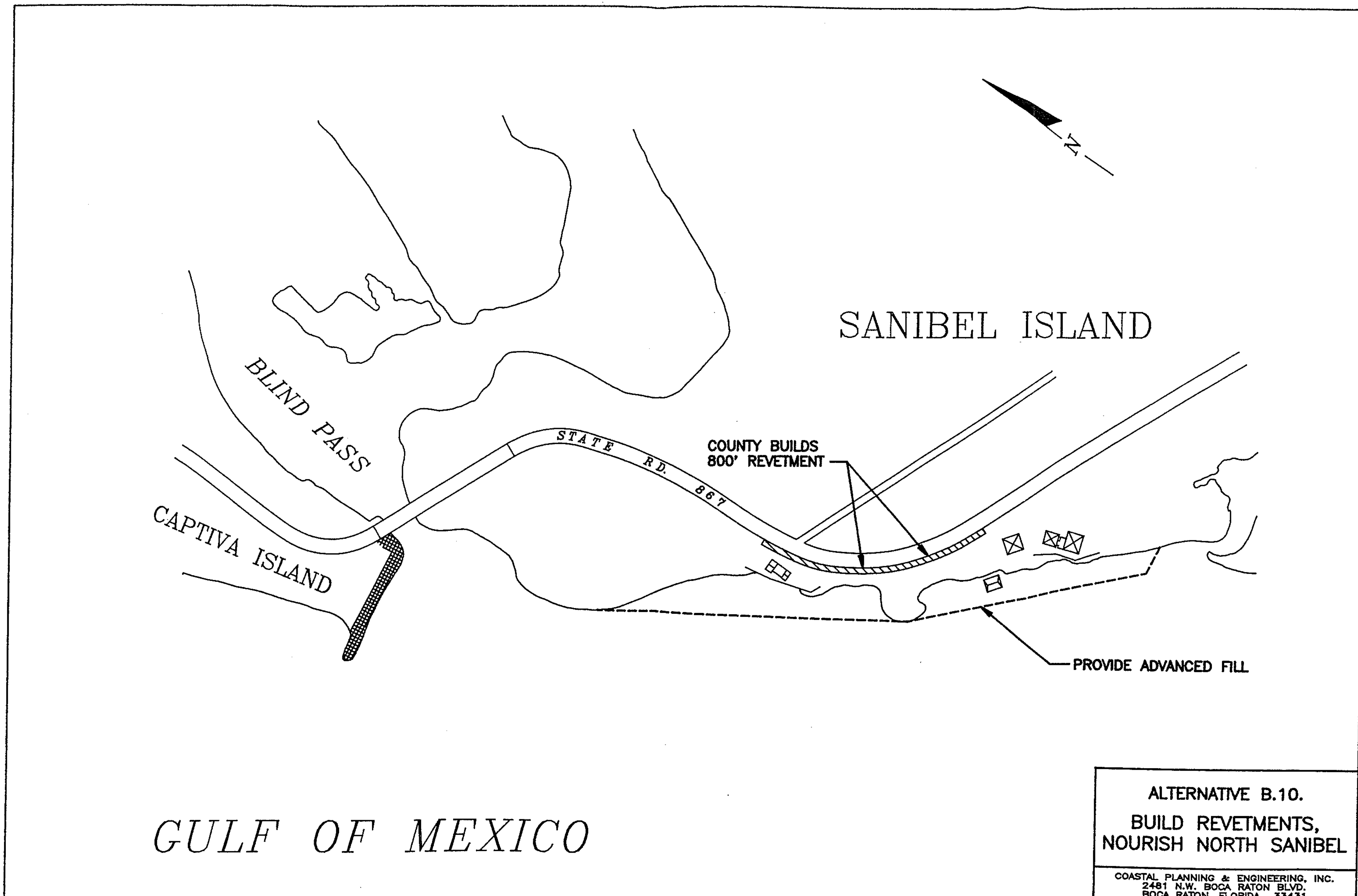

N
SANIBEL ISLAND
BLIND PASS
STATE RD. 867
COUNTY BUILDS
800' REVETMENT
CAPTIVA ISLAND
PROVIDE ADVANCED FILL
GULF OF MEXICO
ALTERNATIVE B.10.
BUILD REVETMENTS,
NOURISH NORTH SANIBEL
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 40

cubic yards of sand (3 years of advanced fill) will then be placed in 1993 on the beach along the northern 1800 feet of Sanibel. Additional fill will be placed at six year intervals beginning in 1996 to make up for losses occurring between fill replacement.

It is estimated that the initial erosion rate will be 45,000 cy/yr. As the fill spreads, the erosion rate should reduce to 35,000 cy/yr.

This option is a storm protection option. Conditions are not allowed to get worse than present day. Storm protection is provided to the road by a revetment. Property owners provide their own storm protection.

This alternative is combined with the construction of an initial revetment fronting the threatened road sections. The initial cost of this alternative is $2,669,000. The annual cost over the project life is $381,000 based on the projected erosion rates.

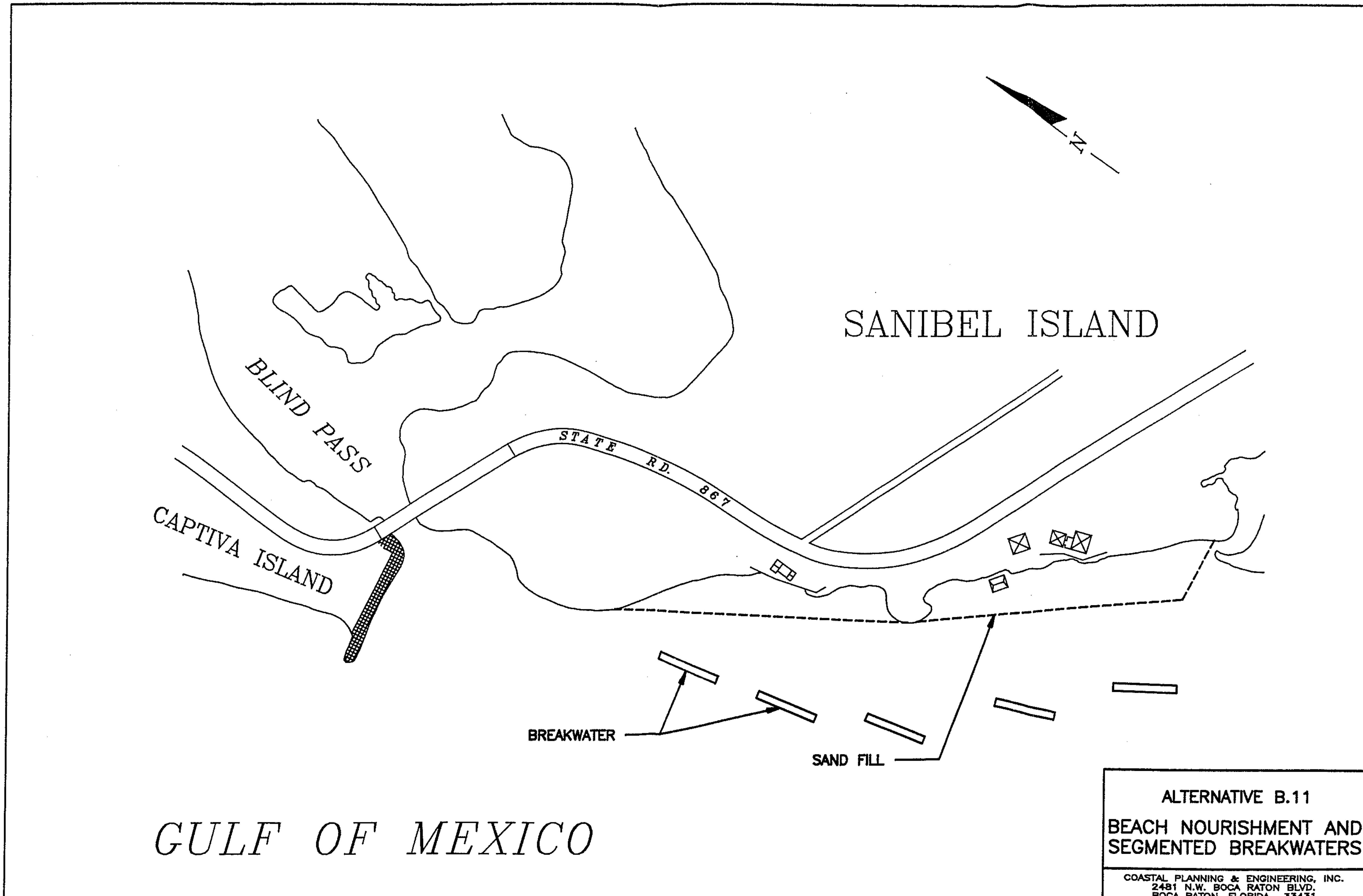
11. <u>Beach Nourishment and Segmented Offshore Breakwater</u>

This alternative consists of constructing five (5) emergent breakwaters along 2000 feet of northern Sanibel. Approximately 160,000 cubic yards of sand would be placed on the beach to restore the shoreline. The goal of this alternative is to reduce the wave energy reaching the shoreline, thus reducing the erosion of the developed shoreline. No modifications to Clam Bayou inlet or to the beach south of Clam Bayou are included in this alternative.

The schematic layout of this alternative is shown in Figure 41. The breakwater placement was developed using the guidelines of Dally and Pope (1986). The breakwaters are 200 foot long segments with 150 foot gaps and are located approximately 400 feet offshore. The configuration should prevent tombolo formation which would interrupt the littoral drift. Detailed engineering, including computer shoreline modeling is required to optimize the placement and size of the breakwaters.

Based on the preliminary design, the initial cost of the breakwaters and initial fill is $5,768,000. The annual cost of this alternative at 3% interest is $218,000. This does not include any future renourishment of the beach which may be necessary.

A potential drawback to this alternative is the impact to the natural ebb shoal bypassing. As sand accumulates in the ebb shoal, some sand will be naturally bypassed along the bar back to the downdrift beach. With the presence of the breakwaters, the natural bypassing may be disrupted. A second disadvantage would be the transfer of erosion from the developed section of coast to the



N
SANIBEL ISLAND
BLIND PASS
STATE RD. 867
CAPTIVA ISLAND
BREAKWATER
SAND FILL
GULF OF MEXICO
ALTERNATIVE B.11
BEACH NOURISHMENT AND SEGMENTED BREAKWATERS
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 41

undeveloped section. Further analysis is required in order to understand the impacts to the littoral drift system.

C. Experimental Systems

1. <u>Mobile Jet Pump System</u>

This system is intended to mechanically bypass sand from the south end of Captiva Island to the northern end of Sanibel. The system consists of a jet pump mounted on a crane connected to a pipe which crosses Blind Pass and discharges the sand approximately 2,000 feet south of Blind Pass (Figure 42). The project includes an initial restoration of Northern Sanibel involving 160,000 cubic yards of fill and 135,000 cubic yards of advanced fill.

The advantage of this system is that the jet pump is mobile; therefore, more sand is available to be transferred to the downdrift beach. The system would operate only when there is sufficient sand available.

The system would increase erosion of the Captiva Project by 15,000 c.y./yr. This sand would be replaced on Captiva every six years. Northern Sanibel would erode at a rate of 30,000 cubic yards/year, which would also be replaced every six years.

There is no advantage to this system, since the same quantities of fill would need to be placed as without the system. The purchase and maintenance of the system would increase the cost.

Several disadvantages to the system exist in this application. The crane would be operating near the water line in Turner Beach Park. This would disrupt the activities on one of the two public beaches on the island. Due to the limited littoral drift on the island, the system would not run continuously. As a result, the owners of the system would have to find employees to work part time. The jet pump would have to be oversized in order to bypass the large shell component of Captiva's beach. Although this is not a significant problem, the use of jet pumps to bypass shelly sand has been limited.

The initial cost of the system is estimated to be $4,036,000. Annual operating costs which include fuel, materials, maintenance, component replacement, and labor are $200,000. The total annual cost of this system (@ 3% interest) over a 50 year life is $654,000 per year.

Due to the impact on the use of the public beach and high annual costs, the system is not recommended for use at Blind Pass.

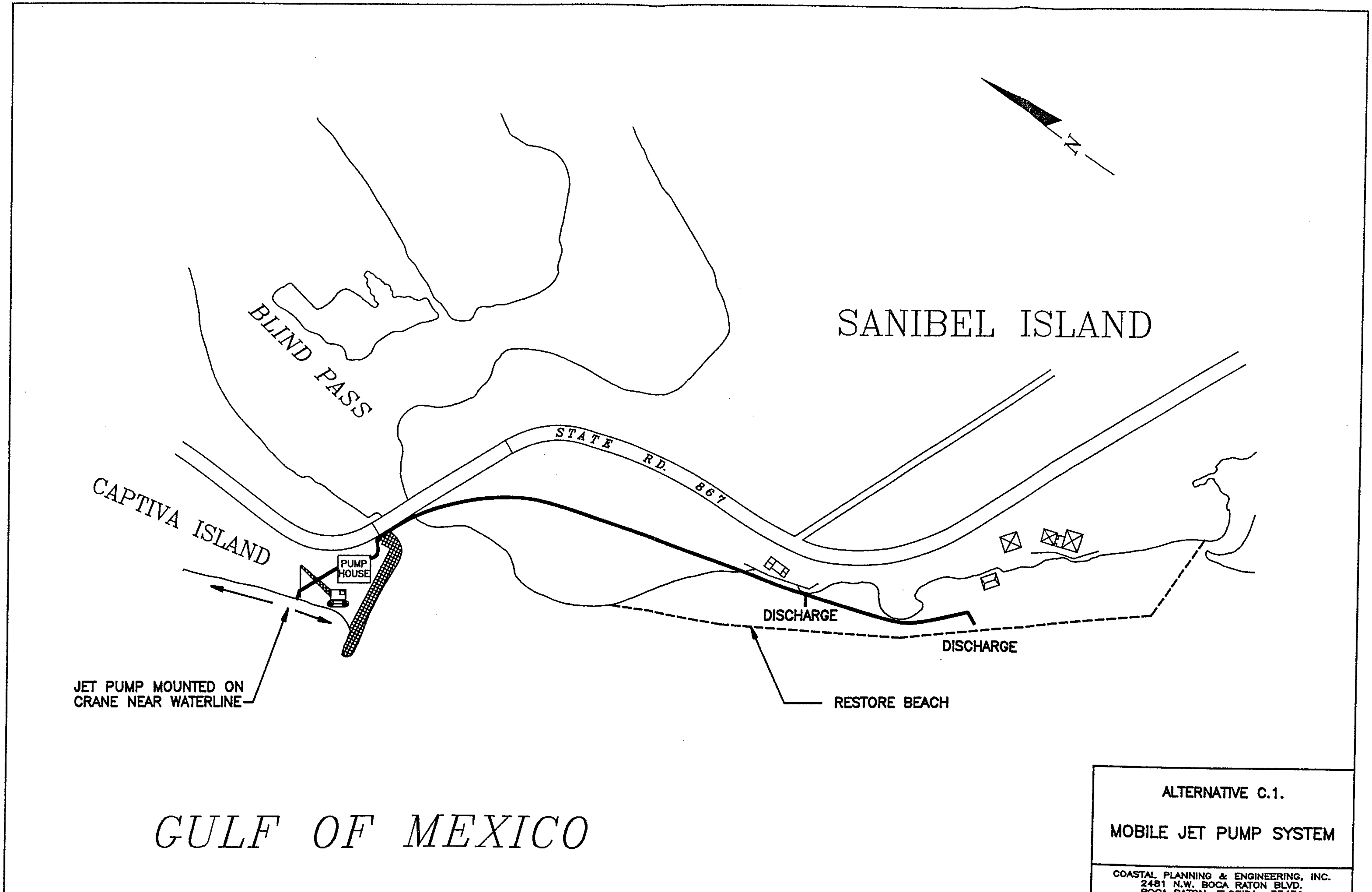

N
SANIBEL ISLAND
BLIND PASS
STATE RD. 867
CAPTIVA ISLAND
PUMP HOUSE
DISCHARGE
DISCHARGE
JET PUMP MOUNTED ON CRANE NEAR WATERLINE
RESTORE BEACH
GULF OF MEXICO
ALTERNATIVE C.1.
MOBILE JET PUMP SYSTEM
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 42

2. <u>Jet Pump in Ebb Shoal with Fluidizer Collector</u>

This system of bypassing sand to Sanibel Island is similar to the previous jet pump system except that the jet pump is not mobile. The jet pump is placed on the ebb shoal where sand has been found to accumulate. In order to expand the area in which the pump can capture sand, a system of fluidizing pipes is installed to move sand to the jet pump (Figure 43). The fluidizing pipes operate by having water pump through them and out small jet ports. The water exiting the ports liquifies the sand and allows gravity to move the liquefied material to the jet pump for transfer.

While the system is technically feasible, the only operating system in use is in Oceanside Harbor, California. It is operated by the Corps of Engineers and is considered experimental. A drawback to this system at Blind Pass is that by operating the system, the natural bypassing of the shoal (bar) would be interrupted. Initially, the shoal would be removed; therefore, less fill volume would be required on Sanibel than for the previous option. Since the ebb shoal does not store significant quantities of sand, most of the sand is naturally bypassed to Sanibel. Renourishment quantities would remain the same. Therefore, it does not appear to be warranted to implement this system.

The initial cost of the system including the first year operation is $1.27 million. Annual operation and maintenance will be approximately $200,000 per year. The total annual cost of this system (at 3% interest) is $618,000 per year.

3. <u>Restore Northern Sanibel, Maintain with Dewatering System</u>

This experimental alternative involves the placement of sand on the northern section of Sanibel (north of Clam Bayou) and maintaining the restored beach with a beach dewatering system (Figure 44). Beach dewatering involves the lowering of the water table within the beach in order to slow or reverse the erosion process. This experimental system has been installed at Sailfish Point, Florida on a beach that is semi-protected by an offshore reef.

The dewatering system consists of a series of pipes buried within the beach that are connected to a pump. The pump draws water from within the beach and discharges the water offshore. The pump would run on a regular basis in order to maintain the beach. Annual maintenance to the pump is required.

The DNR considers these dewatering systems experimental and may require that ongoing tests at Fort Pierce be completed before a second experiment is undertaken (Clark letter, November 14, 1991). Additionally, a successful dewatering system would cause erosion of the downdrift beach.

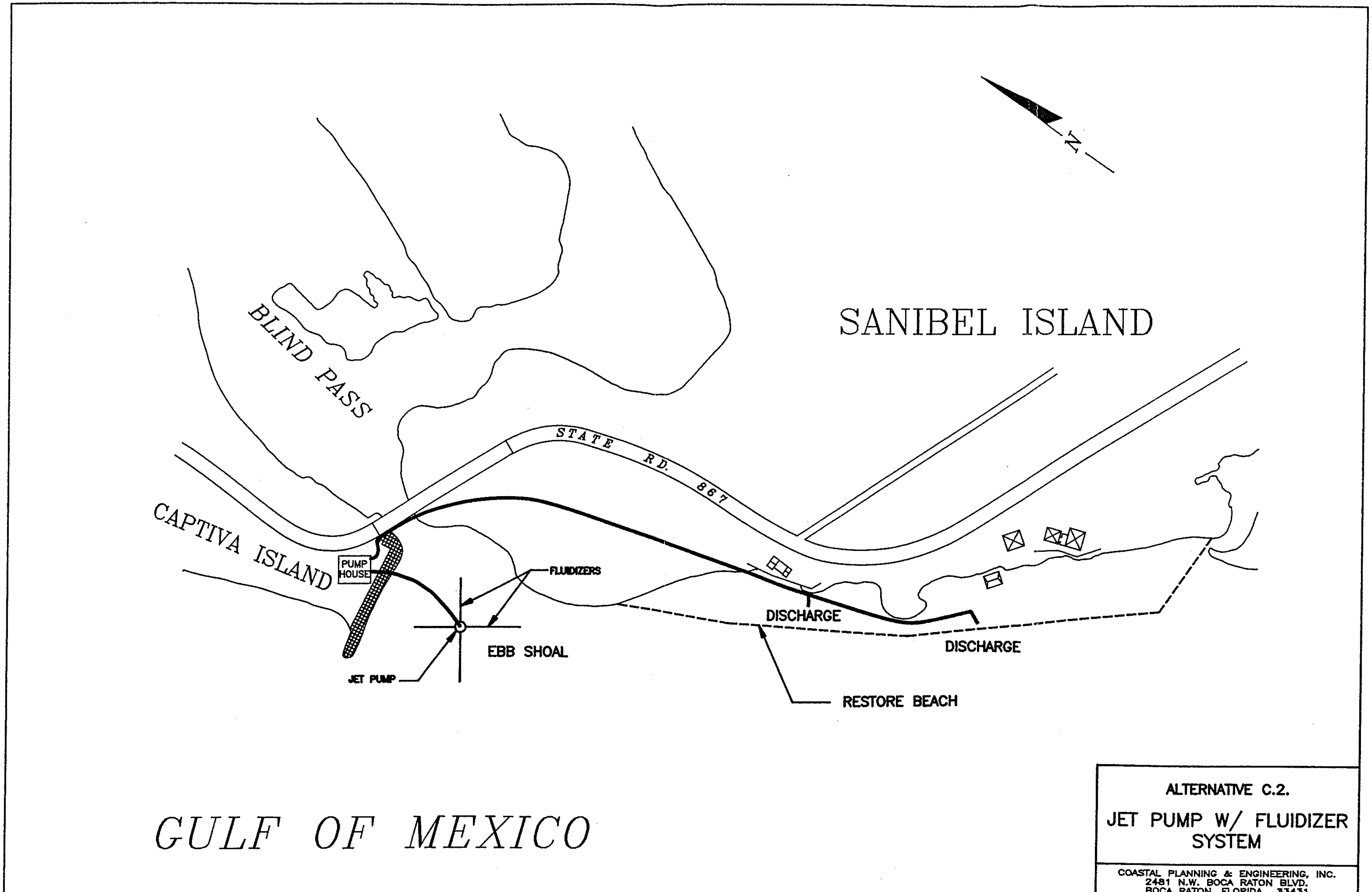

N
SANIBEL ISLAND
BLIND PASS
STATE RD. 867
CAPTIVA ISLAND
PUMP HOUSE
FLUIDIZERS
DISCHARGE
DISCHARGE
EBB SHOAL
JET PUMP
RESTORE BEACH
GULF OF MEXICO
ALTERNATIVE C.2.
JET PUMP W/ FLUIDIZER SYSTEM
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 43

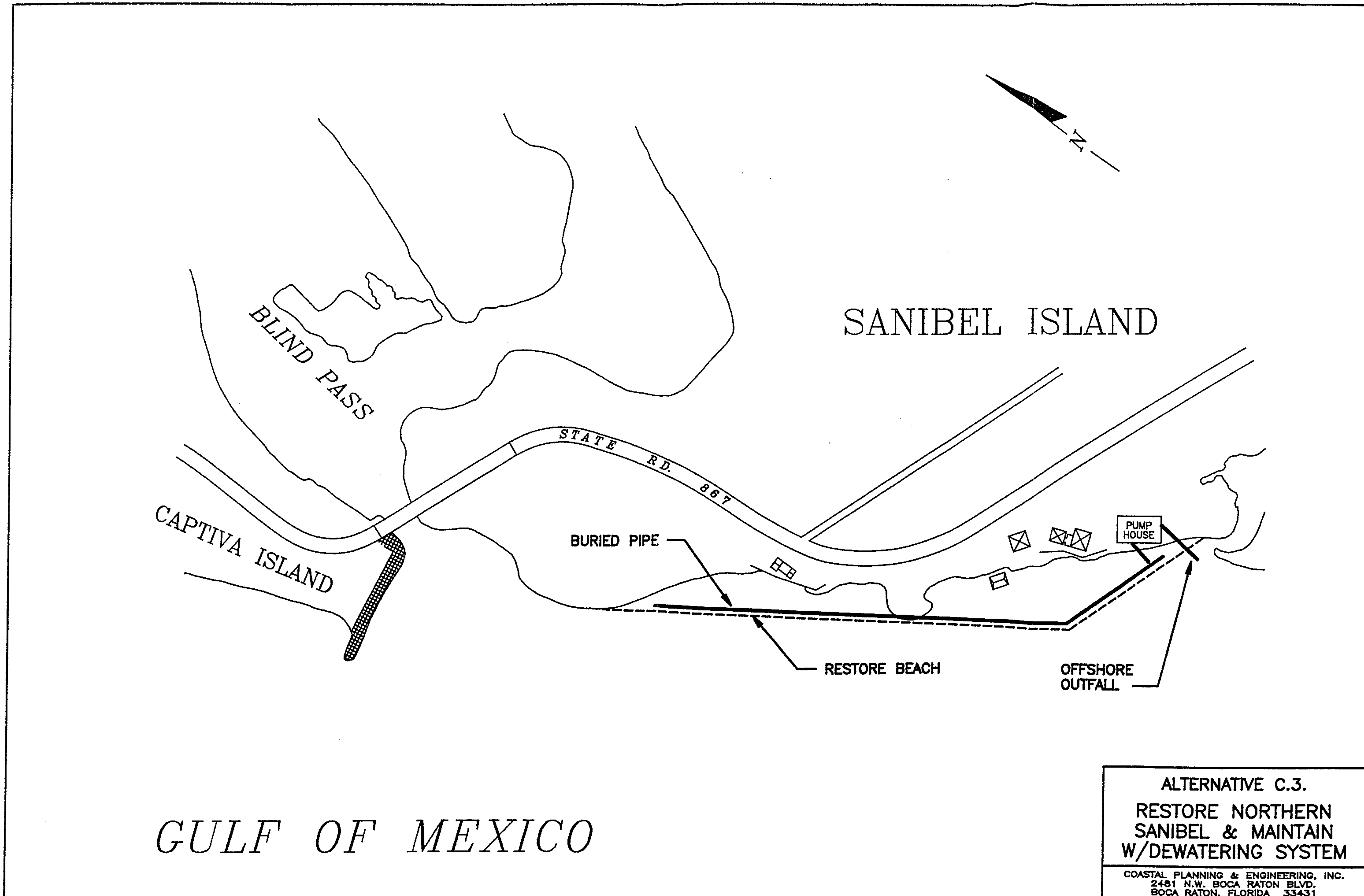

N
SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
STATE RD. 867
BURIED PIPE
PUMP HOUSE
RESTORE BEACH
OFFSHORE OUTFALL
GULF OF MEXICO
ALTERNATIVE C.3.
RESTORE NORTHERN SANIBEL & MAINTAIN W/DEWATERING SYSTEM
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 44

The initial cost of the sand system is $2,786,000. The annualized project cost at 3% interest is $134,000. Of the experimental alternatives, this option appears to hold the most promise.

Tables 24 and 25 show a comparison of the inlet management alternatives. Technical feasibility, permitability, cost, bypassing, mitigation, inlet impacts, environmental concerns, road protection and funding are addressed. The recommended plan will be a composite of the best features of the individual alternatives.

TABLE 24
BLIND PASS (LEE COUNTY) MANAGEMENT PLAN
COMPARISON OF ALTERNATIVES

NUMBER	NAME OF ALTERNATIVE	TECHNICAL FEASIBILITY (YES/NO)	PERMIT-ABILITY (YES/NO)	INITIAL CONSTRUCTION COST($)	ANNUAL PROJECT COST @ 3.0%	DIRECT SEDIMENT BYPASSING	ANNUAL DOWNDRIFT EROSION MITIGATION	MAINTAIN OPEN BLIND PASS	CLAM BAYOU IMPACT
A. CLOSE THE INLET									
1	REMOVE NORTH JETTY AND REVETMENT	YES	MAYBE	$473,000	$29,000	YES	YES	NO	CLOSURE POSSIBLE
2	REMOVE JETTY AND FILL THE INLET	YES	MAYBE	$879,000	$47,000	YES	YES	NO	CLOSURE POSSIBLE
B. INLET BYPASSING SYSTEMS									
1 a.	BEACH NOURISHMENT OF N. SANIBEL (3600 FT.)	YES	YES	$4,655,000	$504,000	YES	YES	PROBABLE	CLOSED
1 b.	SAME AS 1a., EXCEPT MAINTAIN ON CAPTIVA'S SCHEDULE	YES	YES	$3,858,000	$402,000	YES	YES	PROBABLE	CLOSED
2	RESTORE N. SANIBEL, STABILIZE WITH GROIN FIELD	YES	YES	$3,985,000	$171,000	NO	SOME	PROBABLE	OPEN W/ OVERWASH CONTINUING
3	REMOVE JETTY EXTENSION, RESTORE N. SANIBEL & PLACE ADVANCED FILL ON S. CAPTIVA	YES	YES	$3,346,000	$405,000	YES	YES	UNSTABLE	CLOSURE POSSIBLE
4	RESTORE 3600 FT OF SANIBEL AND PLACE ADVANCED FILL ON S. CAPTIVA	YES	YES	$3,858,000	$402,000	YES	YES	PROBABLE	CLOSED
5	BUILD S. JETTY, NOURISH 3600 FT. OF SANIBEL	YES	YES	$5,195,000	$453,000	YES	YES	YES	CLOSED
6	PURCHASE HOMES & REROUTE ROAD	YES	YES	$3,493,000	$136,000	NO	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING
7	PURCHASE HOMES & REVET ROAD	YES	YES	$3,715,000	$152,000	NO	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING
8	DREDGE FLOOD SHOAL	YES	NO	$379,500	$20,000	NO	SOME	YES	OPEN W/ OVERWASH CONTINUING
9	NO ACTION	N.A.	N.A.	$0	$0	NO	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING
10	COUNTY BUILDS 800 FT REVETMENT, MAINTAIN 1800 FT. BEACH ON N. SANIBEL, RENOURISH WITH CAPTIVA	YES	YES	$2,669,000	$381,000	NO	YES	PROBABLE	CLOSURE POSSIBLE
11	BEACH NOURISHMENT AND SEGMENTED BREAKWATERS	YES	YES	$5,768,000	$218,000	NO	SOME	PROBABLE	OPEN W/ OVERWASH CONTINUING
C. EXPERIMENTAL SYSTEMS									
1	MOBILE JET PUMP	EXPERIMENTAL	EXPERIMENTAL	$4,036,000	$654,000	YES	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING
2	JET PUMP WITH FLUIDIZER	EXPERIMENTAL	EXPERIMENTAL	$3,078,000	$279,000	YES	NO	YES	OPEN W/ OVERWASH CONTINUING
3	RESTORE 1800 FT OF SANIBEL & DEWATER	EXPERIMENTAL	EXPERIMENTAL	$2,786,000	$134,000	NO	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING

TABLE 25
BLIND PASS (LEE COUNTY) MANAGEMENT PLAN
COMPARISON OF ALTERNATIVES

NUMBER	NAME OF ALTERNATIVE	ENVIRONMENTAL CONCERNS	HURRICANE EVACUATION ROUTE PROTECTED	RECOMMEND (YES/NO)	DISTRIBUTION OF LOCATION OF WORK BETWEEN: CAPTIVA (%)	SANIBEL (%)
A. CLOSE THE INLET						
1	REMOVE NORTH JETTY AND REVETMENT	WATER QUALITY & SEAGRASS DIMINISH IN BLIND PASS	REDUCED PROTECTION ON CAPTIVA	NO	100%	0%
2	REMOVE JETTY AND FILL THE INLET	WATER QUALITY & SEAGRASS DIMINISH IN BLIND PASS	REDUCED PROTECTION ON CAPTIVA	NO	75%	25%
B. INLET BYPASSING SYSTEMS						
1 a.	BEACH NOURISHMENT OF N. SANIBEL (3600 FT.)	INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	NO	0%	100%
1 b.	SAME AS 1a., EXCEPT MAINTAIN ON CAPTIVA'S SCHEDULE	INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%
2	RESTORE N. SANIBEL, STABILIZE WITH GROIN FIELD	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%
3	REMOVE JETTY EXTENSION, RESTORE N. SANIBEL & PLACE ADVANCED FILL ON S. CAPTIVA	WATER QUALITY & SEAGRASS DIMINISH IN CLAM BAYOU	PROTECTION INCREASED ON SANIBEL PROTECTION DECREASED ON CAPTIVA	NO	50%	50%
4	RESTORE 3600 FT OF SANIBEL AND PLACE ADVANCED FILL ON S. CAPTIVA	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	40%	60%
5	BUILD S. JETTY, NOURISH 3600 FT. OF SANIBEL	WATER QUALITY & SEAGRASS DIMINISH IN CLAM BAYOU	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%
6	PURCHASE HOMES & REROUTE ROAD	LOSS OF SANIBEL BEACH & POTENTIAL LOSS OF MANGROVES	PROTECTION INCREASED ON SANIBEL	NO	0%	100%
7	PURCHASE HOMES & REVET ROAD	LOSS OF SANIBEL BEACH & POTENTIAL LOSS OF MANGROVES	SANIBEL ROAD DIRECTLY PROTECTED	NO	0%	100%
8	DREDGE FLOOD SHOAL	LOSS OF EXISTING VEGETATION & POSSIBLE SEAGRASSES	AS EXISTING	NO	0%	100%
9	NO ACTION	LOSS OF SANIBEL BEACH & POTENTIAL LOSS OF MANGROVES	REDUCED PROTECTION ON SANIBEL	NO	0%	0%
10	COUNTY BUILDS 800 FT REVETMENT, MAINTAIN 1800 FT. BEACH ON N. SANIBEL, RENOURISH WITH CAPTIVA	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	SANIBEL ROAD DIRECTLY PROTECTED	MAYBE	0%	100%
11	BEACH NOURISHMENT AND SEGMENTED BREAKWATERS	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%
C. EXPERIMENTAL SYSTEMS						
1	MOBILE JET PUMP	LOSS OF TURTLE HABITAT ON CAPTIVA	REDUCED PROTECTION ON CAPTIVA	NO	90%	10%
2	JET PUMP WITH FLUIDIZER	MINIMAL	AS EXISTING	NO	60%	40%
3	RESTORE 1800 FT OF SANIBEL & DEWATER	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%

V. SAND SOURCES

A number of potential sources of sand should be investigated for the construction of the beach nourishment portion of the inlet management plan. These sources include offshore material as well as inland borrow material and portions of the flood tidal shoal of Blind Pass.

Intensive offshore investigations were performed by the Captiva Erosion Prevention District in 1990 and 1991 to locate offshore sand sources for the Captiva nourishment project. A number of borrow sources were identified which could be used to nourish the beaches of Captiva Island. For the 1996 project, a borrow area has been selected which sits directly offshore from Captiva Island (approximately 5 miles offshore). This area has been identified as the western borrow area or Site III. It contains about 1.9 million cubic yards of sand with a grain size of 0.34 mm and a silt content of 3.5%.

Portions of the historic Blind Pass ebb tidal shoal had been identified in preliminary investigations in the CEPD study. However, vibracores were not taken in that area. This ebb shoal is situated seaward of the northern mile of Sanibel Island. To implement the Blind Pass Inlet Management Plan it would be appropriate to do further investigations of the sand in the historic ebb shoal of Blind Pass.

Approximately 65,000 cubic yards have been identified within the flood shoals inside Blind Pass. There is concern that this material has significant coverage of seagrass and provides feeding areas for aquatic birds. Since the amount of sand in this flood shoal is limited, and because of the potential environmental problems, the flood shoal sand is not identified as a viable sand source for the first nourishment project. It is possible, however, in the future if continued shoaling occurs within the inlet that some limited dredging could be approved to supplement beach nourishment quantities from an alternate source.

Inland sand sources are available which can be used by trucking sand across the causeway. Highly desirable beach nourishment sand is located at Ortona. There a coarse grained borrow pit has been mined which has low silt quantities. Sand from this pit has been used by the Lee County Department of Transportation during periods of high erosion on Captiva Island to protect portions of the road there. The cost of this material, however, is high, from $15 to $20 per yard in place. It may not represent an economically viable borrow source for that reason.

An engineering study of potential borrow sources is needed to implement the Blind Pass Inlet Management Plan. The study should include offshore investigations in the historic ebb tidal shoal of Blind Pass. Secondarily, the search should be extended further offshore to include sections where sand waves may be located. These investigations should focus on zones that are of the same distance offshore as where good quality sand was found off of Captiva Island. The results of these investigations should be compared with using inland borrow sources to accomplish the beach nourishment.

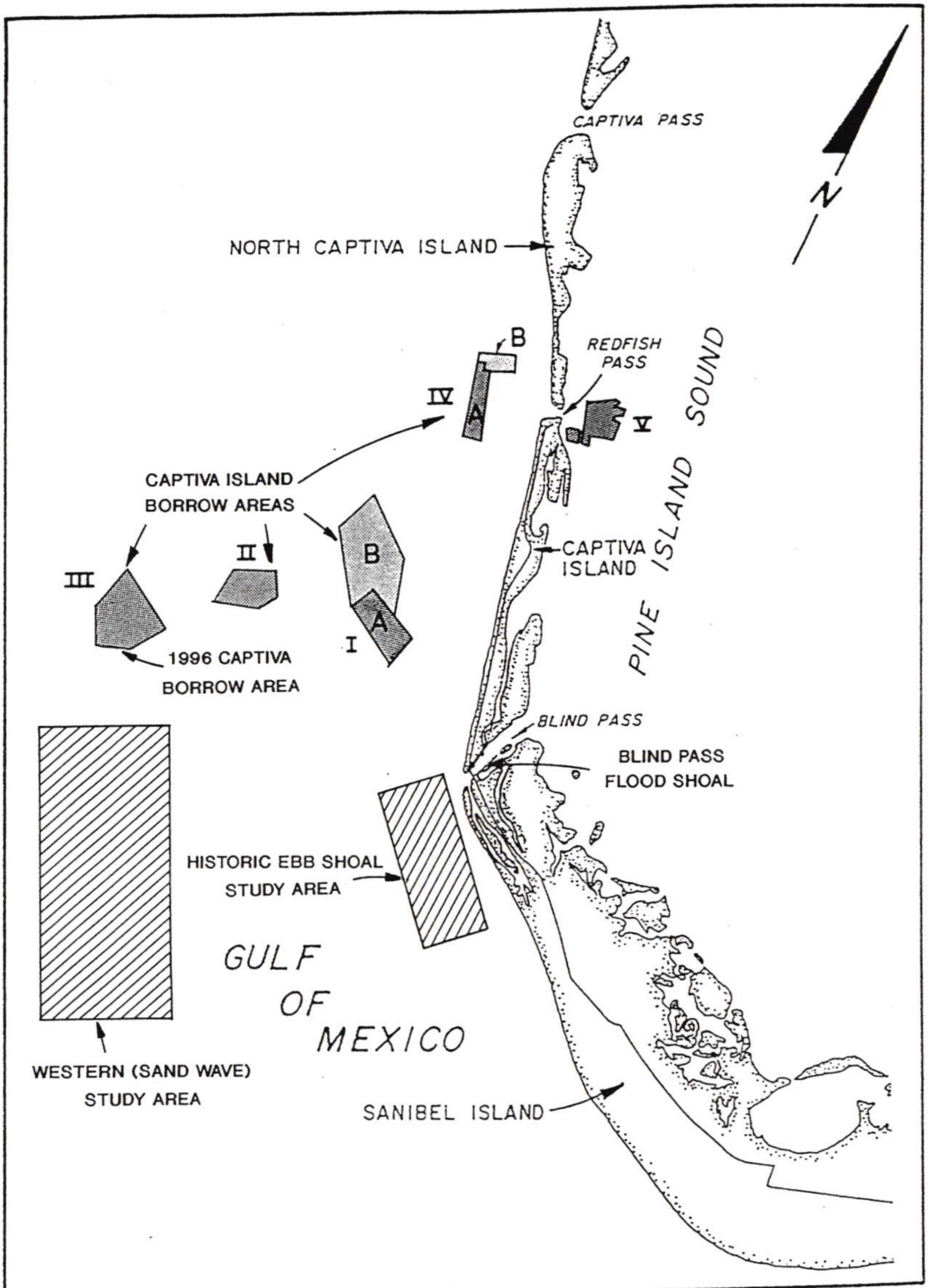


FIGURE 45

BLIND PASS INLET MANAGEMENT PLAN
POTENTIAL BORROW AREAS

COASTAL PLANNING & ENGINEERING, INC. · BOCA RATON · SARASOTA · JACKSONVILLE

VI. ENVIRONMENTAL ANALYSIS

A. Inlet Closure

Closure of the inlet could adversely affect the surrounding environment. Closing the inlet may result in some stagnation of the surrounding estuarine waters. Water quality and dissolved oxygen concentrations of the estuarine waters adjacent to the pass may decrease as a result of inlet closure. Organisms immediately adjacent to Blind Pass which rely on tidal inlet currents to provide food or other nutrients, or to remove pollutants, may perish. Migratory estuarine-oceanic species, such as seatrout and the common snook, would be denied ready access to estuarine nursery grounds or oceanic spawning sites.

B. Bypassing Systems

Many of the proposed sand bypassing alternatives involve the placement of sand from a borrow site onto the beach. If implemented, these alternatives would have similar impacts on the surrounding environment. A majority of these impacts are expected to be minimal, temporary, or can be minimized by using specific procedures. These impacts will be discussed as a group in the following paragraphs. Environmental impacts which are specific to a given alternative are discussed later.

All the proposed sand bypassing alternatives which involve the placement of sand on the beach will have both positive and negative environmental impacts. Depending upon the quantity of the sand used, sand placement would either help maintain, or would greatly increase, the amount of available sea turtle nesting habitat. On the other hand, if sand placement occurs during the sea turtle nesting season, a sea turtle monitoring and nest relocation program would be required by the Florida Department of Natural Resources, the Florida Department of Environmental Regulation and the U.S. Fish and Wildlife Service (Florida Statute 370.12, F.A.C. 16B-41; Endangered Species Act of 1973; and Futch, unpublished).

In addition to the quantity of sand placed on the beach, the quality of sand (silt/clay content and sand grain size), could also affect the surrounding environment. Depending upon the quality of the sand used, sand placement could result in increased turbidity in the nearshore zone. However, if quality (low silt/clay content), compatible sand is used, any increases in turbidity should be temporary.

Placement of sand on the beach will also have a temporary, negative impact on the beach infaunal community. Beach infauna will be buried by sand placement, but is expected to quickly re-populate any affected areas (Nelson, 1985; Saunders, unpublished).

And finally, the placement of sand on the beach, especially that placed south of Blind Pass, could ultimately result in increased, or permanent closure of the tidal entrance to Clam Pass Bayou. Unless mitigated for, the permanent or increased closure of this tidal channel would result in increased stagnation and isolation of both the bayou and Old Blind Pass. As a result, both water quality and dissolved oxygen concentrations may decrease, thereby negatively impacting fish and invertebrate nursery grounds, as well as wading bird populations. Increased closure of the tidal channel would also limit the access of migratory estuarine-oceanic species to their spawning and nursery grounds. Any engineering alternatives which permanently close the tidal entrance to Clam Pass Bayou may require mitigation in order to be permittable.

Those alternatives which involve the dredging of sand from an ebb tidal shoal, flood shoal, or offshore borrow area would also have some negative environmental impacts. These impacts include the loss of benthic infauna at the dredge site (CSA, 1987; Bowen and Marsh, 1988), as well as increased turbidity. Since infauna tend to quickly repopulate disturbed areas (Turbeville and Marsh, 1982; Nelson, 1985; Bowen and Marsh, 1988; Saunders, unpublished), the loss of benthic infauna is expected to be temporary. On the other hand, increased turbidity at the dredge site may negatively affect surrounding seagrass beds or exposed hardbottom communities (CSA, 1987). Therefore, it is recommended that dredge sites in proximity to seagrass beds, or within 400-500 feet of hardbottom, be avoided.

A list of the specific environmental impacts associated with each of the proposed alternatives is provided below.

1. <u>Beach Nourishment of Northern Sanibel</u>

In addition to those impacts associated with offshore dredging and subsequent sand placement, the construction of a 3600 foot beach restoration project could result in the closure of the tidal entrance to Clam Pass Bayou.

2. <u>Restore Northern Sanibel and Stabilize with Groin Field</u>

In addition to the impacts associated with the dredging of a borrow site and the placement of sand on the beach, this alternative would have additional environmental impacts associated with the construction of the groins. Construction of the groins would result in the loss of infauna within the footprint of the groins. However, this loss is not expected to adversely impact the surrounding environment. On the other hand, if groin construction is to occur during sea turtle nesting season, a sea turtle monitoring and nest relocation program would have to be implemented to avoid the burial of, or mechanical damage to, sea turtle nests (Florida Statute 370.12; F.A.C. 16B-41; Endangered Species Act of 1973; and Futch, unpublished).

3. Restore Northern Sanibel, Remove Jetty Extension, Renourish Captiva and Northern Sanibel Together

The removal of the jetty extension and renourishment of Captiva's south beach could result in increased shoaling at the entrance to Blind Pass. Depending on its severity, this shoaling could result in decreased tidal flushing of the estuary, or in an extreme case, closure of the inlet. Any significant decrease in the tidal flushing could result in the same environmental impacts listed in Section A, "Close the Inlet". In addition, the restoration of northern Sanibel could result in the closure of the tidal entrance to Clam Pass Bayou. The environmental impacts associated with the dredging of a borrow site and the placement of sand on the beach are also valid for this alternative.

The removal of the jetty extension would also have some environmental impact. The jetty currently provides habitat and shelter for a variety of fishes and motile invertebrates, as well as an attachment site for sessile invertebrates and algae. The removal of the jetty extension would result in the loss of approximately 100 linear feet of habitat.

4. Restore Northern Sanibel and Overfill South Captiva Island

The construction of a feeder beach on South Captiva Island could result in increased shoaling at the entrance to Blind Pass. If the shoaling does not significantly reduce the tidal flushing of the estuary, it will not adversely affect the surrounding environment. However, if the shoaling does significantly decrease the tidal flushing through the inlet, it could result in the same environmental impacts listed in Section A, "Close the Inlet". In addition, the restoration of northern Sanibel could result in the closure of the tidal entrance to Clam Pass Bayou. The environmental impacts associated with the dredging of a borrow site and sand placement are also valid for this alternative.

5. South Jetty and Beach Nourishment on Northern Sanibel

The addition of a jetty south of Blind Pass could provide additional habitat and shelter for a variety of fishes and motile invertebrates, as well as an attachment site for certain algae and sessile invertebrates. If jetty construction is to occur during the sea turtle nesting season, however, a sea turtle monitoring and nest relocation program would have to be implemented for the construction area in order to avoid mechanical damage to sea turtle nests (Florida Statute 370.12; F.A.C. 16B-41; Endangered Species Act of 1973; and Futch, unpublished). The restoration of northern Sanibel could result in the closure of the tidal entrance to Clam Pass Bayou. The environmental impacts associated with dredge sites and sand placement are valid for this alternative.

6. Purchase Homes and Reroute Road

By itself this alternative will have minimal environmental impact. However, if it is not constructed in conjunction with an erosion control alternative, the continuing erosion will cause the same environmental impacts described in B.9, the "no action" alternative.

7. Purchase Homes and Revet Road

By itself this alternative will have limited environmental impact. Construction of the revetment would result in the loss of the few remaining mangroves adjacent to the road. However, if this alternative is not constructed in conjunction with an erosion control alternative, the continuing erosion will cause the same environmental impacts described in B.9, the "no action" alternative.

8. Dredge Flood Shoal

The flood shoal is located within the Pine Island Sound Aquatic Preserve (Lindblad, personal communication). Since its formation, the flood shoal has become vegetated by a variety of grasses and herbs, including fringe rush (Fimbristylis spathacea), sea blite (Suaeda linearis), sea purslane (Sesuvium portulacastrum), saltwort (Batis maritima), salt grass (Distichlis spicata) and railroad vine (Ipomoea pes-caprae), as well as red, black and white mangroves, and buttonwoods. A variety of shorebirds and wading birds feed and rest on the flood shoal (Lindblad, personal communication). Dredging the shoal would eliminate this viable native plant community and bird habitat. In addition to the loss of the shoal vegetation, turbidity caused by the dredging of the shoal could adversely impact viable seagrass beds located east of the shoal (CSA, 1987). This alternative is not recommended for further consideration.

9. No Action

The "no action" alternative would have some significant environmental impacts. If erosion downdrift of Blind Pass remains unchecked, it will eventually result in the loss of much of the beach ecosystem. As a result, a majority of the available sea turtle nesting habitat would be lost. Continued erosion of the beach could also result in the loss of any remaining native upland vegetation or mangroves located adjacent to the beach. And, although erosion would most likely increase the stability of the inlet leading into Clam Pass Bayou and Old Blind Pass, thereby increasing the tidal flushing of the bayou, the continuous erosion could result in the loss of some of the ecologically important mangrove forest which surrounds the bayou.

10. County Builds Revetment, Maintain Beach on Northern Sanibel, Renourish with Captiva Project

This alternative would have some negative impacts on the surrounding environment. The construction of the revetment would result in the loss of the few remaining mangroves adjacent to the road. Restoration of the beach could result in the closure of the tidal entrance to Clam Pass Bayou. And finally, the impacts associated with dredge and fill activities would also be valid for this alternative.

11. Beach Nourishment and Segmented Offshore Breakwater

The construction of segmented breakwaters would have both positive and negative impacts to the surrounding environment. The construction of emergent breakwaters could provide additional habitat and shelter for a variety of fishes and motile invertebrates, as well as an attachment site for sessile invertebrates and algae. Construction of the breakwaters would result in the loss of infauna within the footprint of the breakwaters. Nevertheless, this loss is not expected to significantly affect the surrounding environment. If breakwater construction is scheduled to occur during the sea turtle nesting season, a sea turtle monitoring and nest relocation program would have to be implemented for the construction area so as to avoid mechanical damage to sea turtle nests (Florida Statute 370.12; F.A.C. 16B-41; Endangered Species Act of 1973; Futch, unpublished). The environmental impacts associated with dredge sites and sand placement are also valid for this alternative.

C. Experimental Systems

1. Mobile Jet Pump

The environmental impacts caused by the jet pump system are expected to be temporary, or may be minimized using specific procedures. A majority of these environmental impacts will occur in the 500 feet of beach and nearshore north of Blind Pass, and in the vicinity of the sand placement. The environmental impacts associated with sand placement have been discussed previously.

Beach and surfzone organisms in proximity to the crane and pipelines are expected to be negatively impacted by this alternative. Sea turtle nesting along the 500 feet of beach north of the inlet would also be affected by this alternative. The implementation of a sea turtle monitoring and nest relocation program for the 500 feet of beach north of the inlet would be required to prevent mechanical damage to nests during the sea turtle nesting season (Florida Statute 370.12; F.A.C. 16B-41; Endangered Species Act of 1973; Futch, unpublished).

Construction of the deposition basin and operation of the jet pump is expected to cause some localized turbidity. While the amount of turbidity will depend upon the silt/clay content and the sand grain size of the material dredged, normal gulf tides and currents are expected to quickly dissipate any resulting turbidity. This temporary increase in turbidity is not expected to adversely affect the surrounding sand bottom.

2. Jet Pumps in Ebb Shoal with Fluidizer

The environmental impacts caused by this alternative are expected to be minimal. Although this alternative will increase the turbidity and sedimentation over the ebb shoal, the impact to the surrounding sand habitat is expected to be minimal. This alternative is not expected to adversely affect seagrasses within the sound. The environmental impacts associated with the dredging of the shoal and sand placement have been discussed previously.

3. Restore Northern Sanibel and Maintain with Dewatering System

The environmental impacts associated with dredge sites and sand placement are valid for this alternative.

To date, only one dewatering system has been installed in Florida, the system at Sailfish Point in Martin County. There are no known studies which document the impact of the Sailfish Point system on the surrounding environment. Nevertheless, some concern has been expressed regarding the installation of a dewatering system at Sanibel Island. Since dewatering systems are designed to lower the water table, their implementation may result in changes in the moisture content of the surrounding substratum. State environmental agencies have expressed concern that the potential change in moisture content may reduce the hatching success of adjacent sea turtle nests. In addition, the effect of the dewatering system on beach infauna has also been identified as an area of concern.

VII. COMPREHENSIVE INLET MANAGEMENT PLAN

The recommended plan for Blind Pass inlet management is a comprehensive plan addressing storm protection, erosion control, mitigation, sand bypassing and (to a lesser extent) navigation. The plan is a composite of alternatives designed to meet physical requirements and local desires. The recommended plan (Figure 46) consists of placement of 300,000 cubic yards of sand on northern Sanibel to restore the shoreline, with periodic nourishment to replace expected losses. A feeder beach is to be placed on southern Captiva to increase sand bypassing. Additionally, overwash areas in Clam Pass Bayou and Old Blind Pass are to be mechanically pushed westward, into a dune with the placed fill. An 800 foot revetment is to be constructed along the road area most vulnerable to storm damage on northern Sanibel. Finally, five private parcels south of the pass will be purchased to create public beach.

A more detailed explanation of the individual components of the plan follows:

A. Storm Protection Element

A revetment will be constructed along 800 feet of Sanibel-Captiva Road in 1993 to provide protection of the evacuation route. Part of the storm protection element will be to leave in place the groin built by Lee County and extended by CEPD. This action will maintain a protective beach in front of the Sanibel-Captiva Road just north of the Blind Pass bridge.

B. Mitigation for Past Inlet Improvement Effects

A total quantity of 300,000 cubic yards of sand will be placed on northern Sanibel to mitigate for effects that have been caused by the groin constructed by Lee County in 1972. This amounts to 15,000 cubic yards per year over a 20-year period. The construction will be accomplished in two phases. The first phase is to be implemented with the revetment construction in 1993; a total of 200,000 cubic yards will be placed at that time. The second phase will be constructed in 1996 as part of the Captiva Island beach renourishment program. Approximately 100,000 cubic yards of additional fill will be placed along with that project.

C. Sand Bypassing Element

To increase sand bypassing from Captiva to Sanibel Island, a feeder beach will be placed near the southern end of Captiva Island which will increase sand bypassing around the groin. This feeder beach is intended to mitigate future potential impacts of the groin and inlet system to the beaches to the south. The feeder beach would be placed every six years as part of maintenance. The feeder beach would consist of 15,000 cubic yards per year, or 45,000 cubic yards in 1992 and 90,000 cubic yards every six years thereafter.

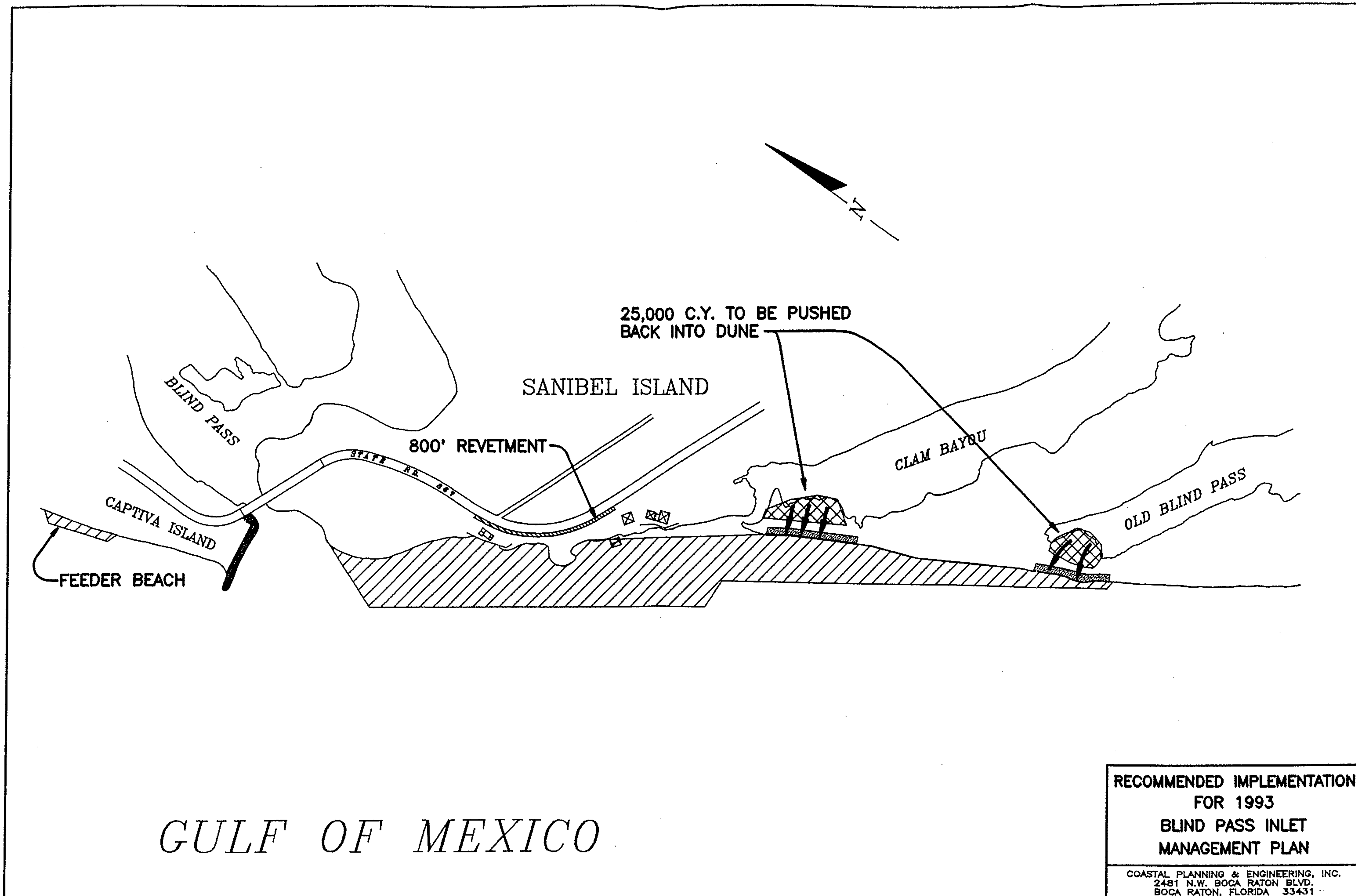

N
25,000 C.Y. TO BE PUSHED
BACK INTO DUNE
SANIBEL ISLAND
BLIND PASS
800' REVETMENT
CLAM BAYOU
OLD BLIND PASS
CAPTIVA ISLAND
FEEDER BEACH
GULF OF MEXICO
RECOMMENDED IMPLEMENTATION
FOR 1993
BLIND PASS INLET
MANAGEMENT PLAN
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 46

D. Erosion Control Element

The erosion control element consists of two components. The first component is intended to control the high retreat rates in the vicinity of Clam Pass Bayou and Old Blind Pass. Sand that has washed into the bayou will be pushed up into a berm and integrated with the beach nourishment program so that frequent overwash can be avoided. This element also ties in with the environmental element in that it allows the beach to be intermittently breached at this location. This provides for flushing of Clam Pass Bayou and Old Blind Pass as has been historically the case. Should a major storm overwash these islands and again lower the elevation, immediate emergency action would be undertaken to rebuild these spits to protect against frequent winter storm events. It is estimated that 25,000 cubic yards of sand is available for this purpose.

The second part of the erosion control element is the long term maintenance of the beaches adjacent to the pass. This includes both Captiva and Sanibel Islands. Captiva Island already has planned to renourish its beach on approximate 6-year intervals. Under the inlet management program, northern Sanibel beaches will be renourished on the same interval. Fill will be required in addition to the mitigation fill placed in 1993 and 1996 to address historical erosion rates for northern Sanibel. These rates have been estimated to be approximately 20,000 cubic yards per year. This amount is based on an historical erosion rate of 35,000 c.y./yr. less 15,000 c.y./yr. extra bypassing as a result of the feeder beach. Based on these projections, northern Sanibel's beaches will need approximately 60,000 cubic yards in 1993, and 120,000 cubic yards as part of the renourishment program in the year 1996 and every 6 years thereafter.

E. Navigation and Flushing Element

Part of the navigation and flushing element is to leave the north jetty in place which has apparently increased the stability and flushing capability of the pass. It is recognized that the feeder beach proposed under the sand transfer element will increase the sediment loads moving past the inlet. However, it has been determined that intermittent closure of the pass is acceptable to the adjacent communities as it replicates the historical, natural functioning of the pass. It is believed that the pass will remain as stable (or more stable) than it has been in the past with the above described actions undertaken.

Future consideration should be given to the potential construction of a south jetty on the pass to help direct tidal currents moving through the pass and to assist in stabilizing the sand transfer system along the ebb tidal shoal.

Consideration should also be given to dredging of active shoaling areas within the pass to improve the hydraulic stability of the pass as well as to recapture sand that is lost from the beach system. Dredge planning should be sensitive to seagrass communities and bird feeding areas that have developed within the pass as a result of historic and active shoaling.

The interior of the pass should be monitored annually subsequent to beach fill south of the inlet. It is possible that placement of fill immediately south of the inlet without a south jetty in place may increase shoaling within the pass. The monitoring would enable future evaluations for the need for a south jetty and/or interior dredging of Blind Pass.

F. Environmental Elements

The first environmental element for this program includes the movement of sand out of Clam Pass Bayou and Old Blind Pass to rebuild the beachface berm and dune system. This will enable Old Blind Pass and Clam Pass Bayou to interact with the Gulf in a manner in which they have historically, with intermittent flushing of the estuary systems.

The second environmental element of the program is to leave the jetty and jetty extension built by Lee County and the CEPD in place. This has shown to improve flushing of the pass and provides for water quality improvement within the pass.

The third component of the environmental plan is to forego consideration of dredging interior shoals within Blind Pass at this time. Portions of the flood shoal of Blind Pass are covered with seagrass and serve as nursery grounds for fish. In the surrounding tidal flats, terns, egrets, and herons forage upon small crustaceans, gastropods, worms and fish.

G. Public Access/Use Element

To address the public need for beach access, five private parcels located south of Blind Pass will be purchased, and the homes and structures will be removed. A parking lot will be constructed and dune vegetation will be planted on the vacant property. This will cause part of future expenditures for erosion control to be used for maintenance of public beach. The public beach will also provide storm protection for the evacuation route.

H. Cost Estimates

Table 26 shows the projected costs of the inlet management plan over a 50-year project life at an interest rate of 3%. The initial cost in 1993, which includes 800 feet of revetment, 200,000 cubic yards of fill on northern Sanibel, a 45,000 cubic yard feeder beach on Captiva, 60,000 cubic yards of advanced fill on northern Sanibel, and redistribution of 25,000 cubic yards of overwash volumes into the dune is $5,200,000.

In 1996, the remaining 100,000 cubic yards of fill and 210,000 cubic yards for advanced fill and the feeder beach will be placed at the same time as renourishment on Captiva at a cost of approximately $2,400,000. Maintenance would continue on the Captiva renourishment schedule every six years at a cost of approximately $1,600,000. Purchase of parcels will cost an estimated $900,000. The annual cost of implementing the plan, over a 50-year project life is $478,000.

TABLE 26

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
FINAL MANAGEMENT PLAN COST ESTIMATE

CONTINGENCY	15%
E&D&S&A	10%
REVETMENT	$800,000
LAND PURCHASE	$900,000

MOBILIZATION (1993 ONLY)	$500,000
UNIT COST	$6.00
FILL VOLUME (1993)	200,000
FILL VOLUME (1996)	100,000
ADV. NOUR. - CAPTIVA/YR.	15,000
ADV. NOUR. - SANIBEL/YR.	20,000
OVERWASH VOLUME @$2.50	25,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	
1993	$5,161,200	0.97087	$5,010,874	305,000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$2,352,900	0.88849	$2,090,521	310,000
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$1,593,900	0.74409	$1,186,011	210,000
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$1,593,900	0.62317	$993,266	210,000
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$1,593,900	0.52189	$831,844	210,000
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$1,593,900	0.43708	$696,657	210,000
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$0	0.39999	$0	
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$1,593,900	0.36604	$583,439	210,000
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$1,593,900	0.30656	$488,621	210,000
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$1,593,900	0.25674	$409,212	210,000
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	
SUM OF PRESENT WORTHS			$12,290,445	
CAPITAL RECOVERY FACTOR			0.03887	
AVERAGE ANNUAL VALUE			$477,674	

VIII. FUNDING/GOVERNMENTAL ANALYSIS

Governmental Analysis

The purpose of this section is to establish sponsorship and funding of the inlet management plan. The implementation of the inlet management plan will be undertaken by a local sponsor(s) with funding assistance from the State of Florida. Since no one government agency has total responsibility for Blind Pass it may be appropriate to share the duties of the local sponsor between the following local governments:

A. Lee County
B. The City of Sanibel
C. Captiva Erosion Prevention District (CEPD)
D. West Coast Inland Navigation District (WCIND)

While each government may participate financially in the plan, it would be appropriate for one government to take the lead in the administration of the program. Each government agency has a vested interest in seeing inlet improvements as follows:

A. Lee County - The County constructed the 1972 jetty at Blind Pass; maintains a public beach north of the Pass (Turner Beach), is responsible for coastal management countywide and is interested in maintaining the passes and bays. The County maintains the bridge and roads of Captiva Island and has planned a revetment to protect the roadway in Northern Sanibel Island. The County should provide the local funding for the mitigation, sand bypassing, navigation and flushing, environmental and public use element. They should share costs with Sanibel on the erosion control element.

B. The City of Sanibel - Northern Sanibel suffers from high erosion and is vulnerable to storm damage putting Sanibel residents at risk. The Sanibel/Captiva Road that Sanibel maintains is threatened by natural background erosion of the beach of 20,000 c.y./yr. The City should help facilitate the public access and use element by coordinating the land purchase. The City should also be joint sponsor of the erosion control element with the County.

C. CEPD - The CEPD is responsible for erosion control on Captiva Island. In 1988-89 an erosion control project was constructed which restored the beach and extended a terminal groin. The groin extension and beach erosion control project permits require mitigation for impacts caused by the extension. The beaches in northern (6300') Sanibel have been retreating faster since the completion of the Captiva erosion control project. Since the groin may be partially responsible for this retreat, a mitigation amount of 32,000 cubic yards has been identified. This amount is approximately 10% of the total mitigation fill. The CEPD should initiate its role of joint sponsorship in planning the implementation of the inlet management plan, and by incorporating the 1996 Inlet Management Plan in their construction plans for their renourishment project. If monitoring of the constructed plan shows that the groin extension is not causing erosion, then their responsibility under the mitigation element should be re-evaluated.

D. WCIND - The WCIND is responsible for navigation and boating in Lee, Charlotte, Sarasota and Manatee Counties. The WCIND collects taxes in the four county area for use by navigation and marine-related public projects. The WCIND should participate in the navigation and flushing element and future inlet construction.

Table 27 shows a schedule of costs, broken down by element for the inlet management plan implementation. Table 28 shows the percentage of funding to be provided by the various governments that will share in the costs of the program. DNR representatives have indicated that a funding share of 75% for the State would be acceptable. The local government shares are based on the benefits and responsibilities of the governments as described previously. Tables 29-31 present the levels of funding to be provided by each government for each phase of implementation of the inlet management plan.

TABLE 27

SUMMARY OF COSTS FOR THE INLET MANAGEMENT PLAN

	1993	1996	2002
A. STORM PROTECTION ELEMENT	1,000,000		
B. MITIGATION ELEMENT	2,200,000	800,000	
C. SAND BY PASSING ELEMENT	300,000	700,000	700,000
D. EROSION ELEMENT	500,000	900,000	900,000
E. NAVIGATION ELEMENT			
F. ENVIRONMENTAL ELEMENT	100,000		
G. PUBLIC ACCESS & USE	1,100,000		
TOTAL COST	$5,200,000	$2,400,000	$1,600,000

TABLE 28
FUNDING LEVELS FOR SPONSORS

	STATE	COUNTY	SANIBEL	CAPTIVA	WCIND
A. STORM PROTECTION ELEMENT	75.0%	25.0%			
B. MITIGATION ELEMENT	75.0%	22.5%		2.5%	
C. SAND BY PASSING ELEMENT	75.0%	25.0%			
D. EROSION ELEMENT	75.0%	12.5%	12.5%		
E. NAVIGATION ELEMENT	75.0%				25.0%
F. ENVIRONMENTAL ELEMENT	75.0%	12.5%	12.5%		
G. PUBLIC ACCESS & USE	75.0%	22.5%	2.5%		

TABLE 29
COST SHARING FOR 1993 PROJECT

	STATE	COUNTY	SANIBEL	CAPTIVA	WCIND
A. STORM PROTECTION ELEMENT	750,000	250,000	0	0	0
B. MITIGATION ELEMENT	1,650,000	495,000	0	55,000	0
C. SAND BY PASSING ELEMENT	225,000	75,000	0	0	0
D. EROSION ELEMENT	375,000	62,500	62,500	0	0
E. NAVIGATION ELEMENT	0	0	0	0	0
F. ENVIRONMENTAL ELEMENT	75,000	12,500	12,500	0	0
G. PUBLIC ACCESS & USE	825,000	247,500	27,500	0	0
	3,900,000	1,142,500	102,500	55,000	0

TABLE 30

COST SHARING FOR 1996 PROJECT

	STATE	COUNTY	SANIBEL	CAPTIVA	WCIND
A. STORM PROTECTION ELEMENT	0	0	0	0	0
B. MITIGATION ELEMENT	600,000	180,000	0	0	0
C. SAND BY PASSING ELEMENT	525,000	175,000	0	0	0
D. EROSION ELEMENT	675,000	112,500	112,500	0	0
E. NAVIGATION ELEMENT	0	0	0	0	0
F. ENVIRONMENTAL ELEMENT	0	0	0	0	0
G. PUBLIC ACCESS & USE	0	0	0	0	0
	1,800,000	467,500	112,500	0	0

TABLE 31

COST SHARING FOR 2002 PROJECT

	STATE	COUNTY	SANIBEL	CAPTIVA	WCIND
A. STORM PROTECTION ELEMENT	0	0	0	0	0
B. MITIGATION ELEMENT	0	0	0	0	0
C. SAND BY PASSING ELEMENT	525,000	175,000	0	0	0
D. EROSION ELEMENT	675,000	112,500	112,500	0	0
E. NAVIGATION ELEMENT	0	0	0	0	0
F. ENVIRONMENTAL ELEMENT	0	0	0	0	0
G. PUBLIC ACCESS & USE	0	0	0	0	0
	1,200,000	287,500	112,500	0	0

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Aerial Photographs Reviewed for Blind Pass Analysis

1. Captiva Island & Northern Sanibel Island (9 vertical views)
   April 9, 1991, Kucera South, Inc.

2. Captiva Island, Redfish Pass to Blind Pass (6 vertical views)
   December 13, 1990, Kucera South, Inc.

3. Blind Pass, Lee County, FL (vertical)
   February 14, 1970. University of Florida Archives.

4. Blind Pass, Lee County, FL (vertical)
   November 1, 1978. University of Florida Archives.

5. Redfish Pass, Lee County, FL (vertical)
   February 17, 1944. University of Florida Archives.

6. Redfish Pass, Lee County, FL (vertical)
   May 5, 1952. University of Florida Archives.

7. Redfish Pass, Lee County, FL (vertical)
   October 21, 1958. University of Florida Archives.

8. Redfish Pass, Lee County, FL (vertical)
   November 22, 1960. University of Florida Archives.

9. Redfish Pass, Lee County, FL (vertical)
   May 31, 1969. University of Florida Archives.

10. Redfish Pass, Lee County, FL (vertical)
    February 14, 1970. University of Florida Archives.

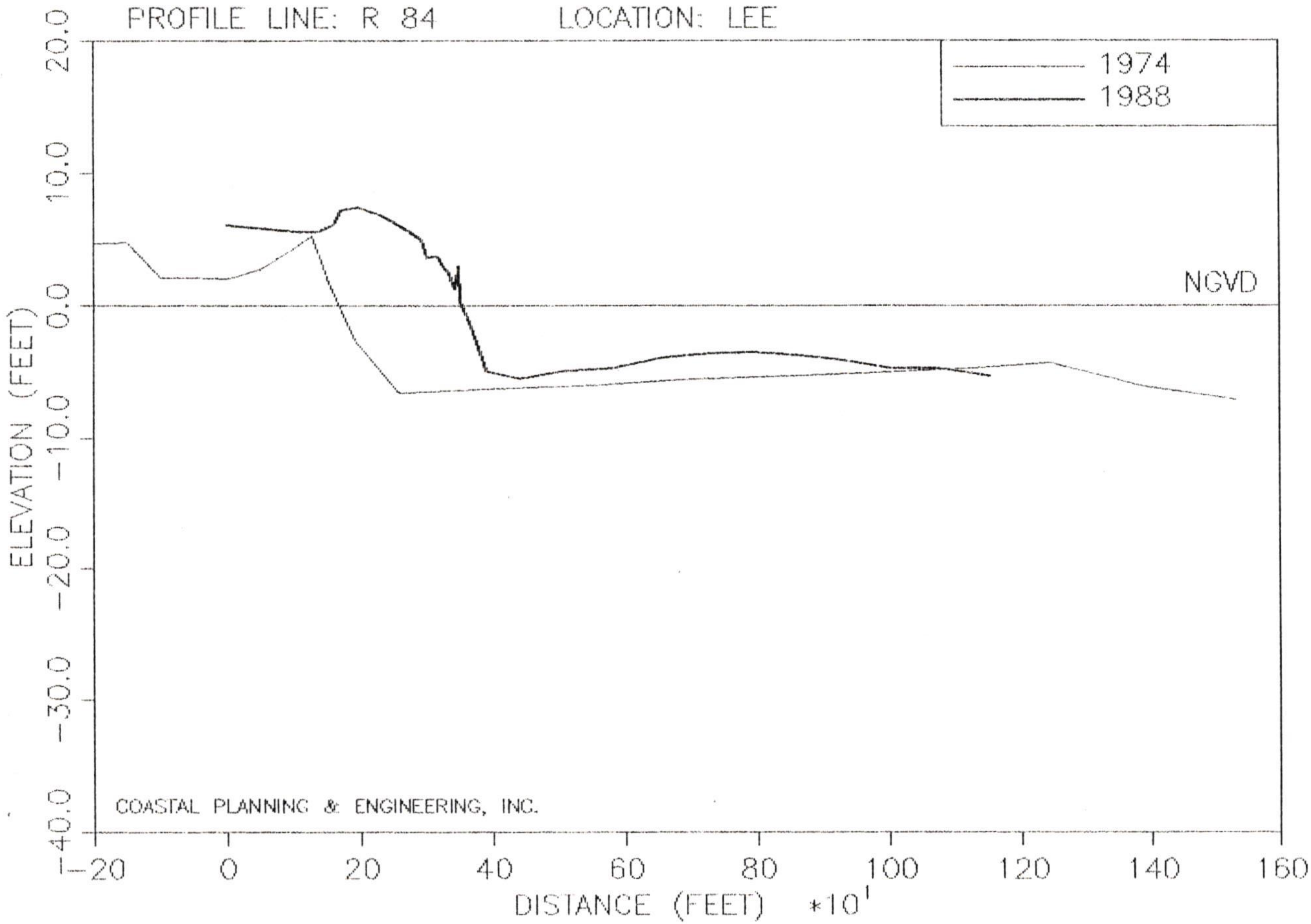
11. Redfish Pass - Captiva Pass, Lee County, FL (vertical)
    September 27, 1976. University of Florida Archives.

APPENDIX A

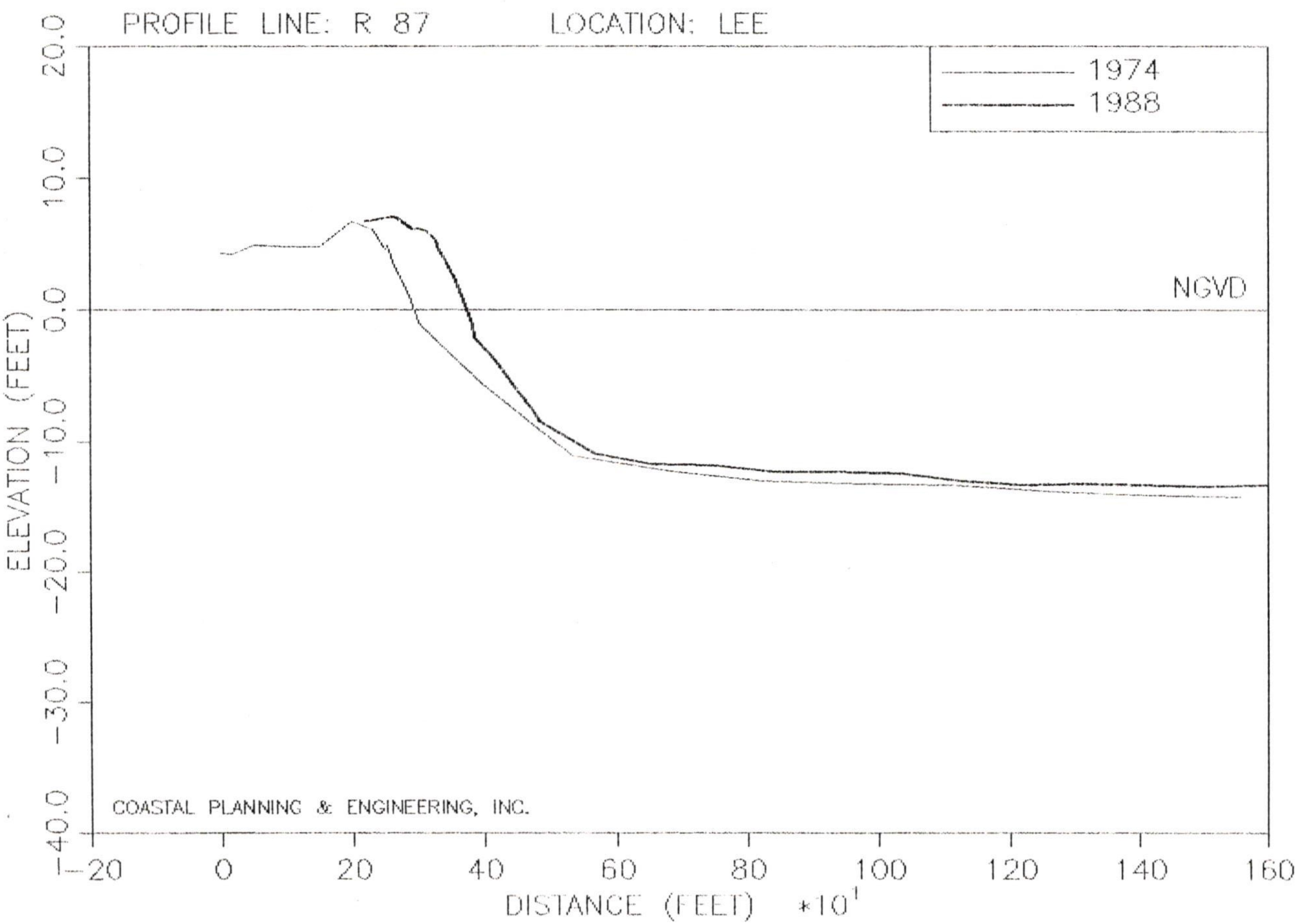
COMPARATIVE BEACH PROFILE PLOTS

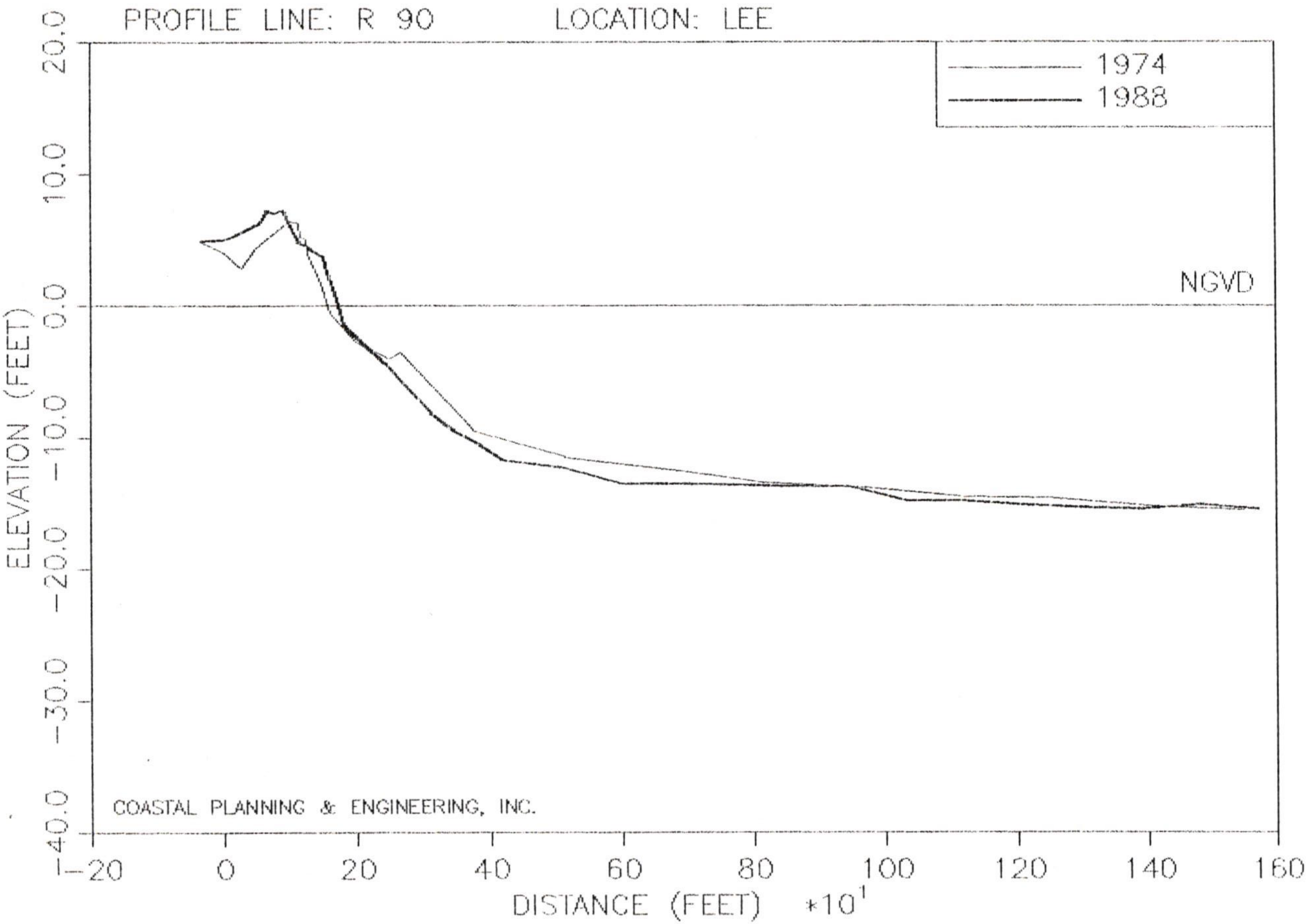
Comparative Beach Profile Plots

1974 vs. 1988

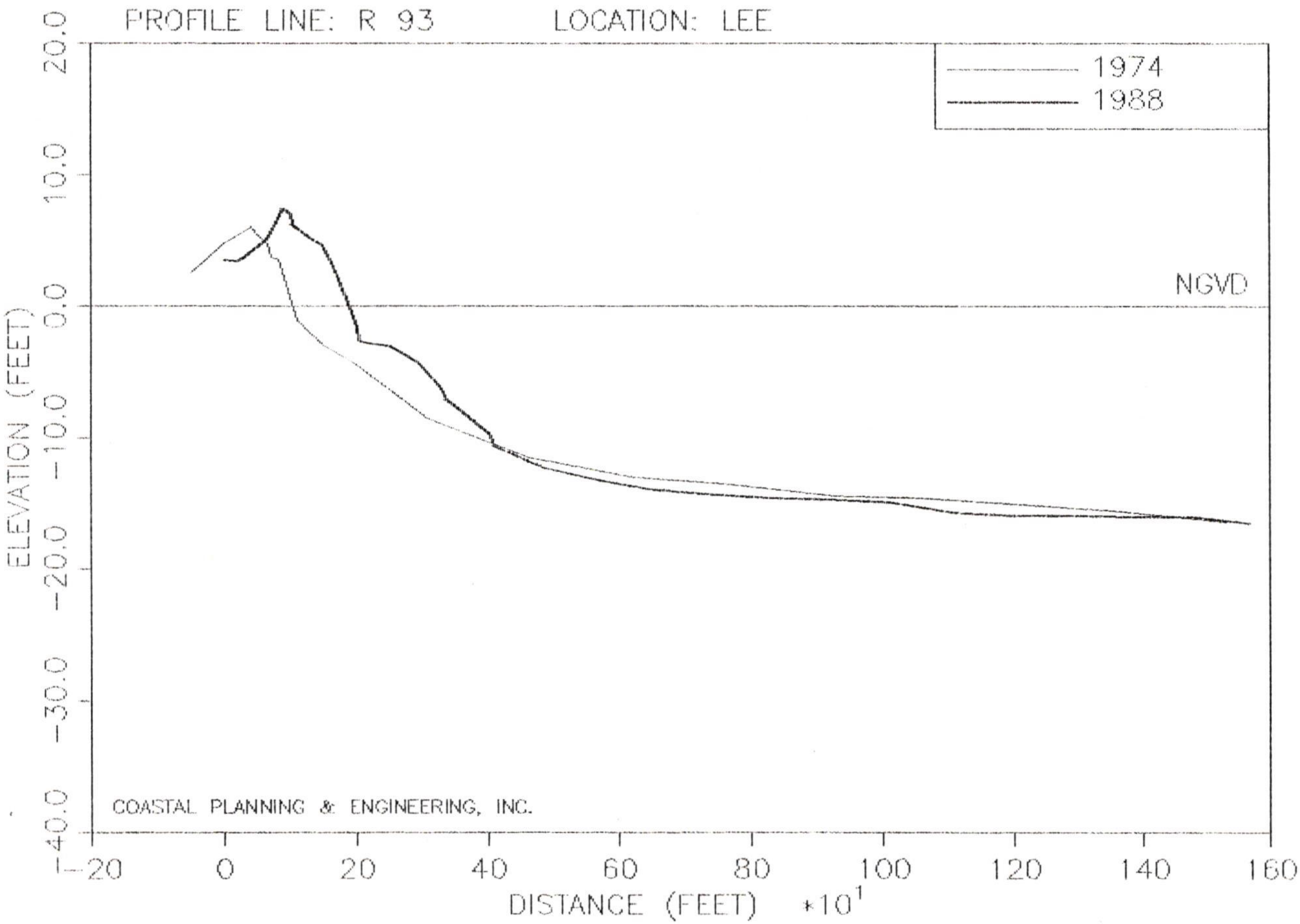


PROFILE LINE: R 84
LOCATION: LEE
1974
1988
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

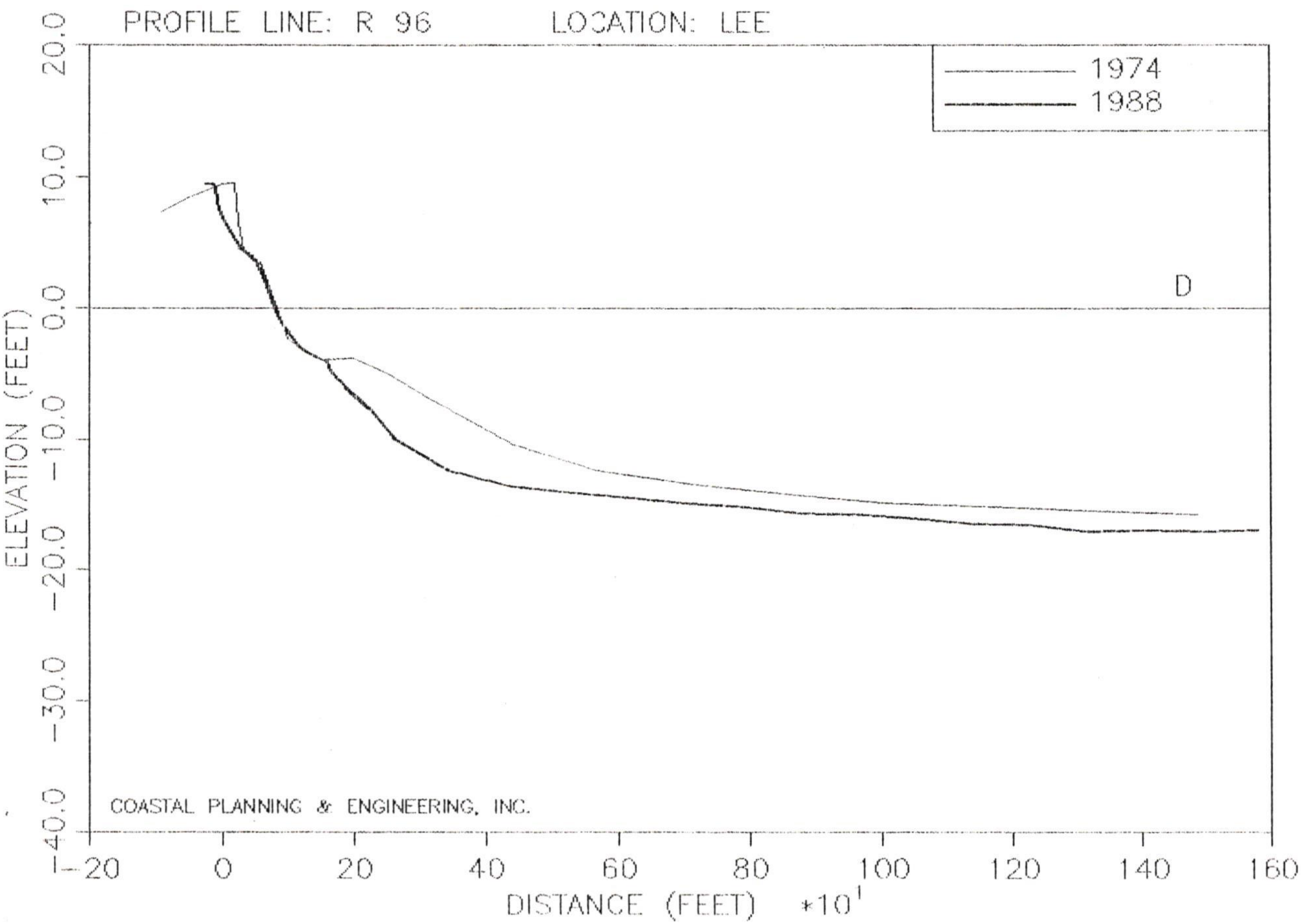

PROFILE LINE: R 87
LOCATION: LEE
1974
1988
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10¹



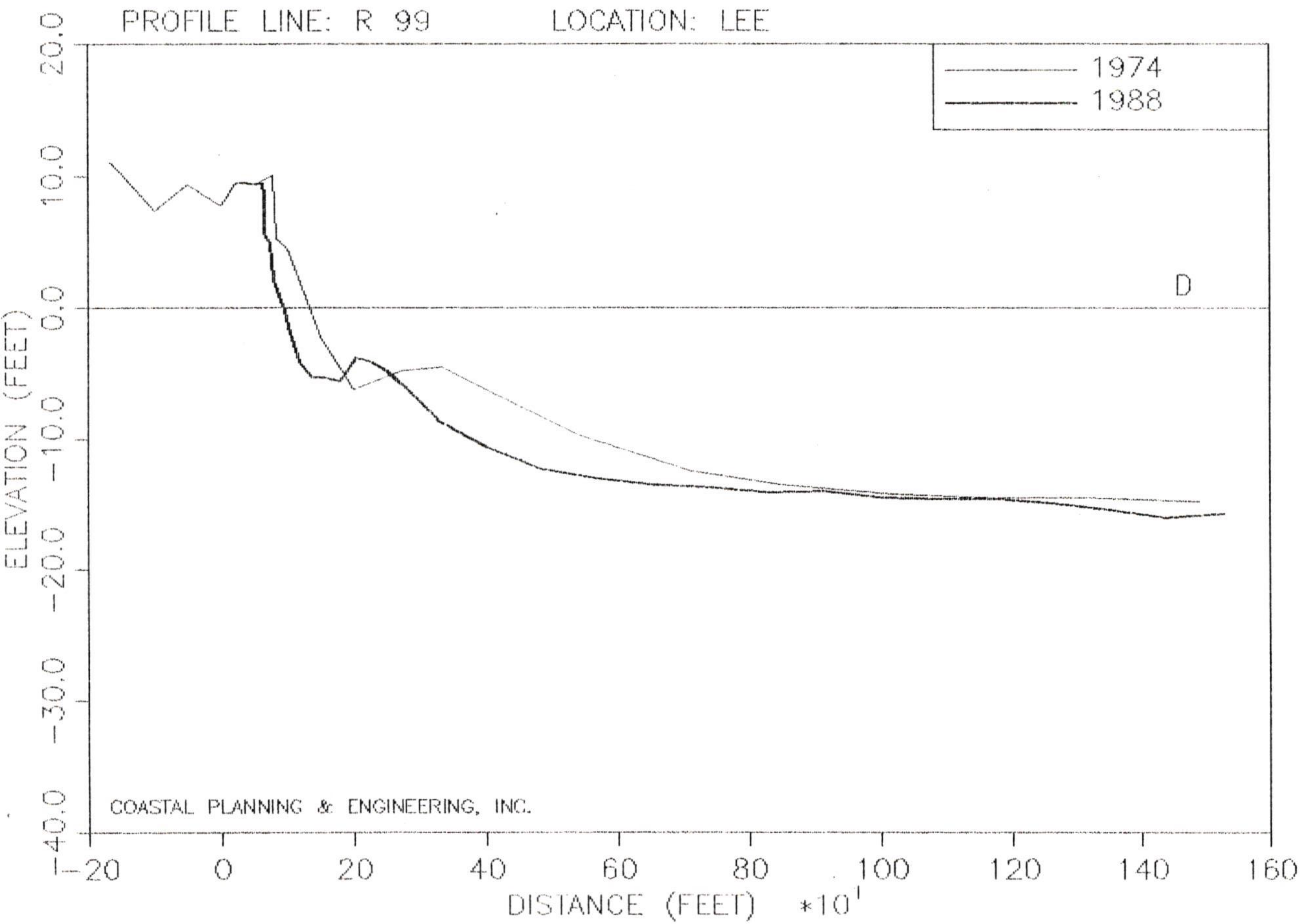
PROFILE LINE: R 90
LOCATION: LEE
1974
1988
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



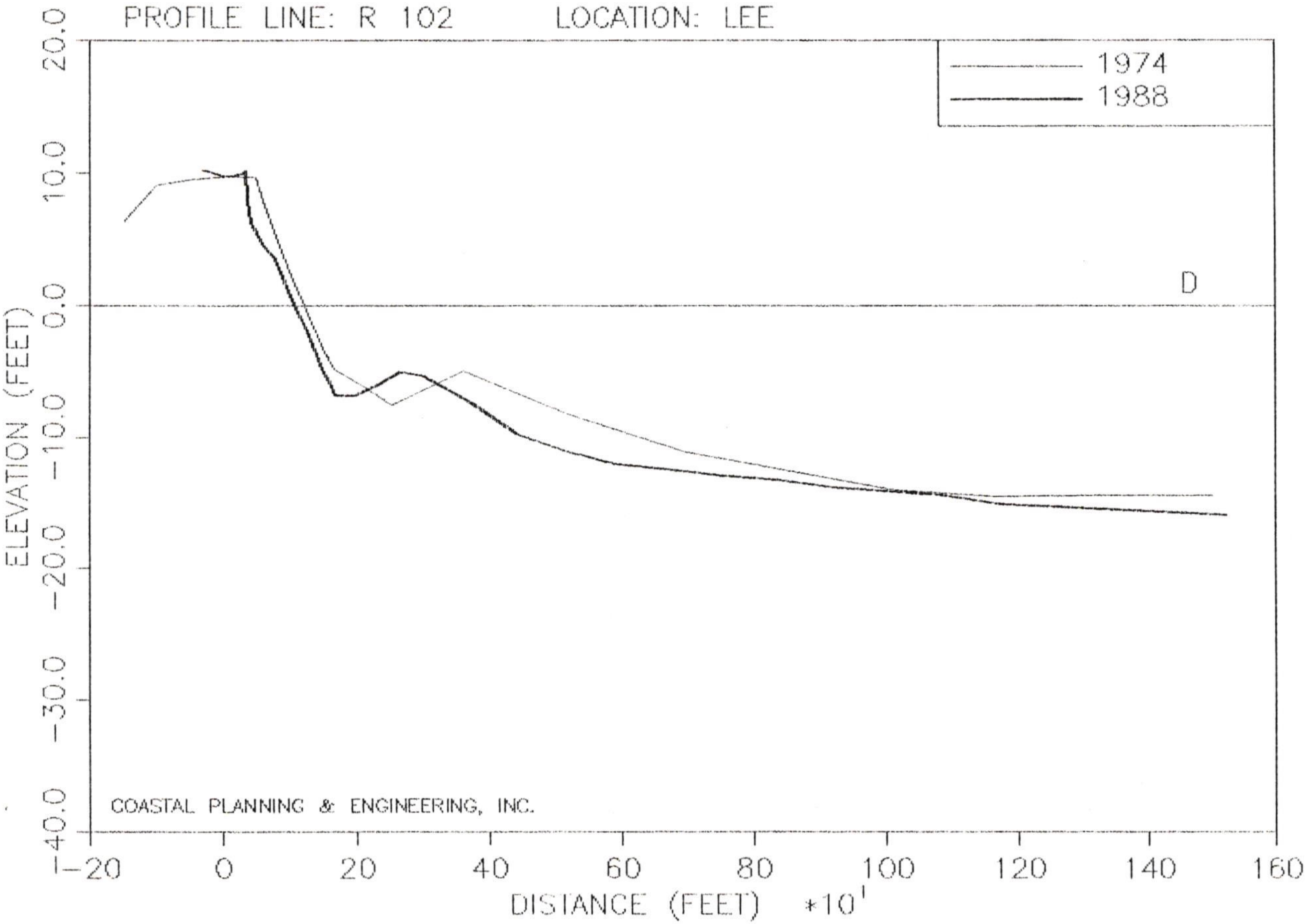
PROFILE LINE: R 93
LOCATION: LEE
1974
1988
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



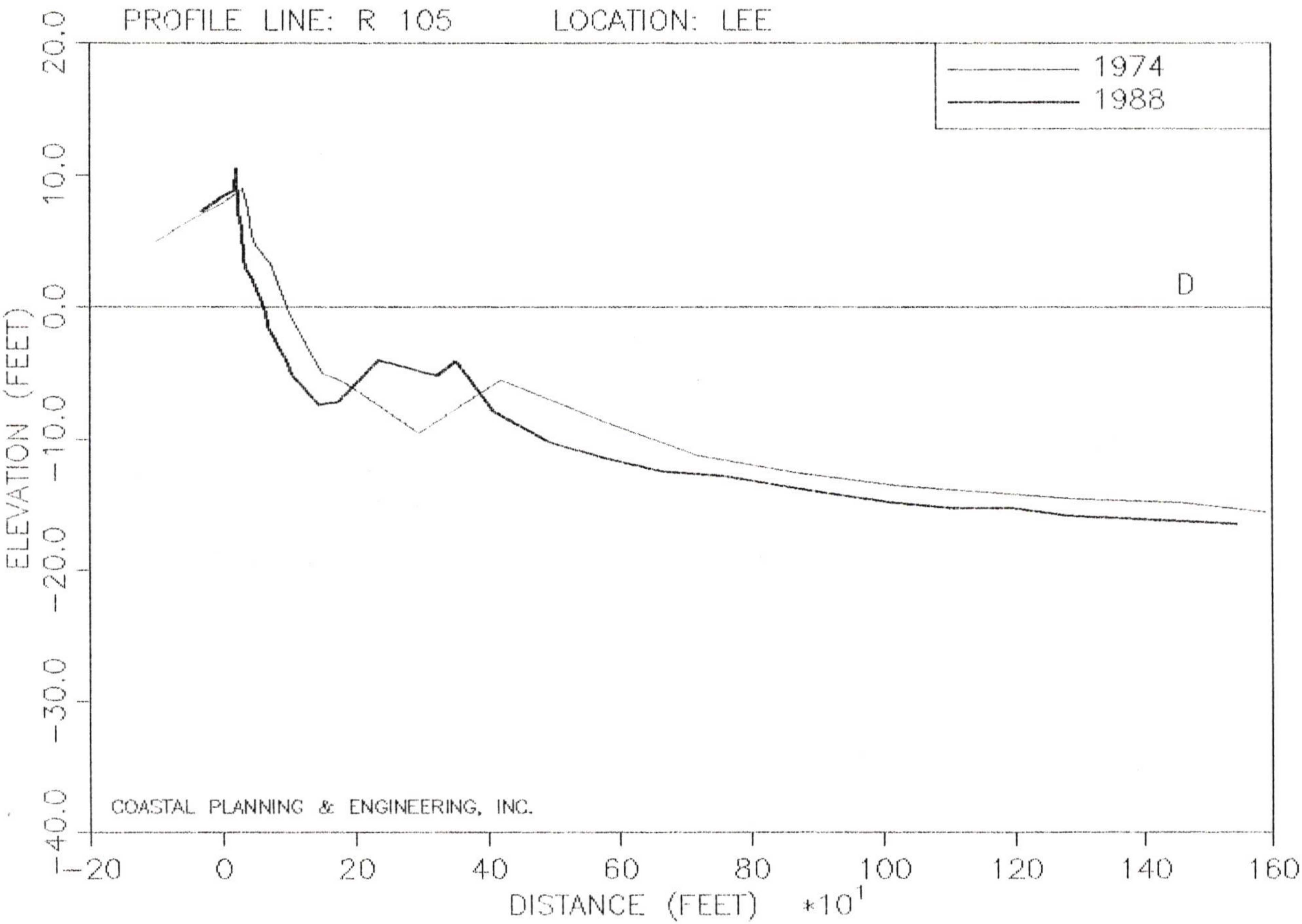
PROFILE LINE: R 96
LOCATION: LEE
1974
1988
D
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



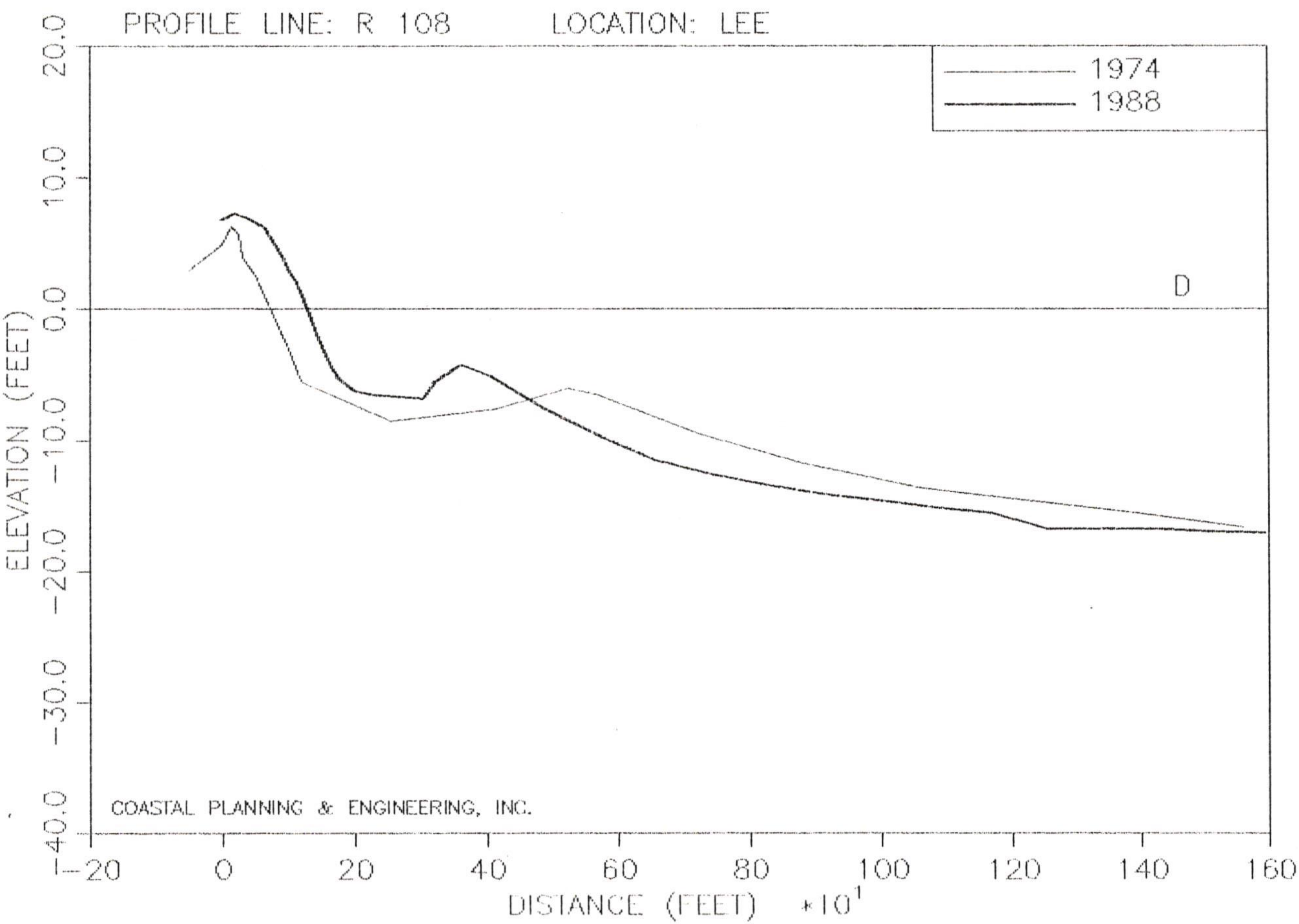
PROFILE LINE: R 99
LOCATION: LEE
1974
1988
D
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



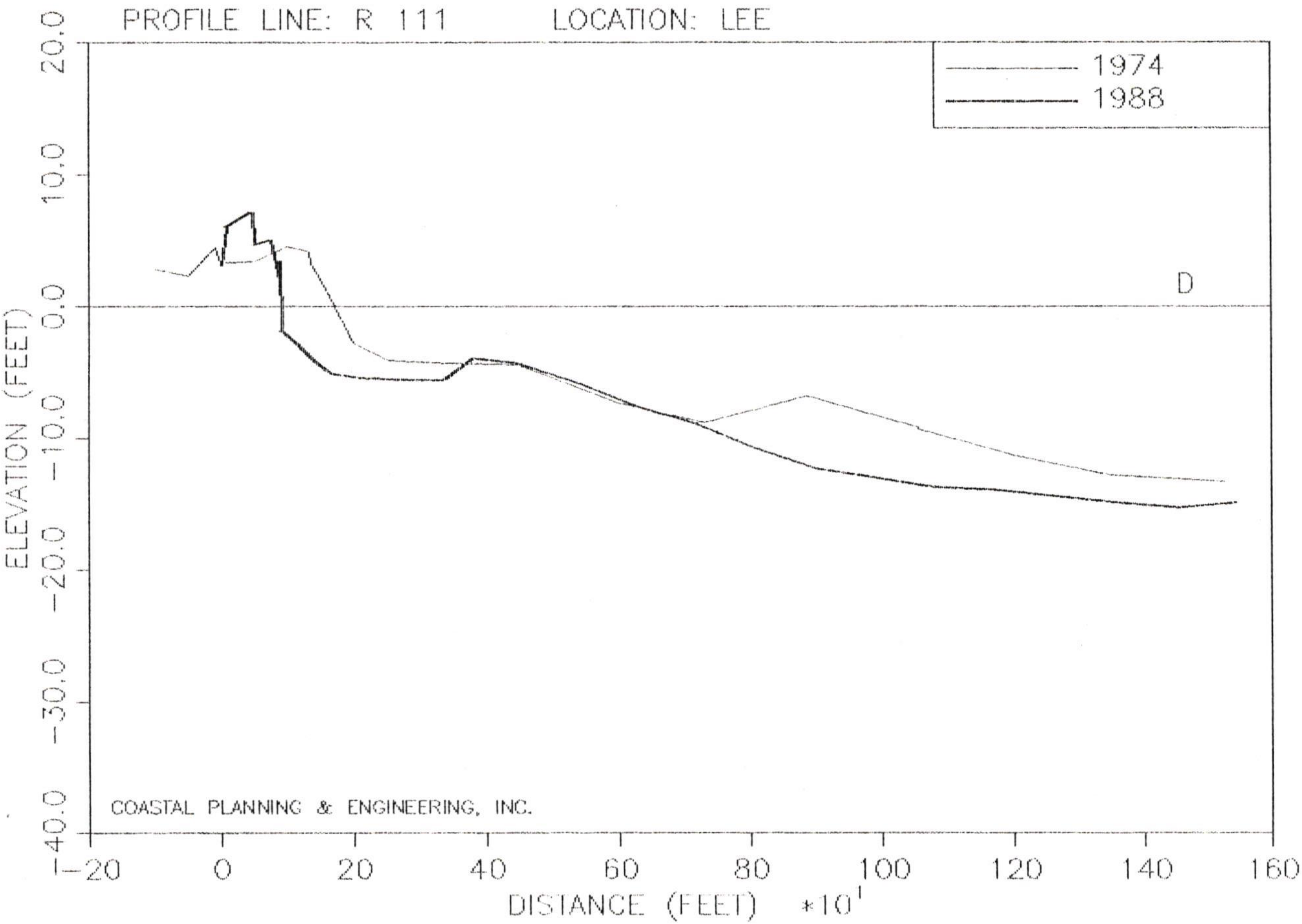
PROFILE LINE: R 102
LOCATION: LEE
1974
1988
D
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



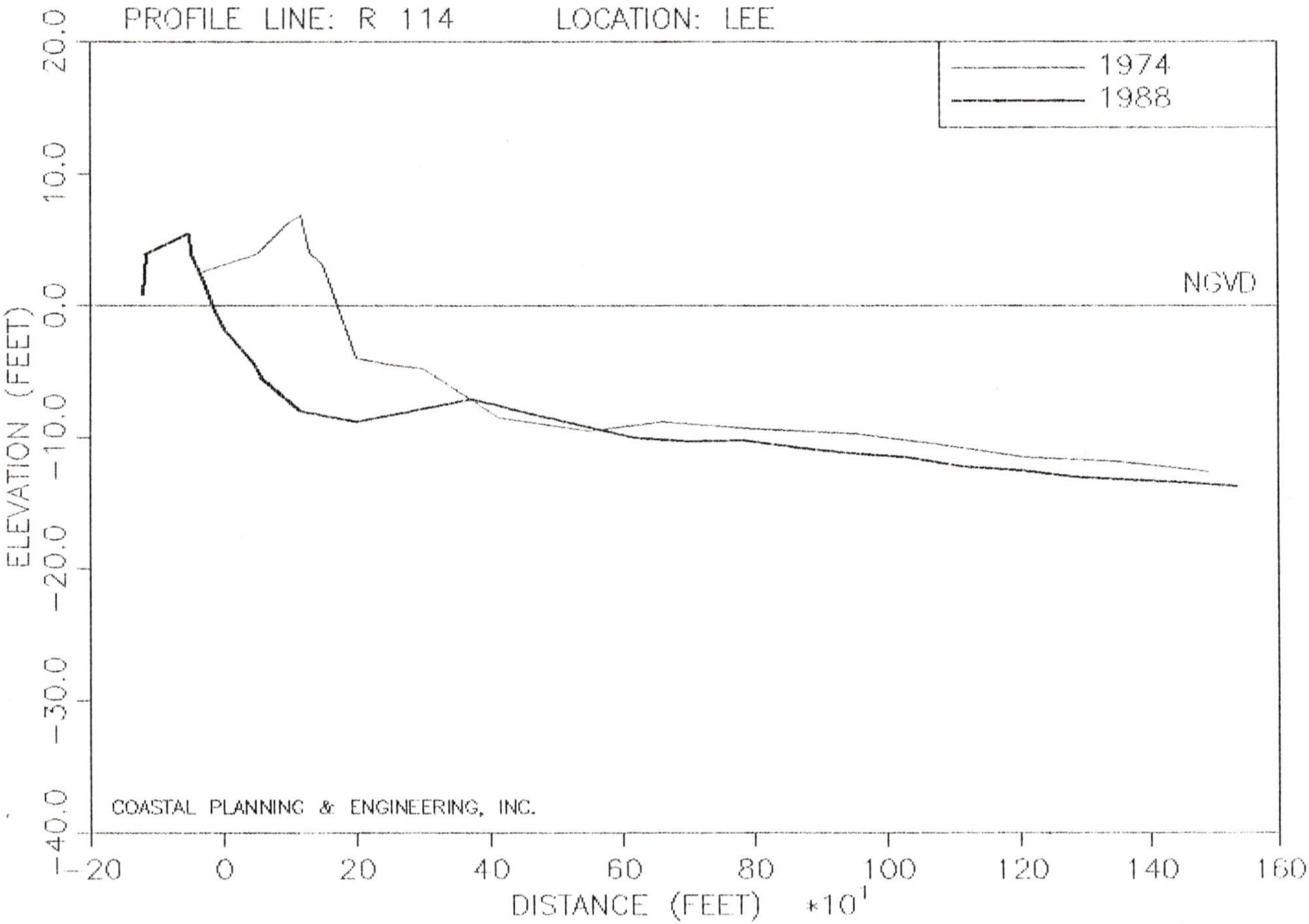
PROFILE LINE: R 105
LOCATION: LEE
1974
1988
D
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



PROFILE LINE: R 108
LOCATION: LEE
1974
1988
D
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



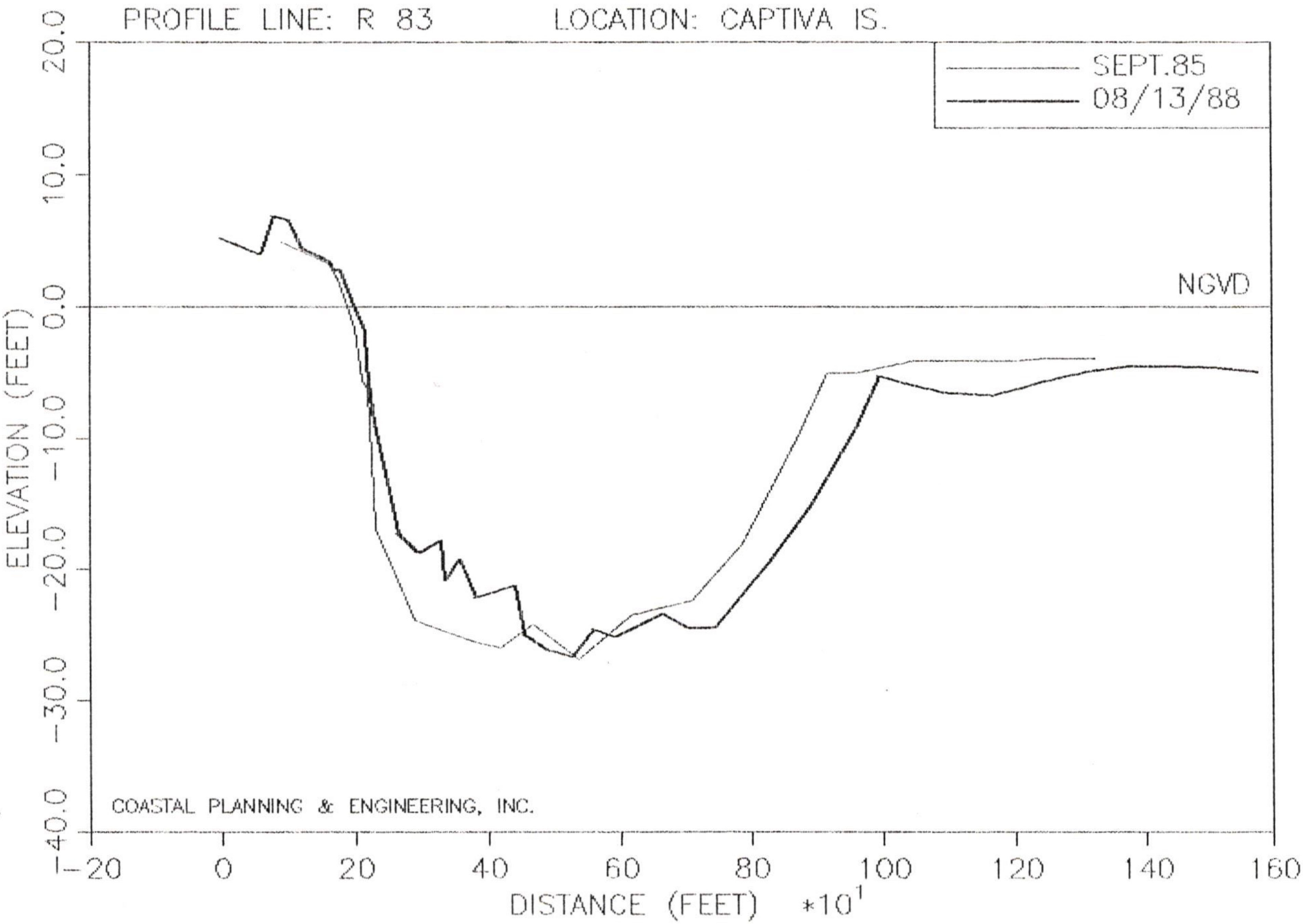
PROFILE LINE: R 111
LOCATION: LEE
1974
1988
D
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

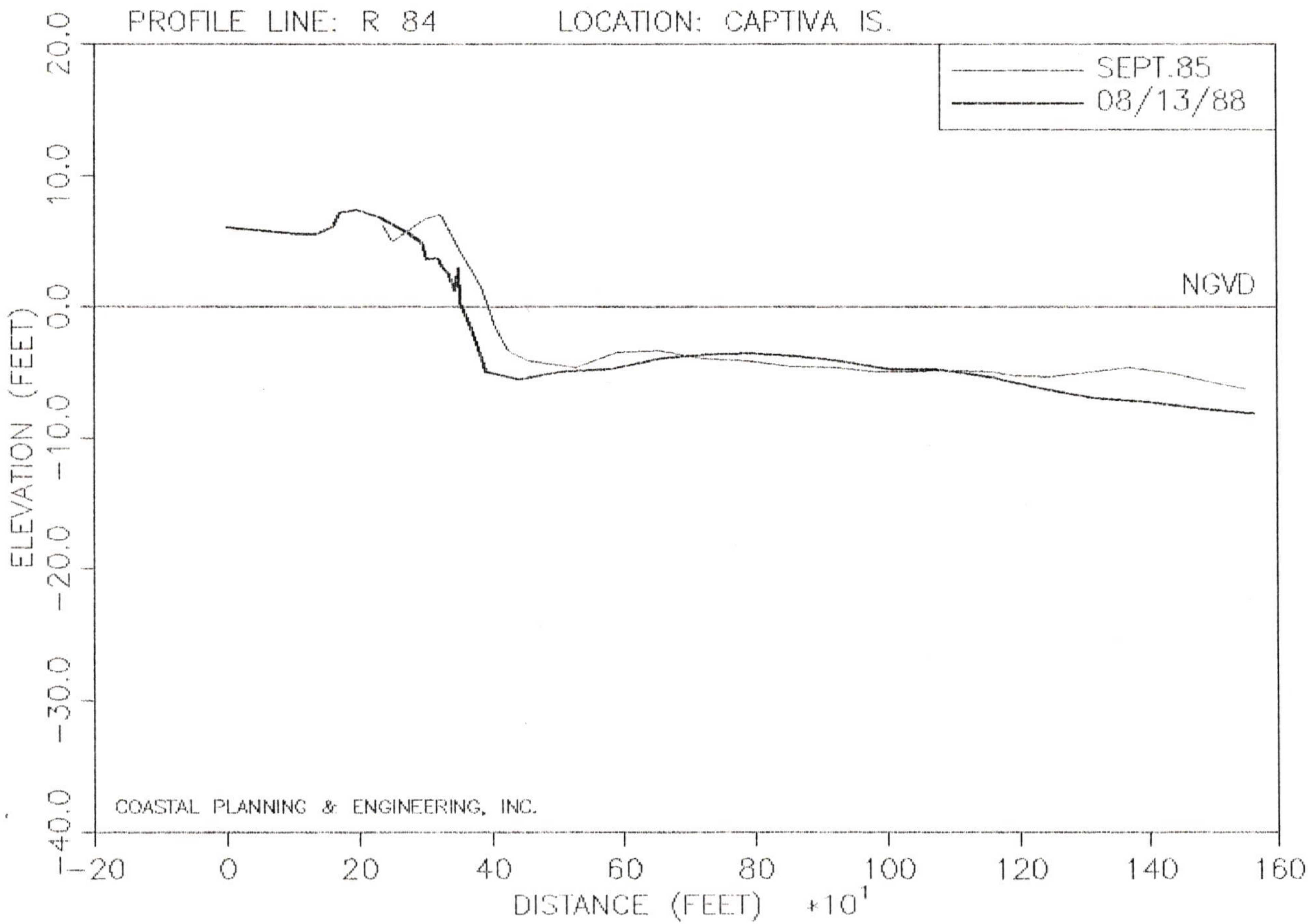


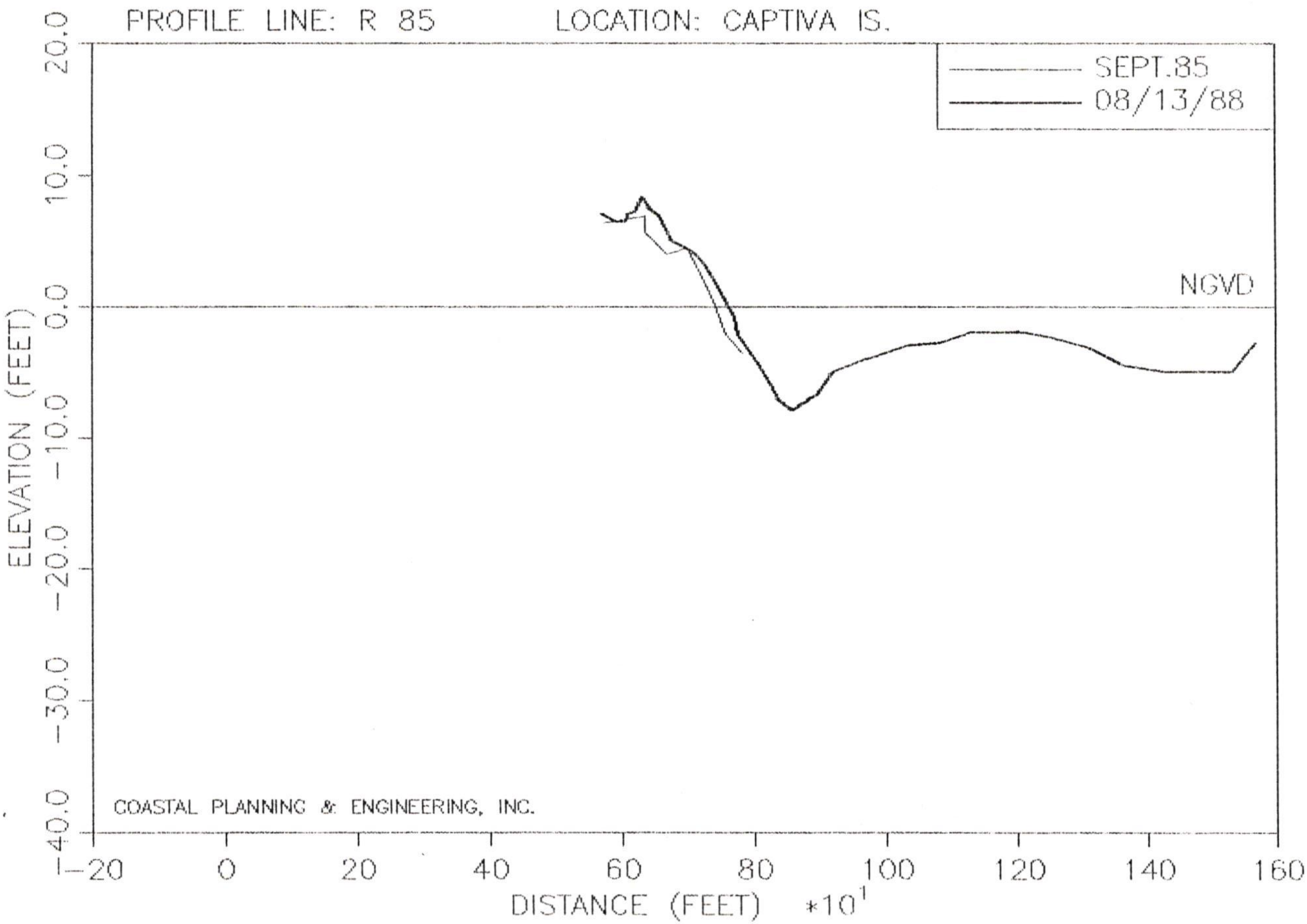
PROFILE LINE: R 114
LOCATION: LEE
1974
1988
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

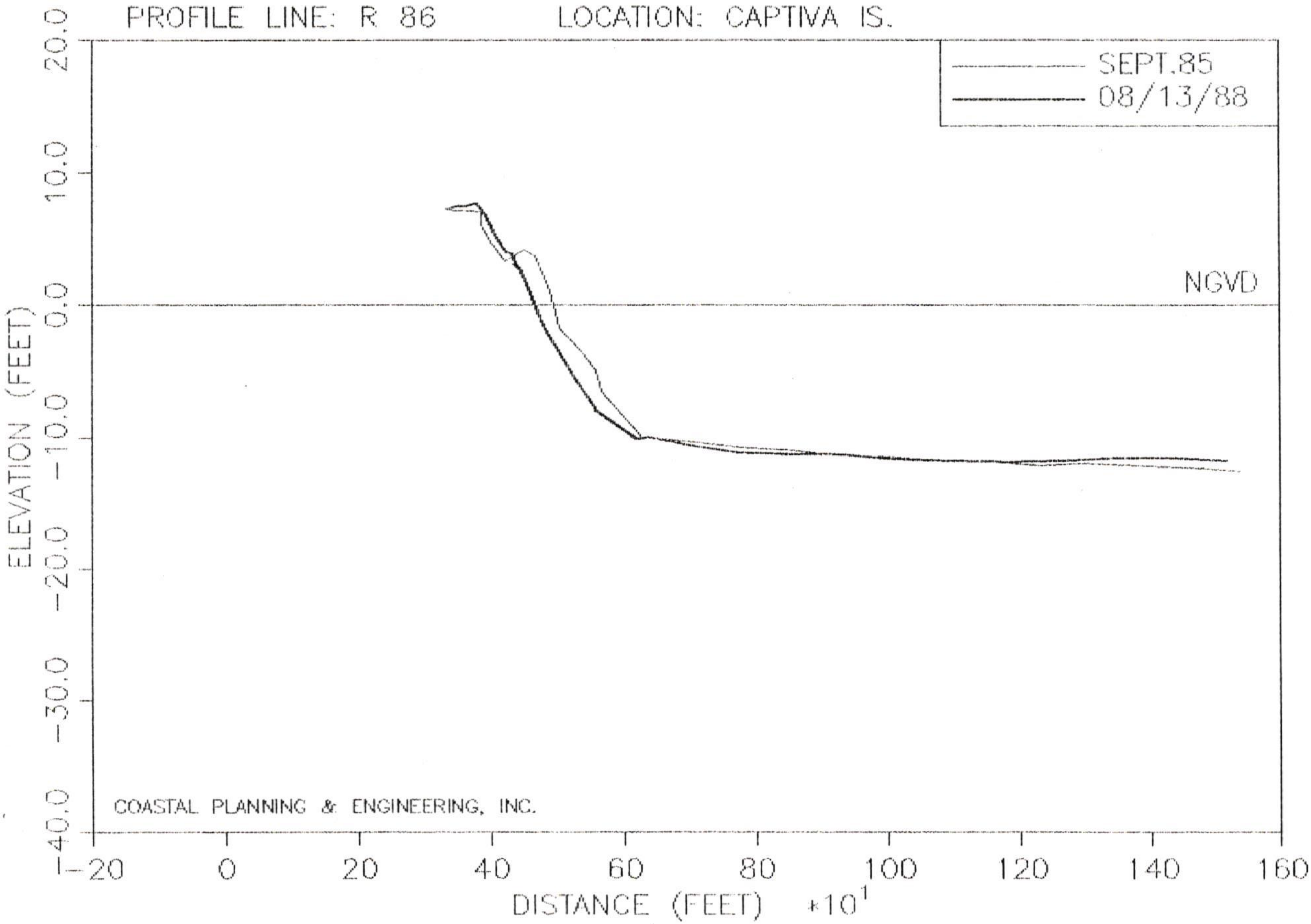
Comparative Beach Profile Plots

September 1985 vs. August 13, 1988

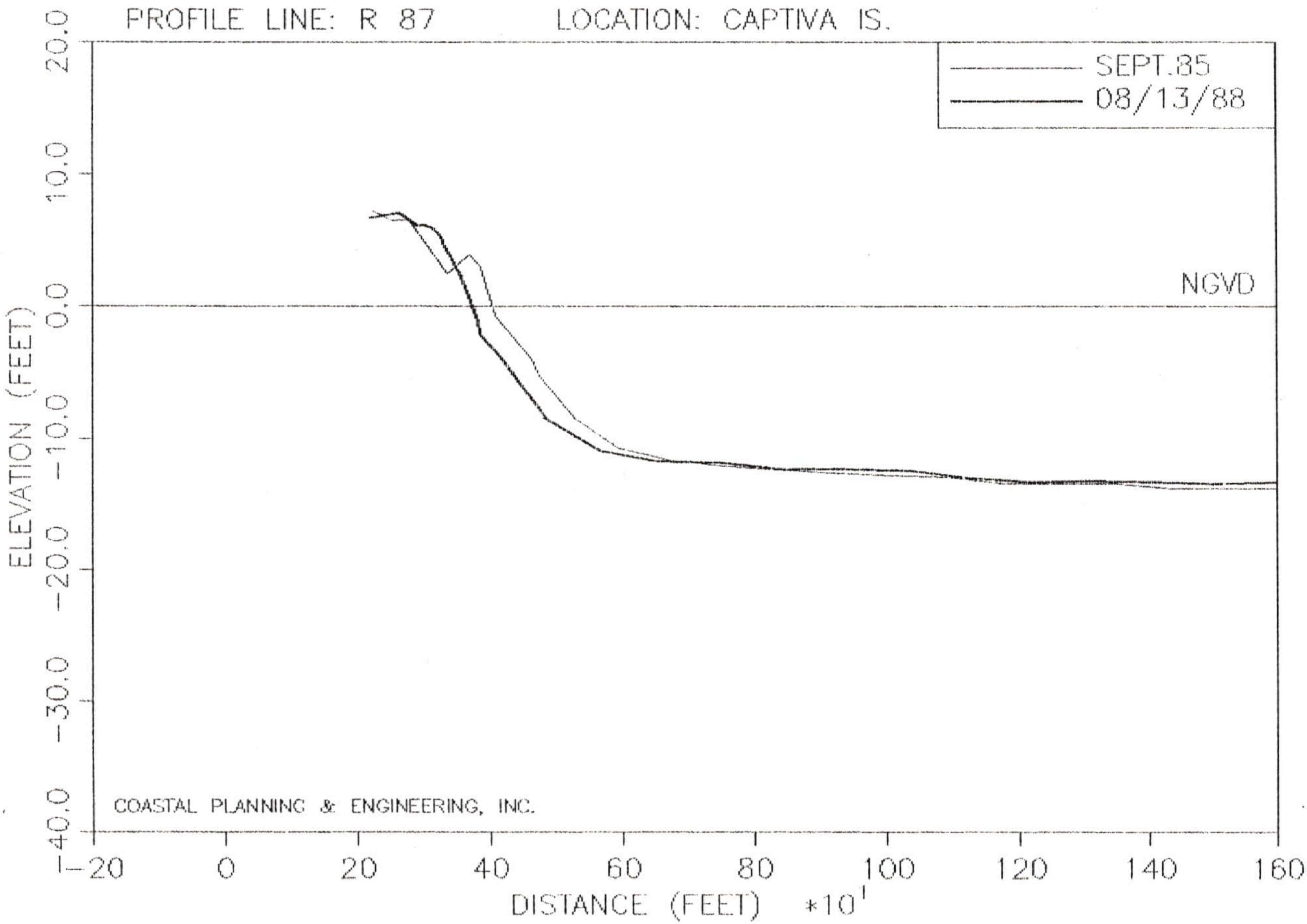

PROFILE LINE: R 83
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R 84
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R 85
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



PROFILE LINE: R 86
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



PROFILE LINE: R 87
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
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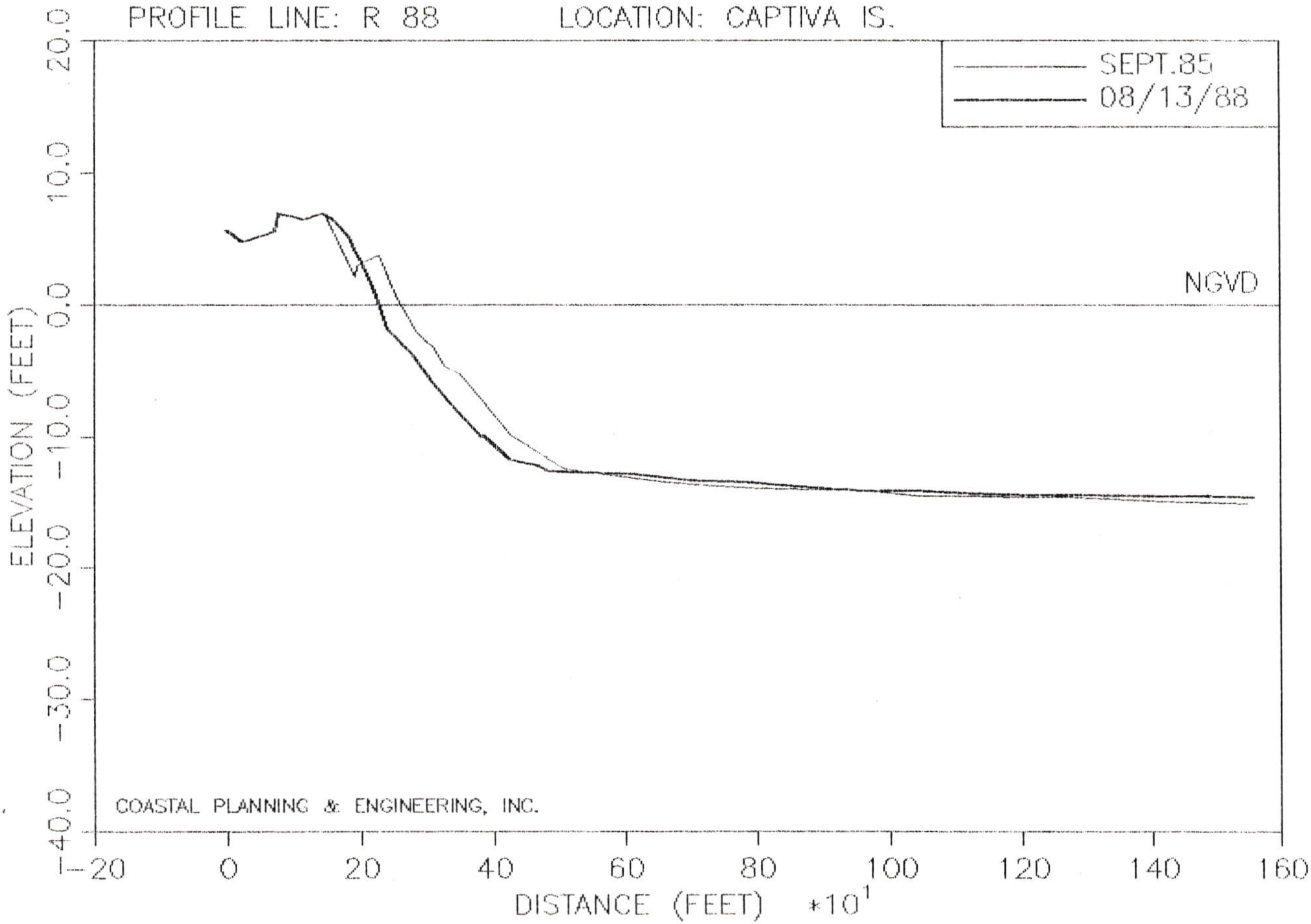
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.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LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
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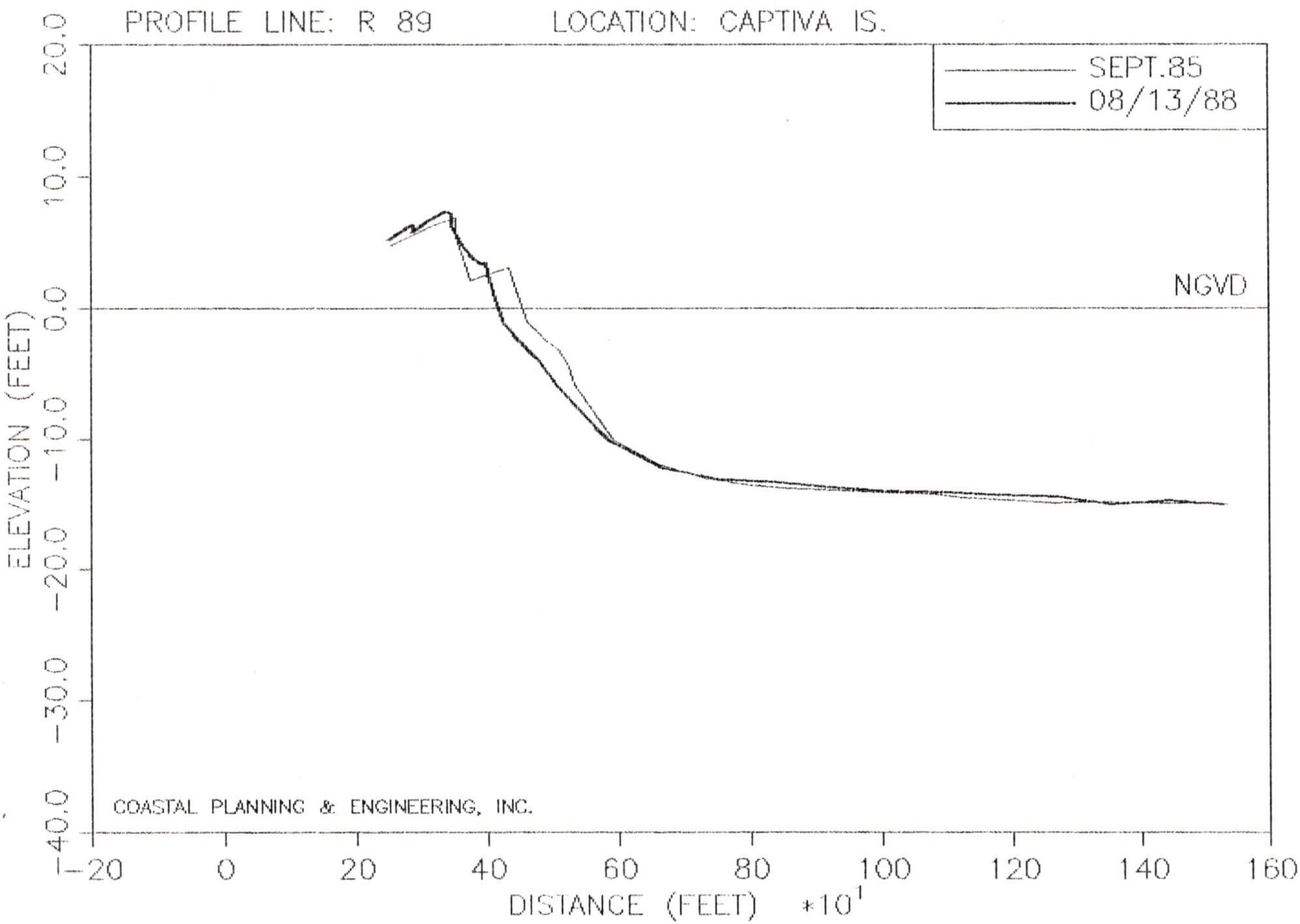
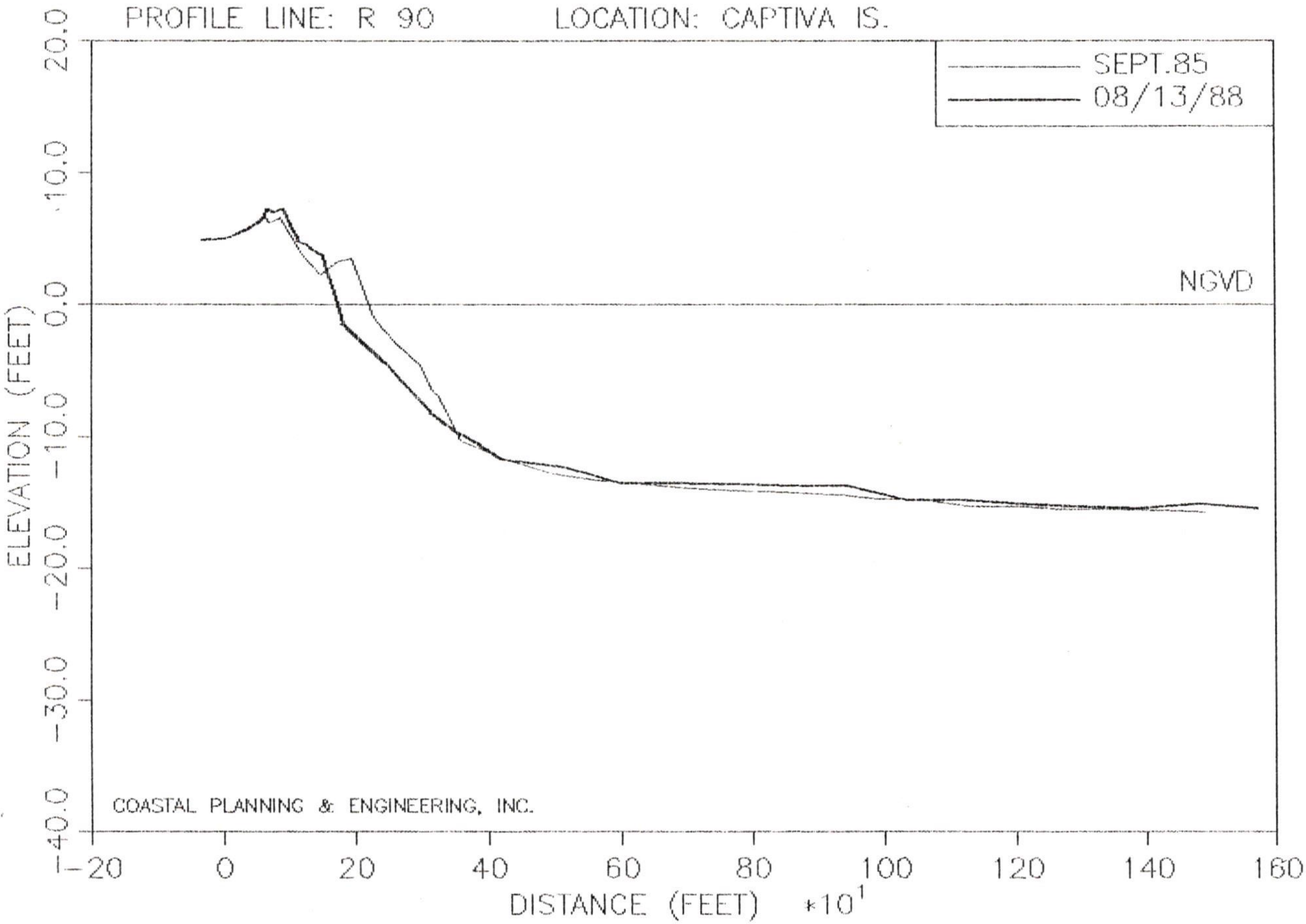
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1


PROFILE LINE: R 89
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]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SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
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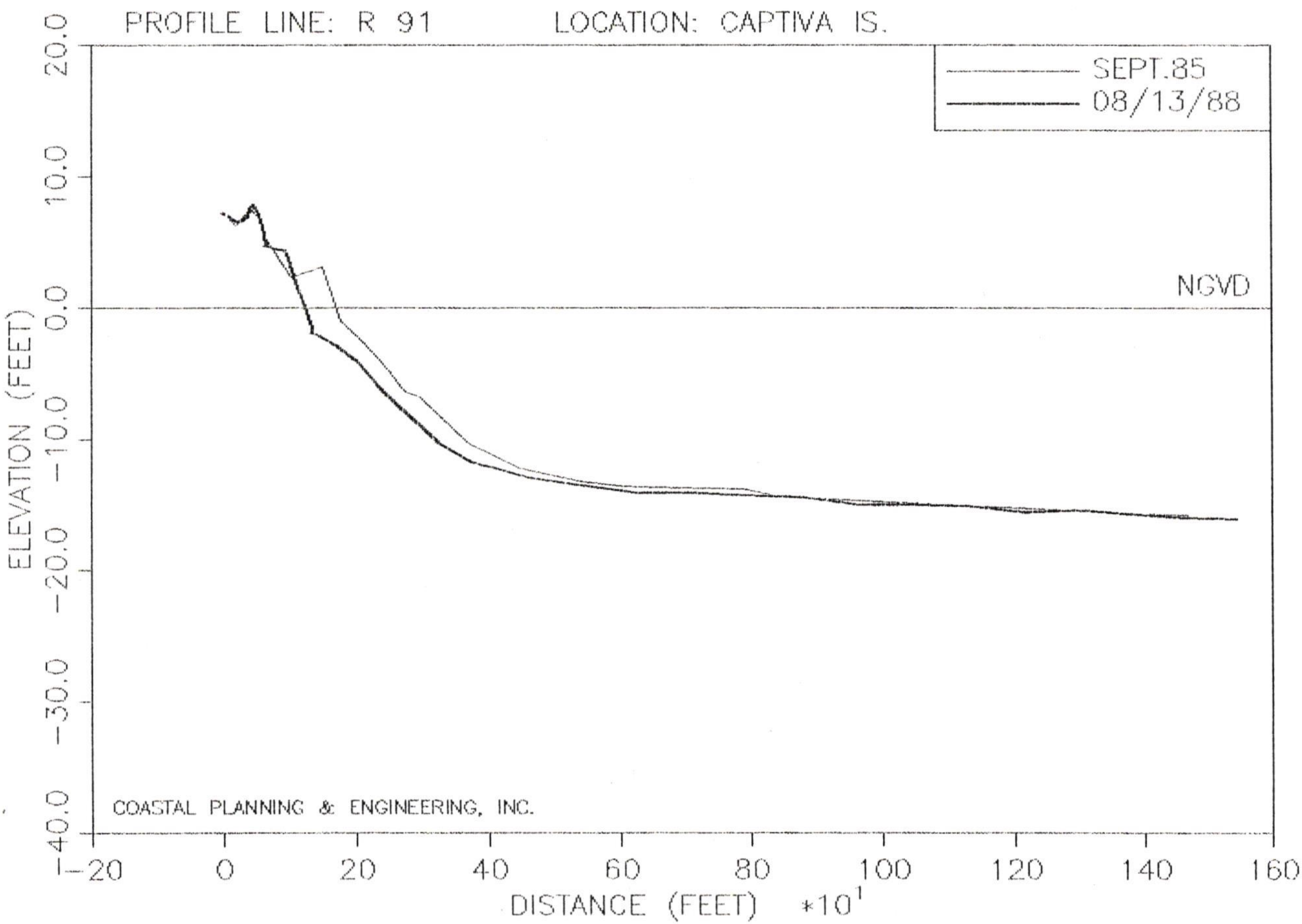
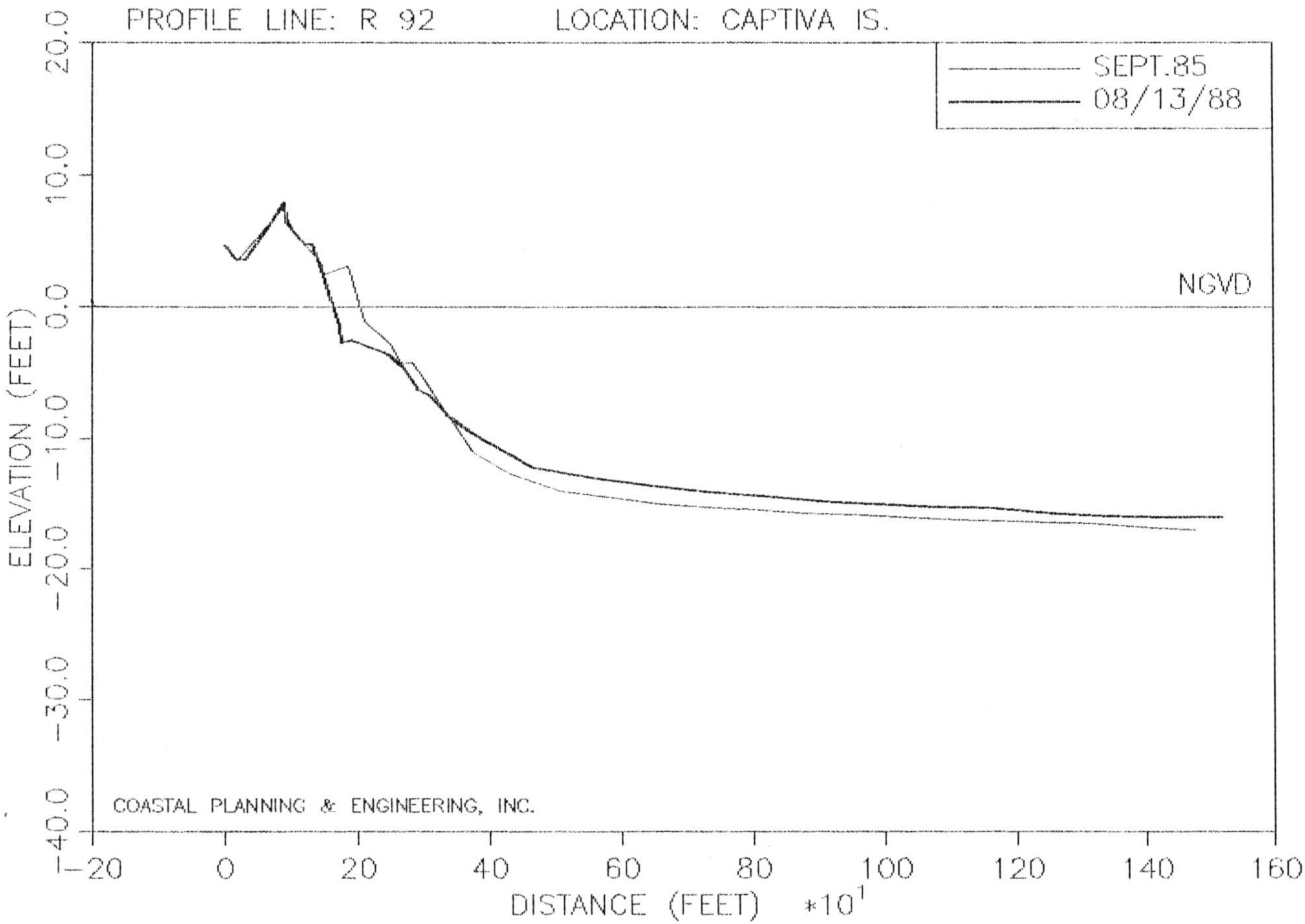
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1



PROFILE LINE: R 91
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]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LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
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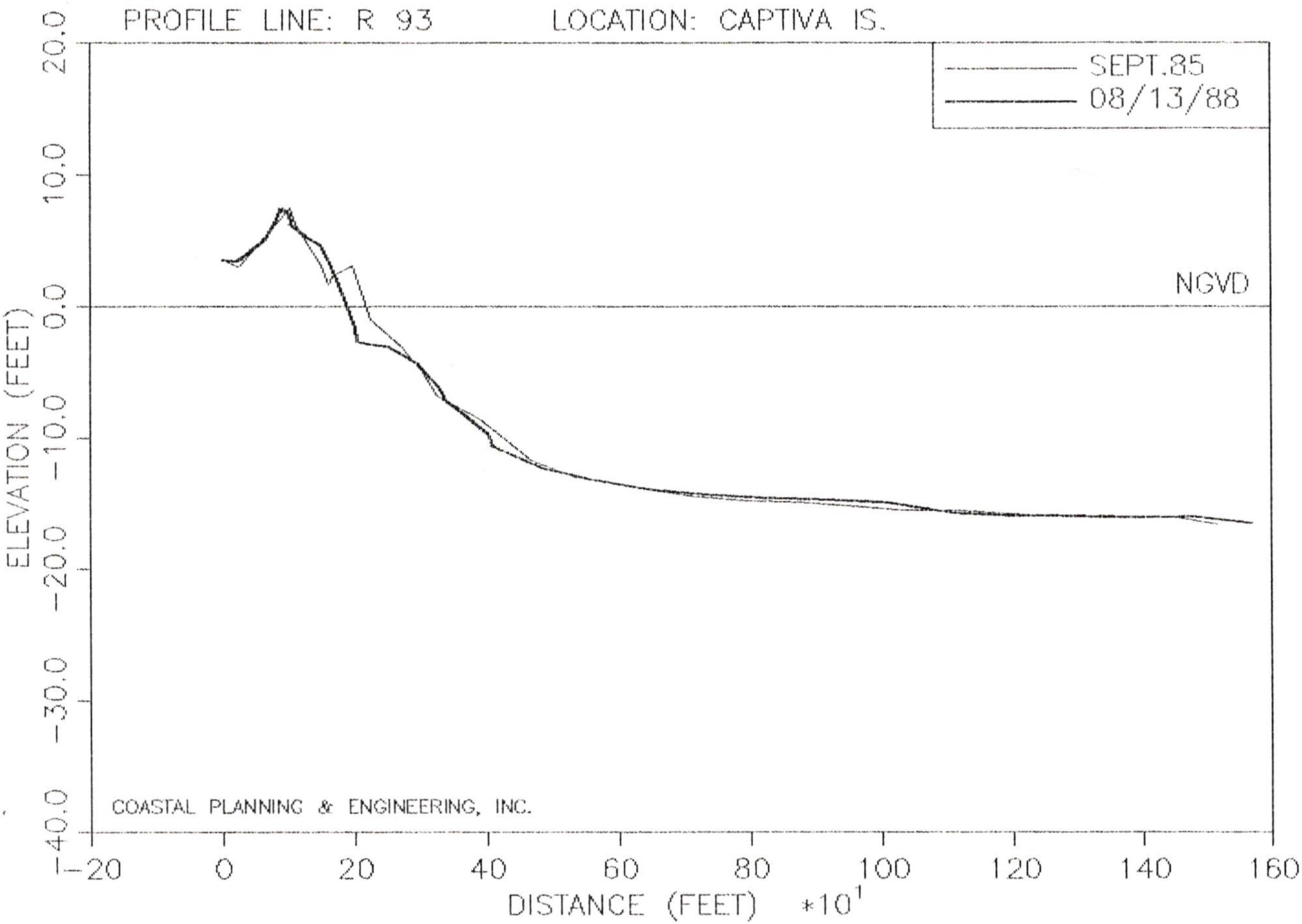
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



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LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
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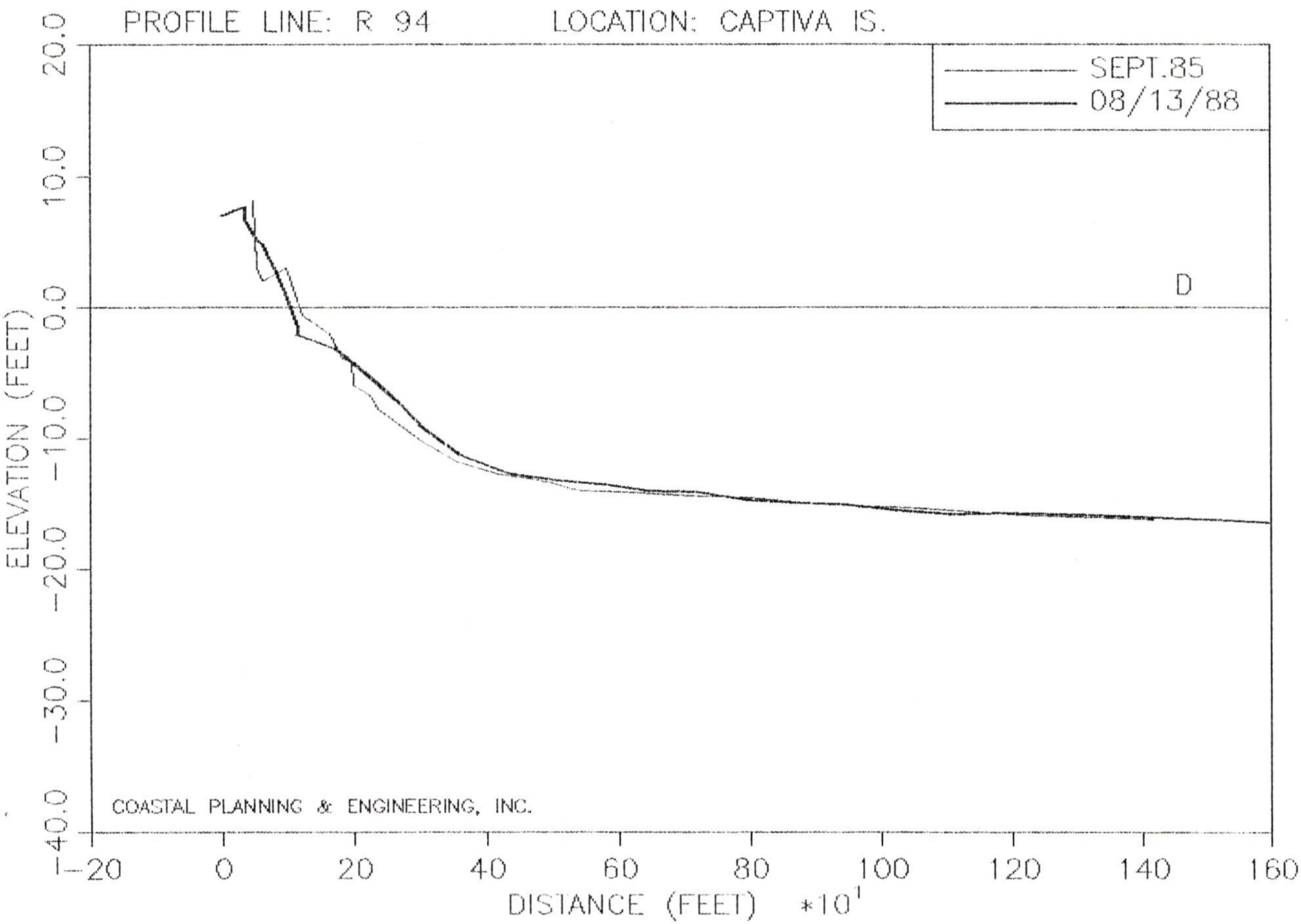
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.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LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
D
ELEVATION (FEET)
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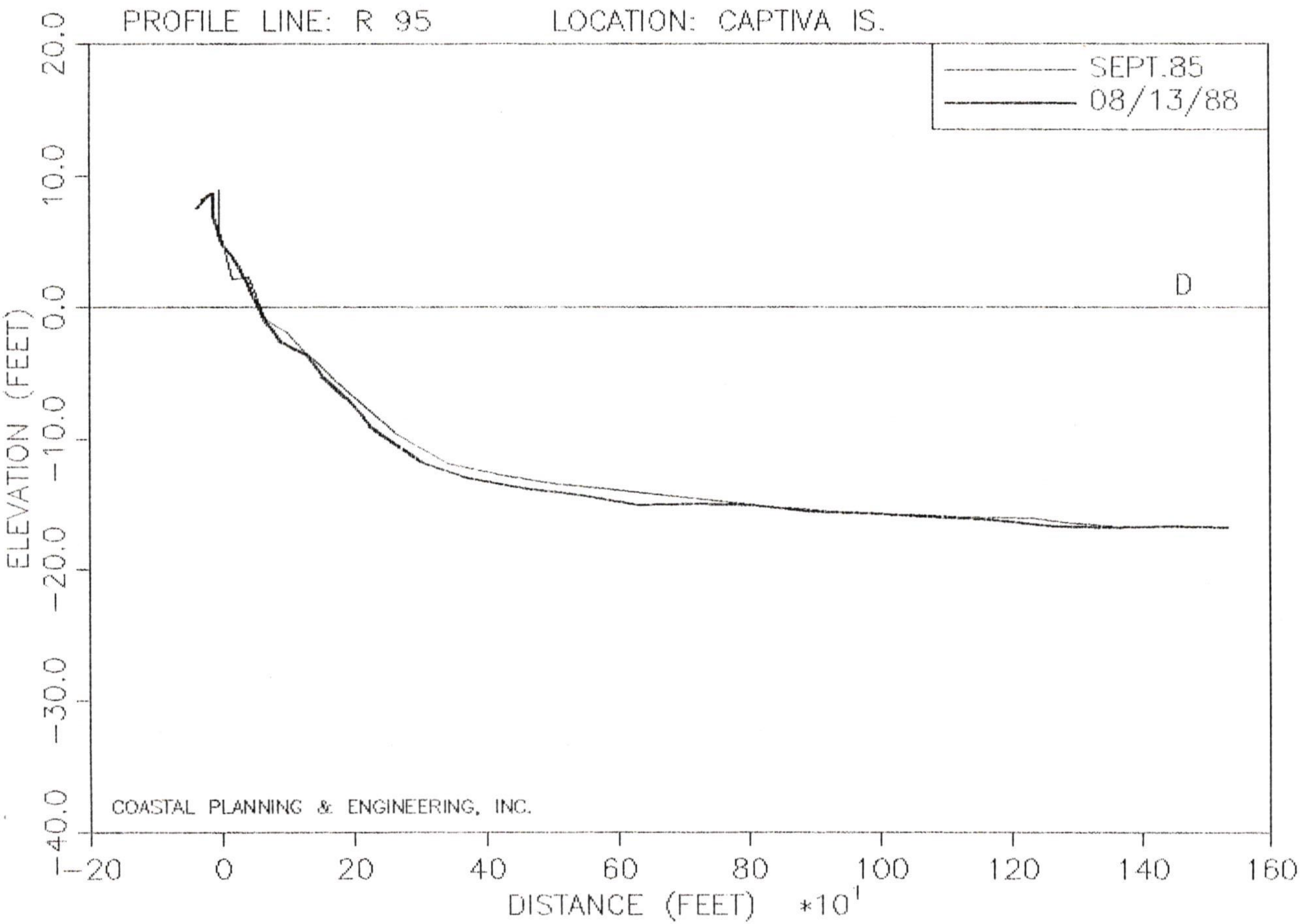
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



PROFILE LINE: R 95
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
D
ELEVATION (FEET)
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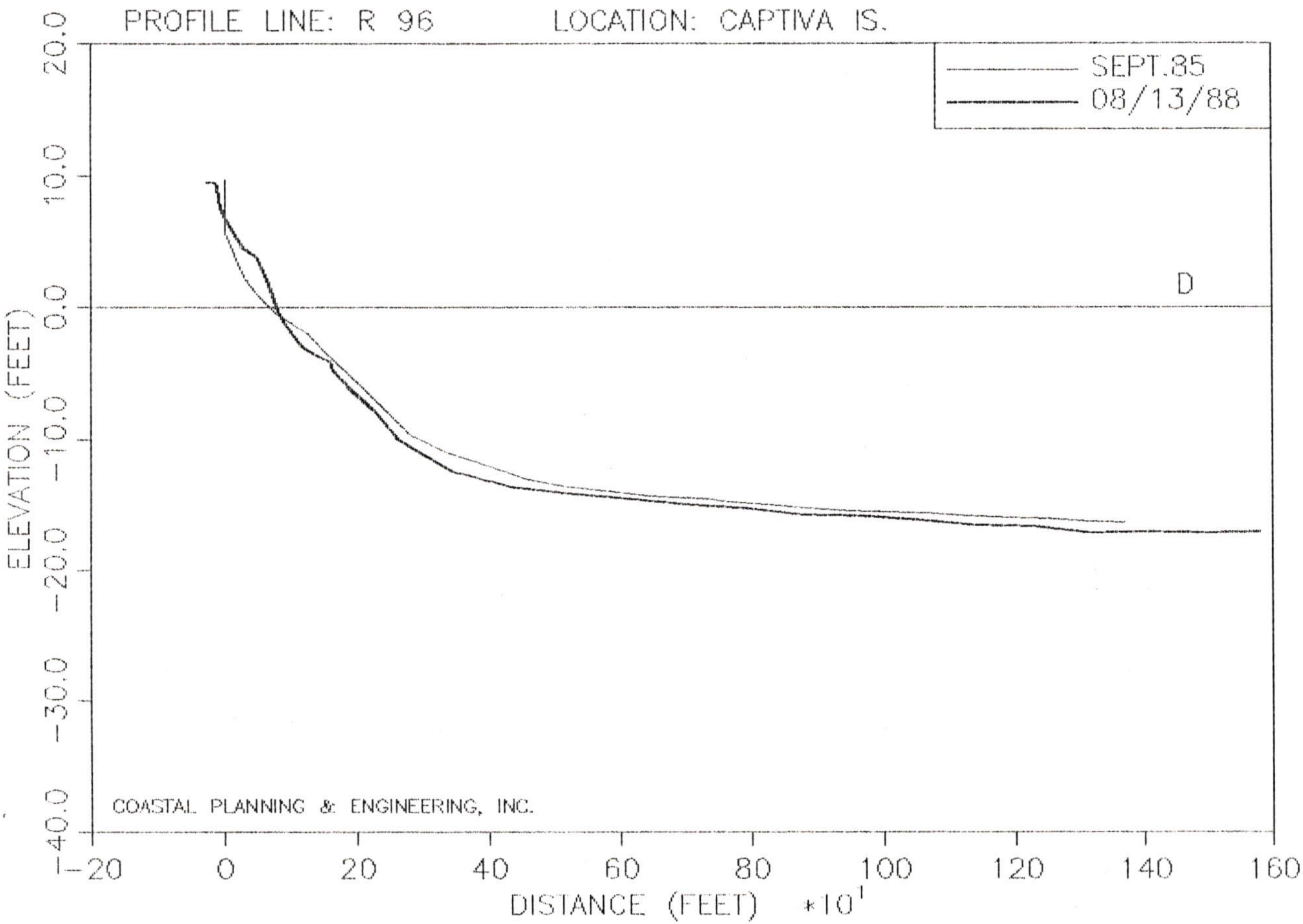
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



PROFILE LINE: R 96
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
D
ELEVATION (FEET)
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10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
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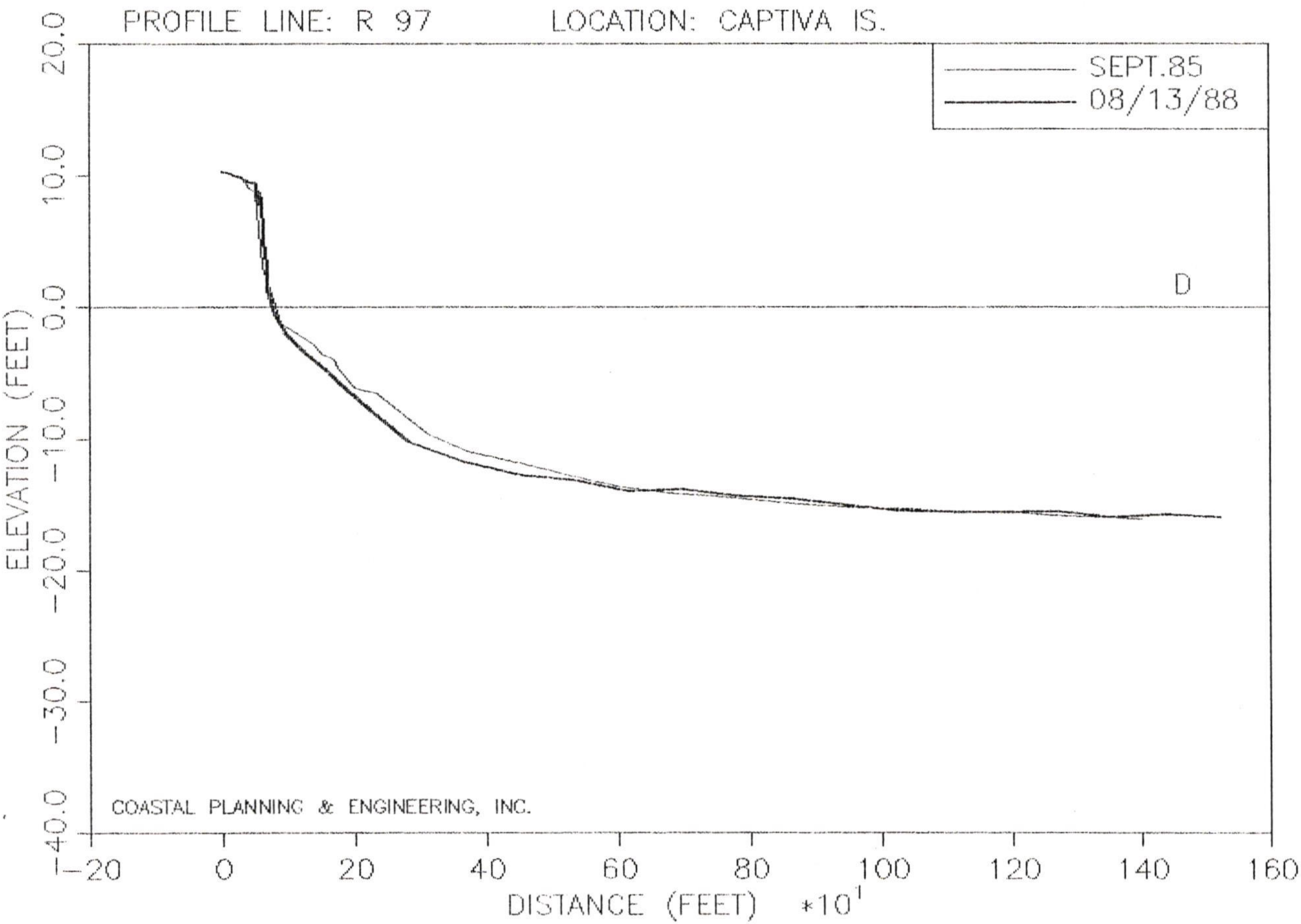
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R 97
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
D
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
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100
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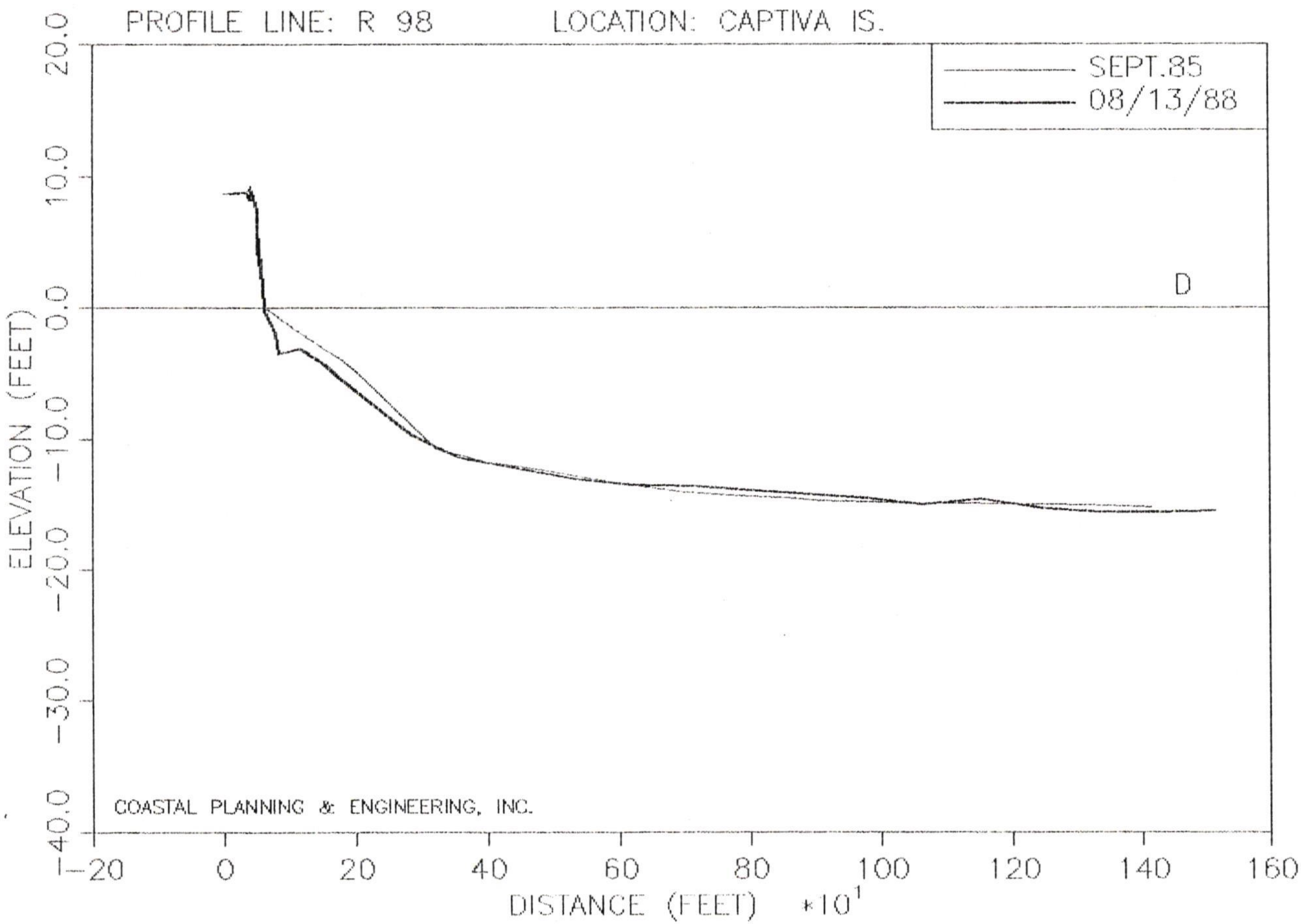
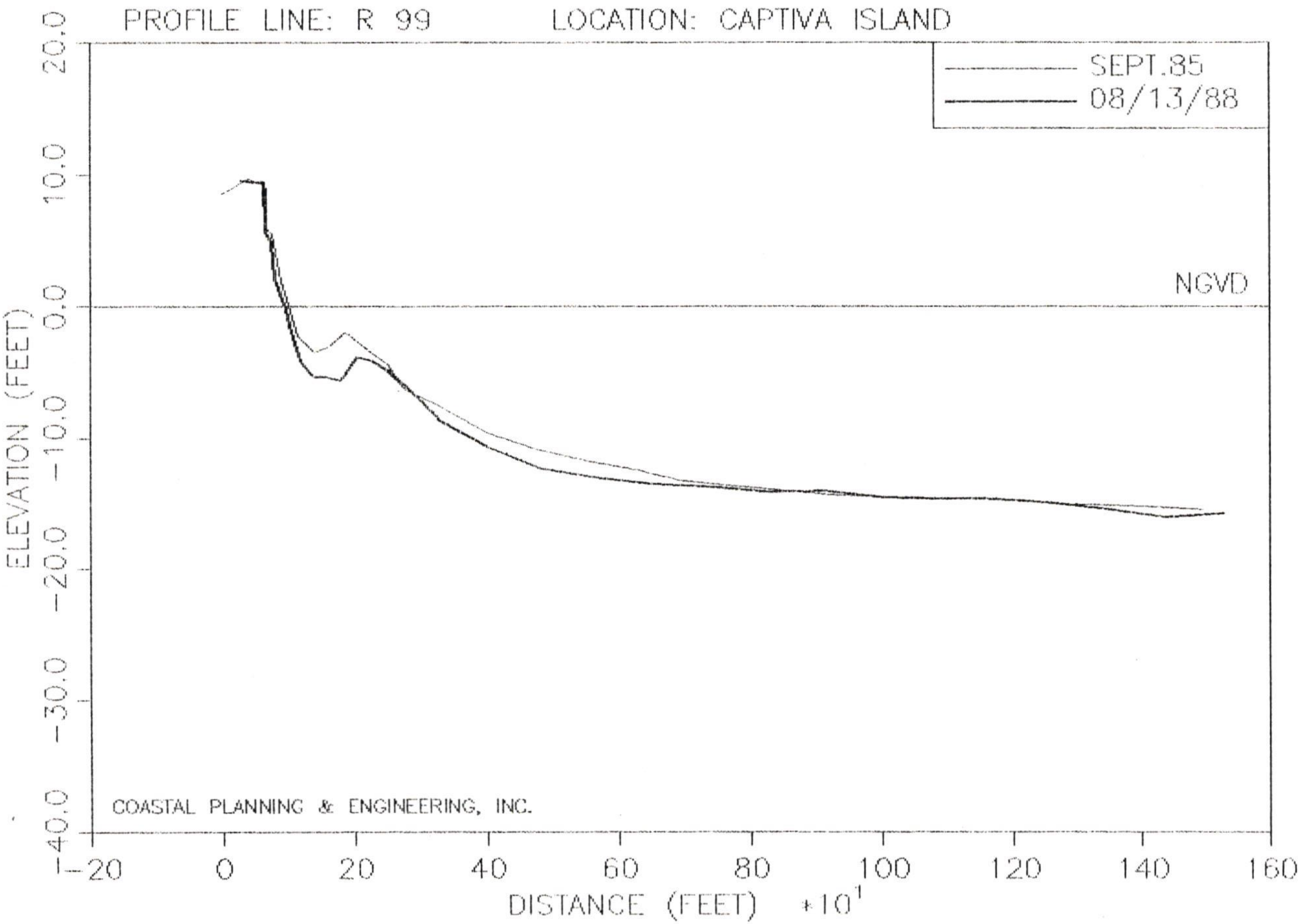
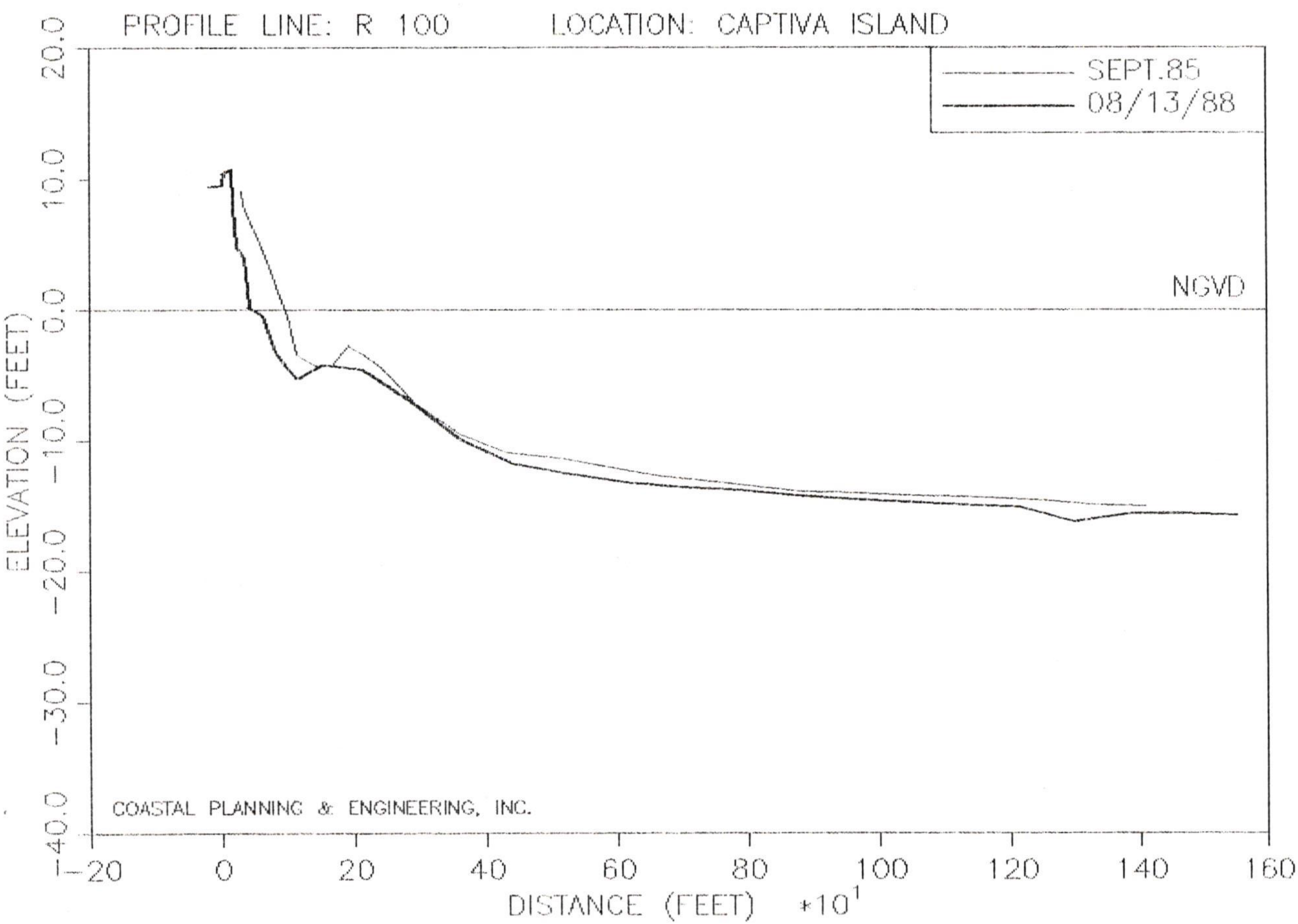
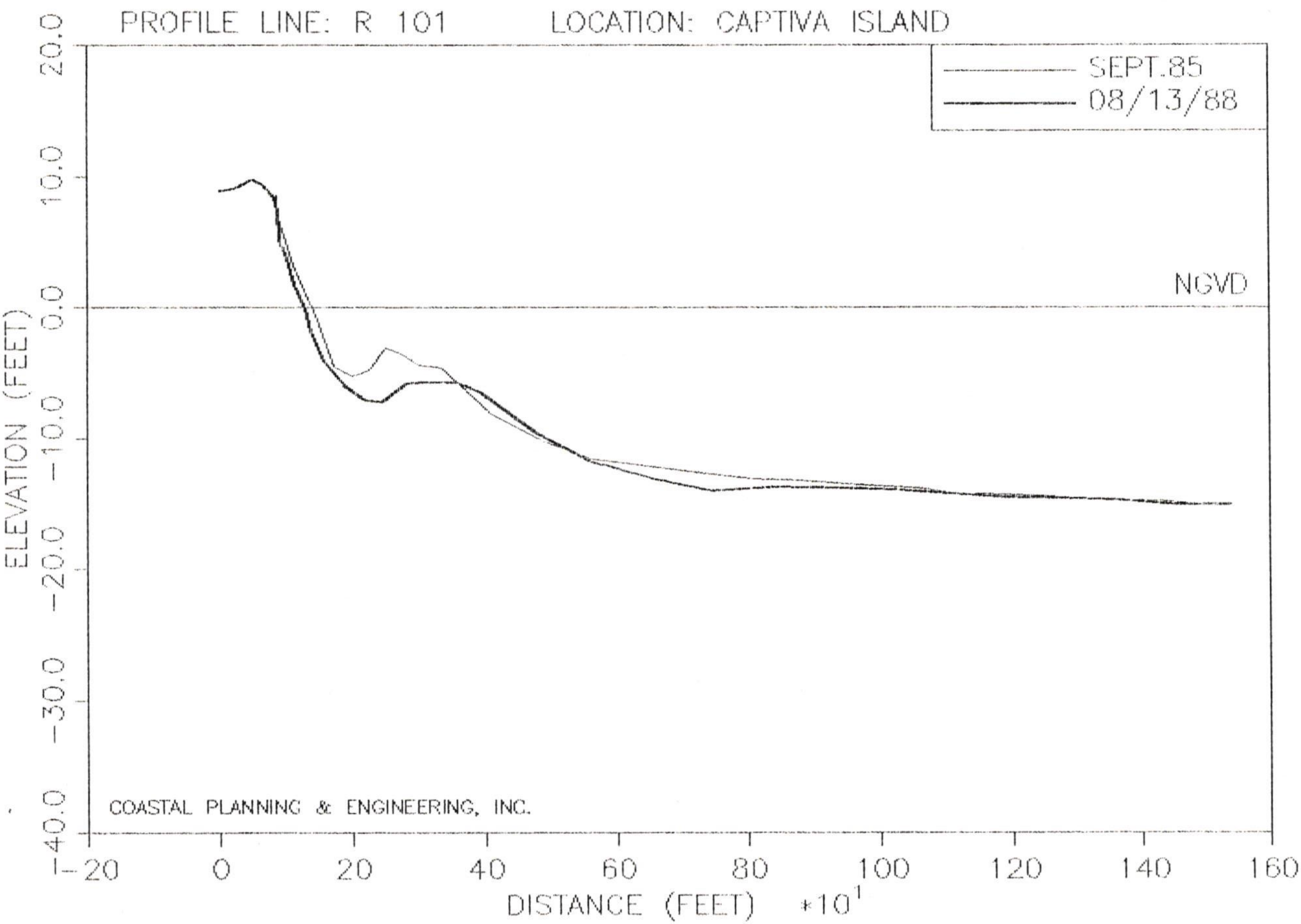
140
160
DISTANCE (FEET) *10[1]

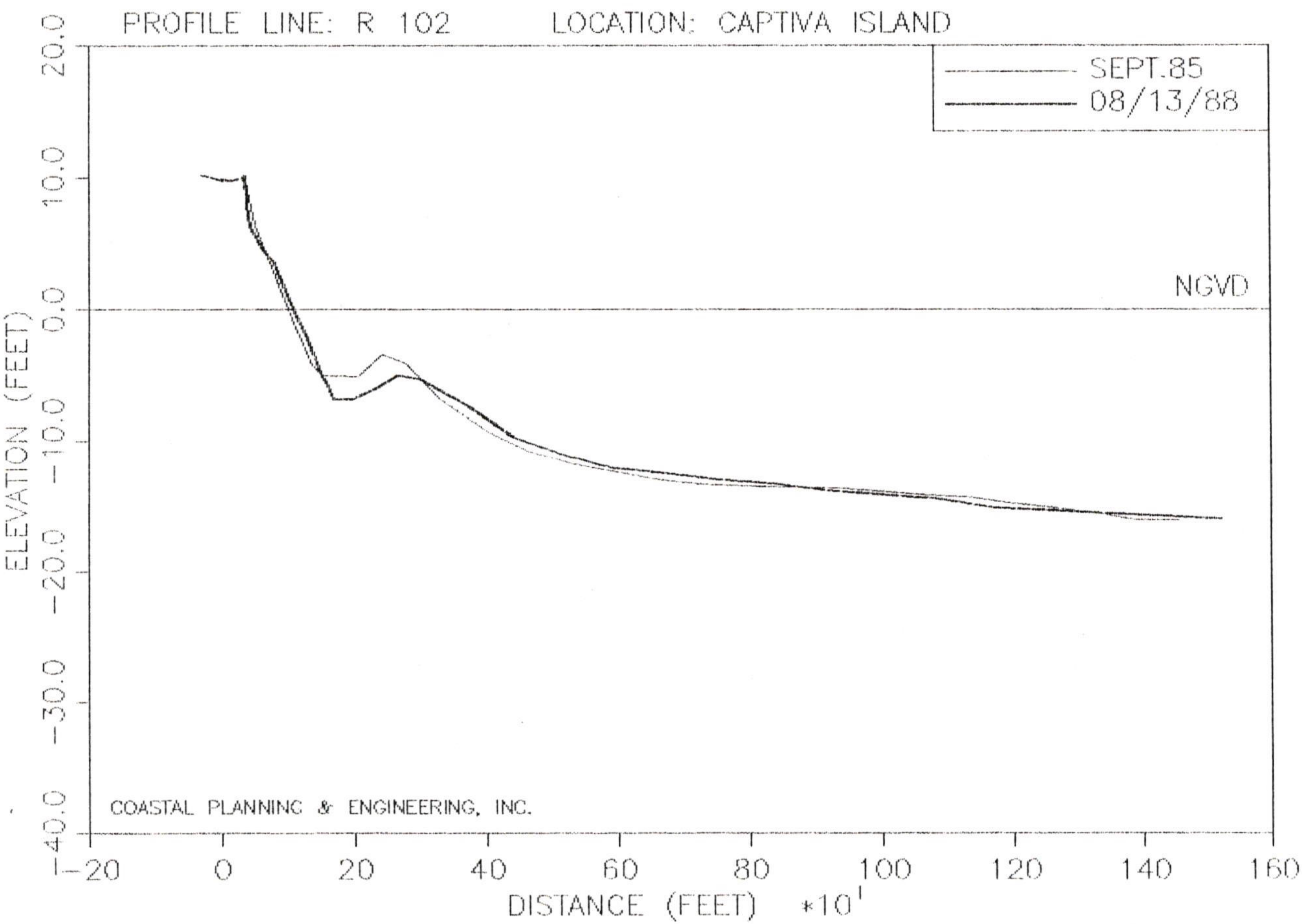


PROFILE LINE: R 98
LOCATION: CAPTIVA IS.
SEPT.85
08/13/88
D
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

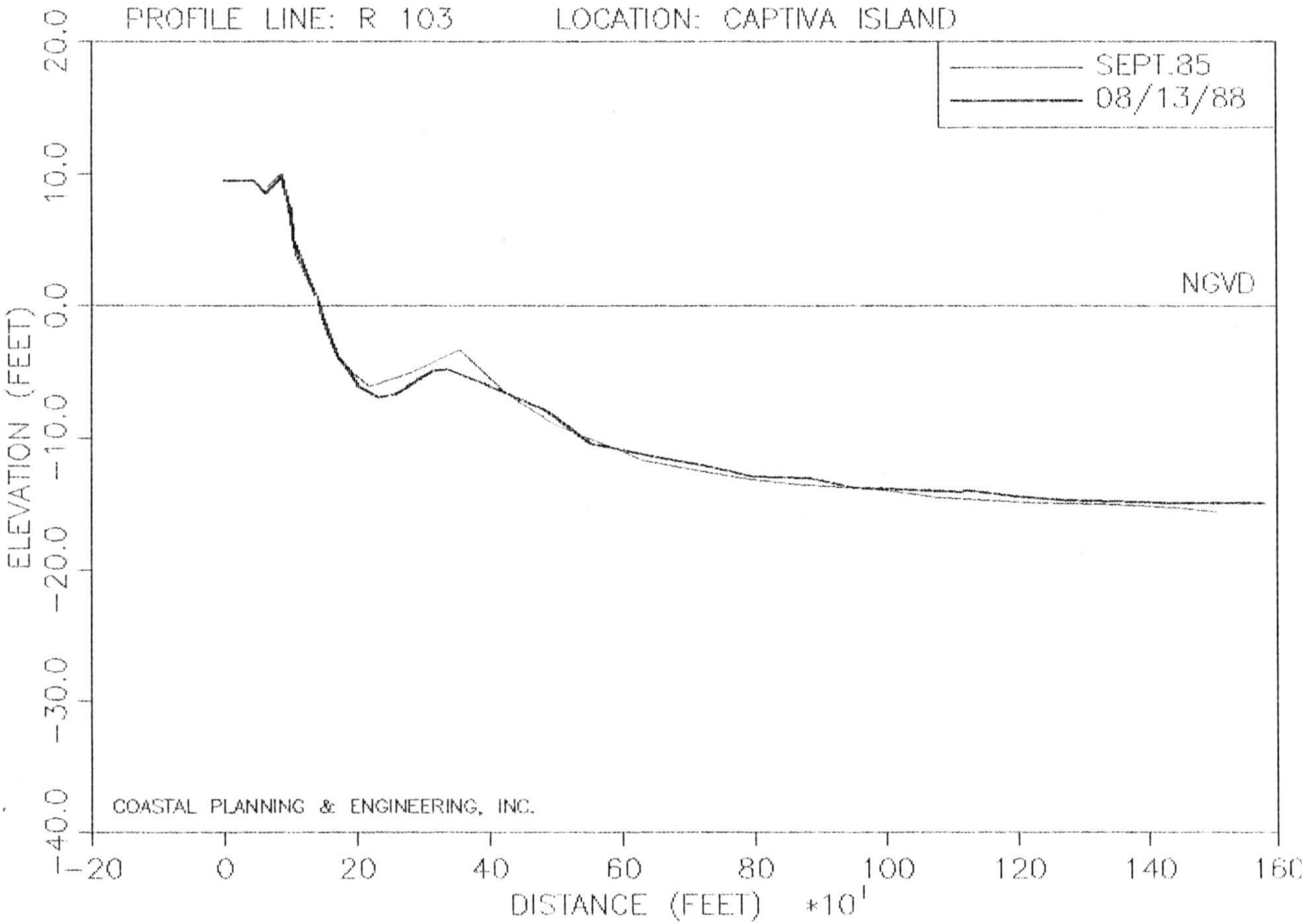

PROFILE LINE: R 99
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R 100
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

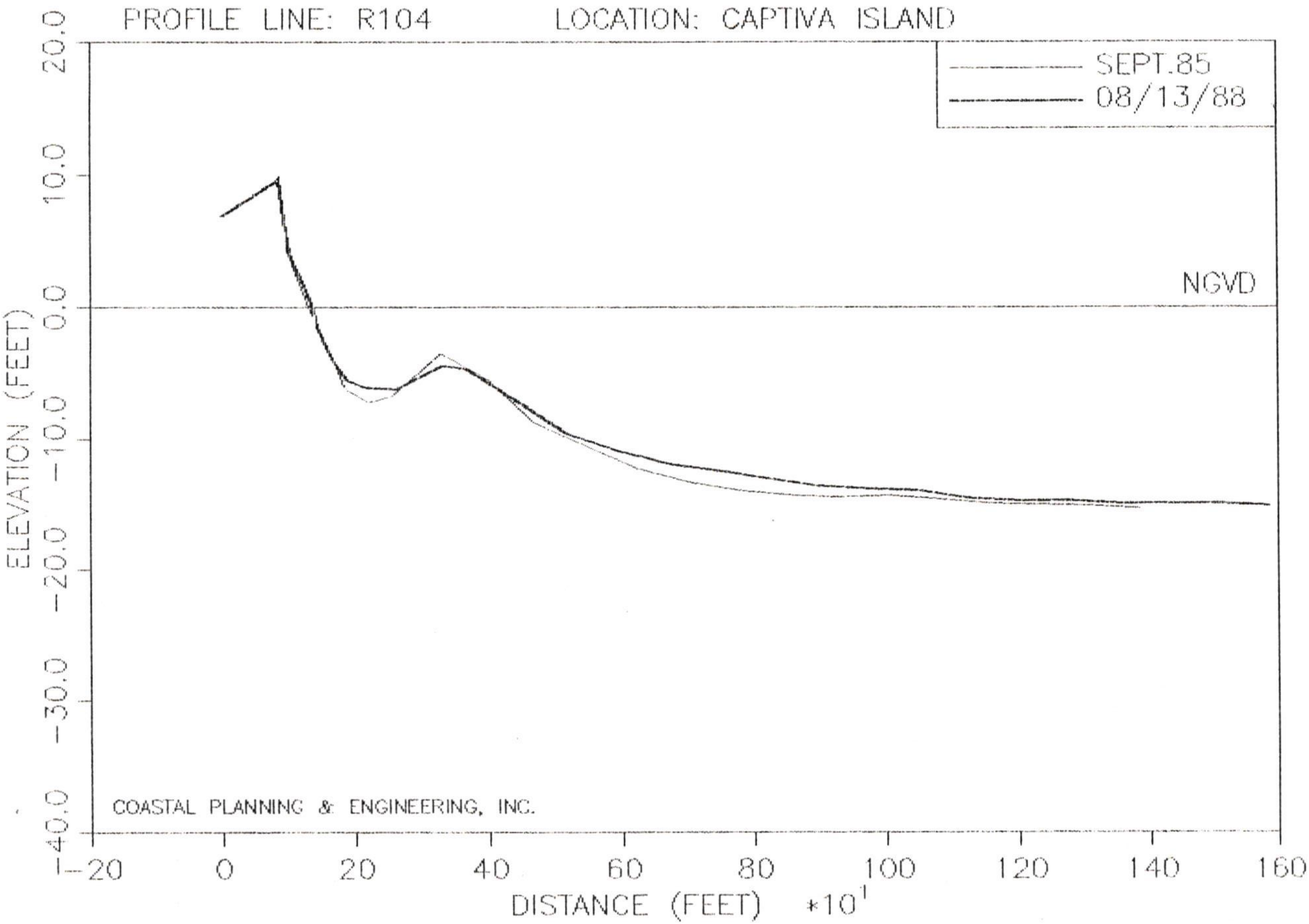

PROFILE LINE: R 101
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1



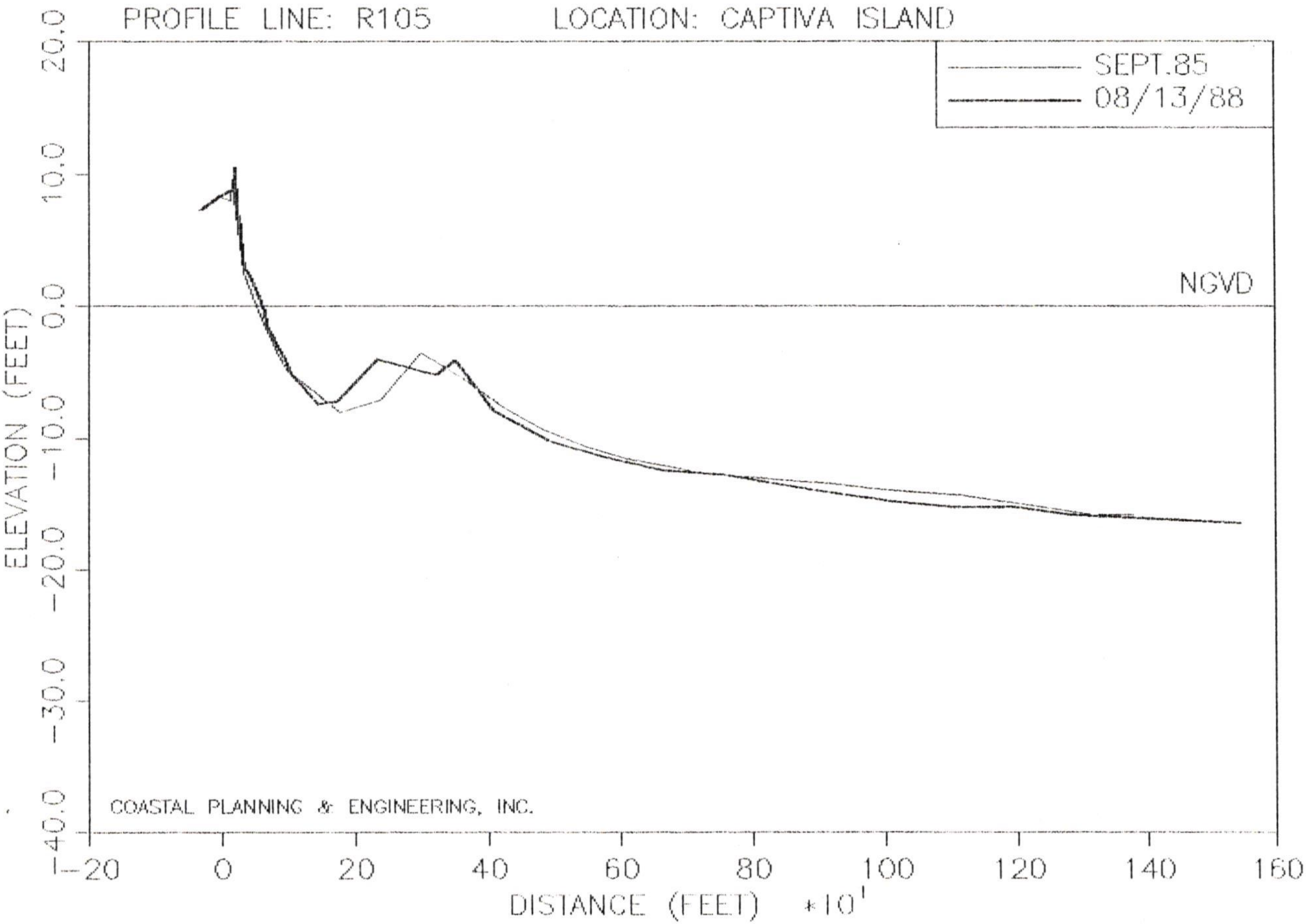
PROFILE LINE: R 102
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



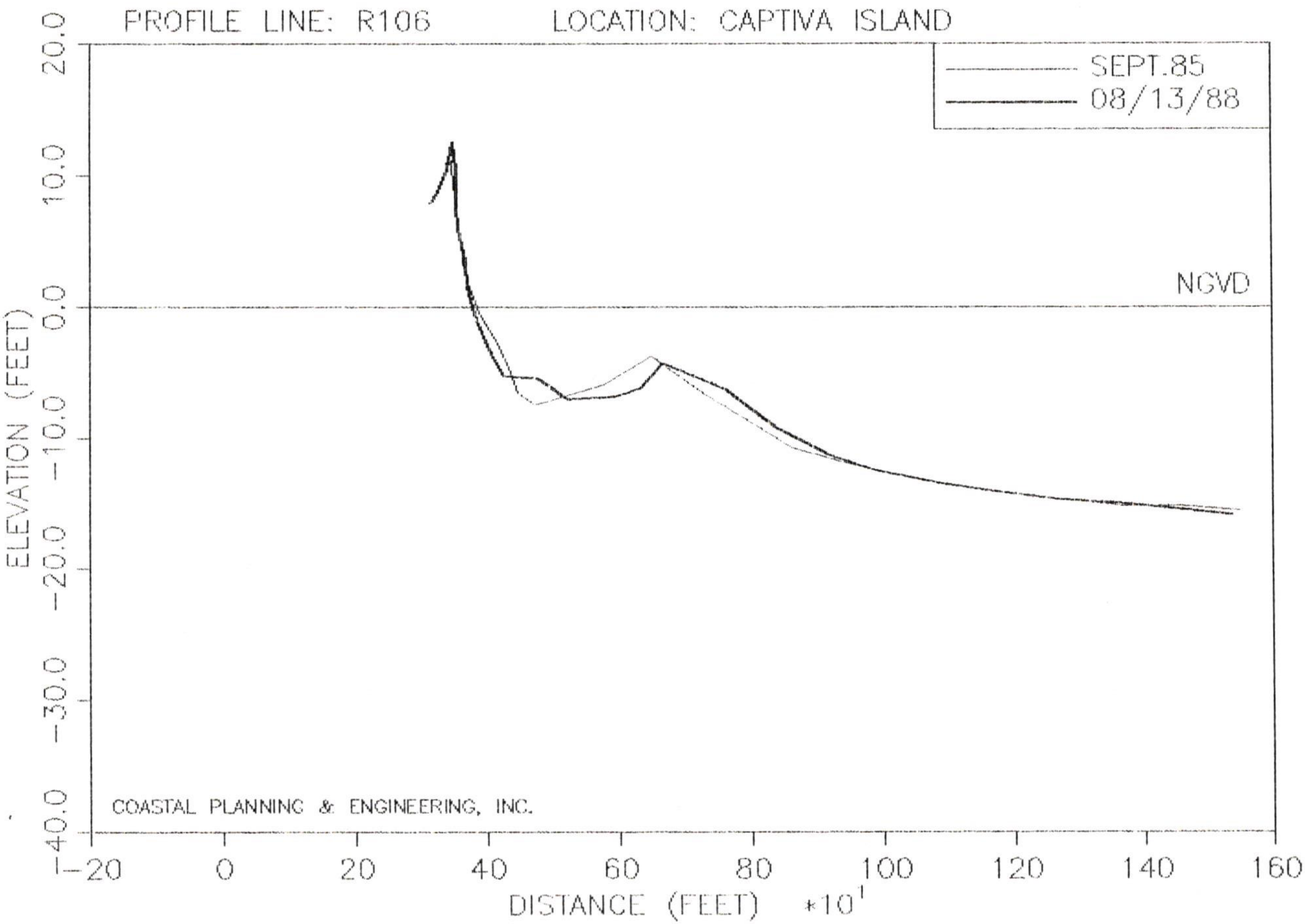
PROFILE LINE: R 103
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

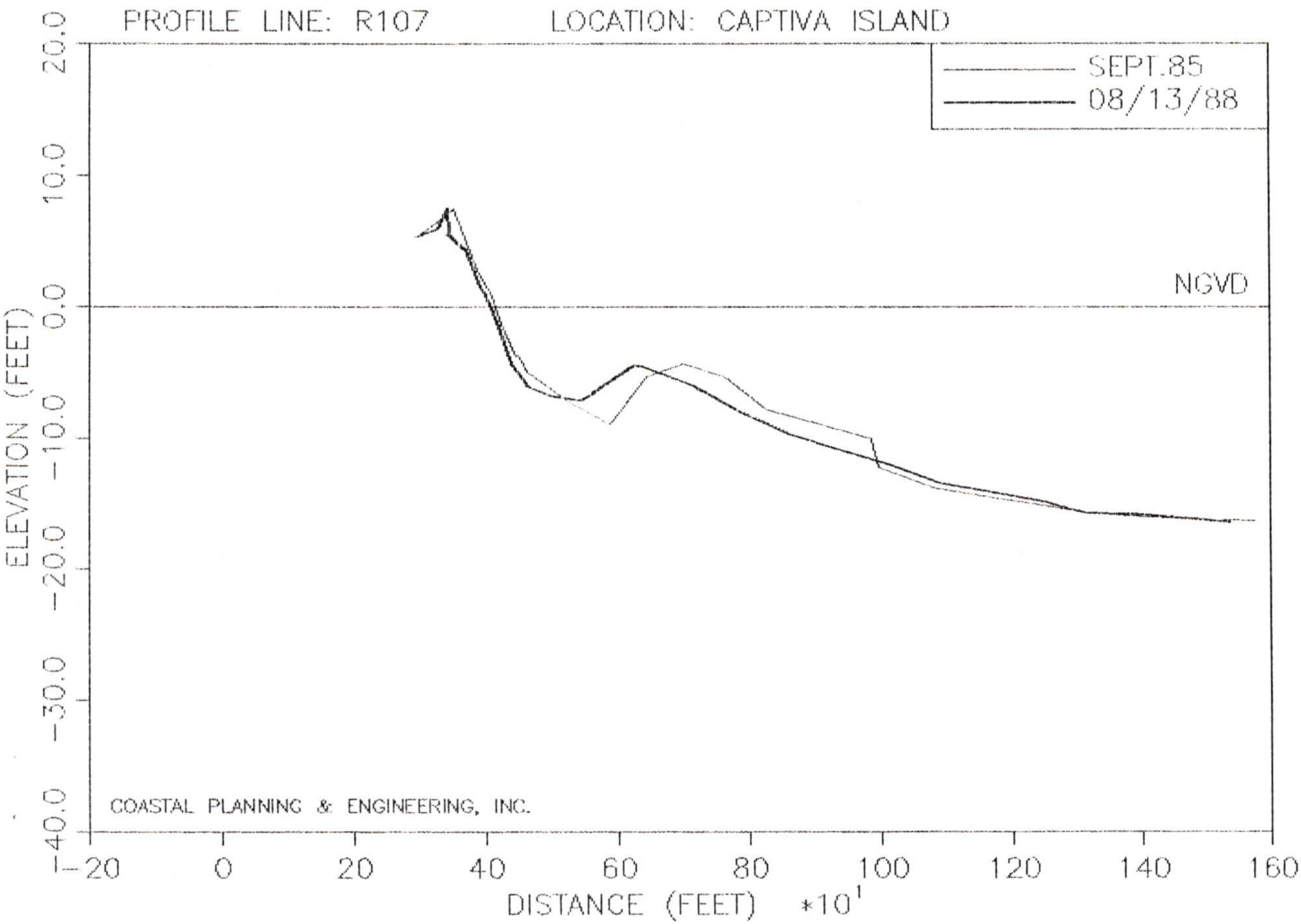


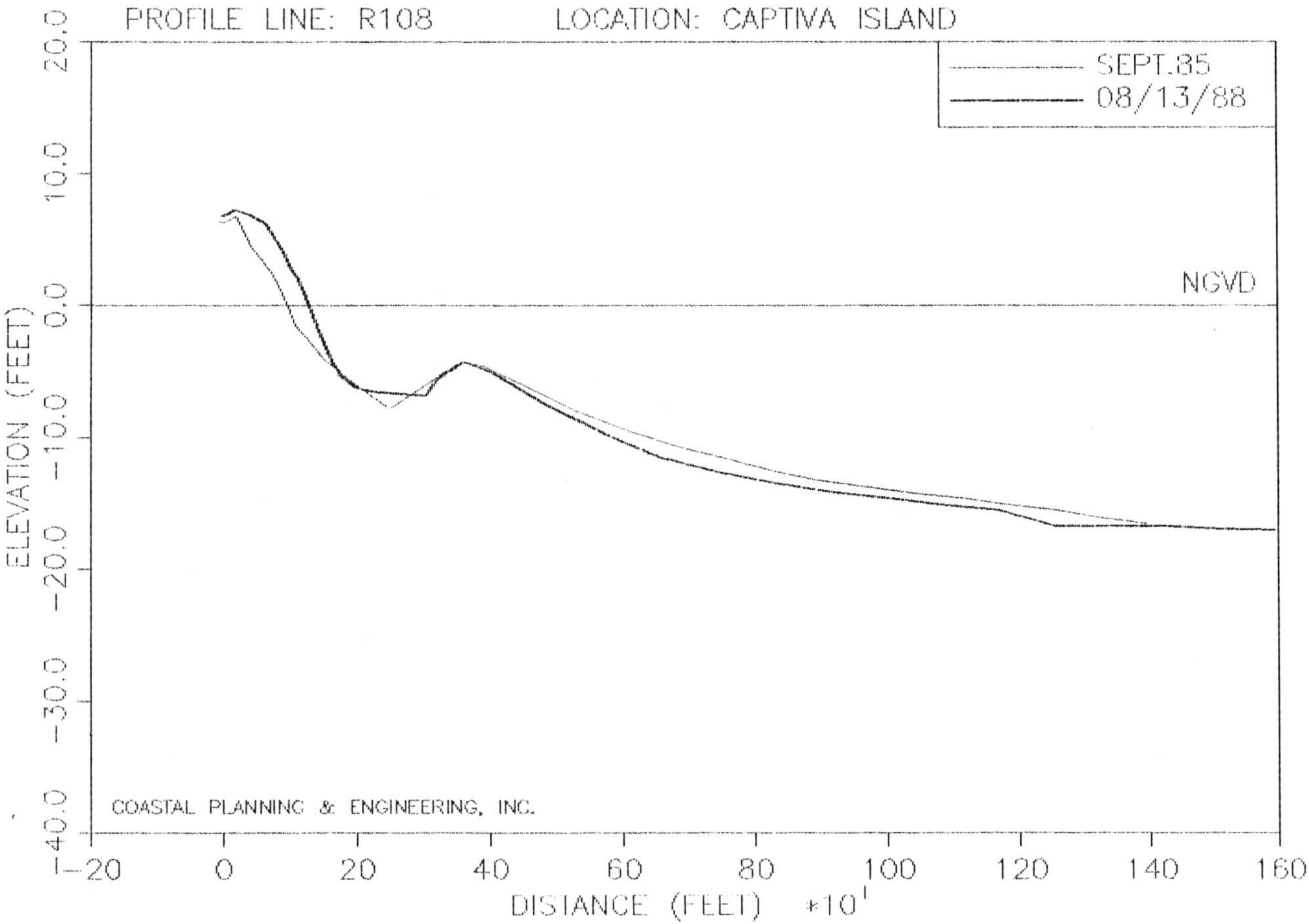
PROFILE LINE: R104
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

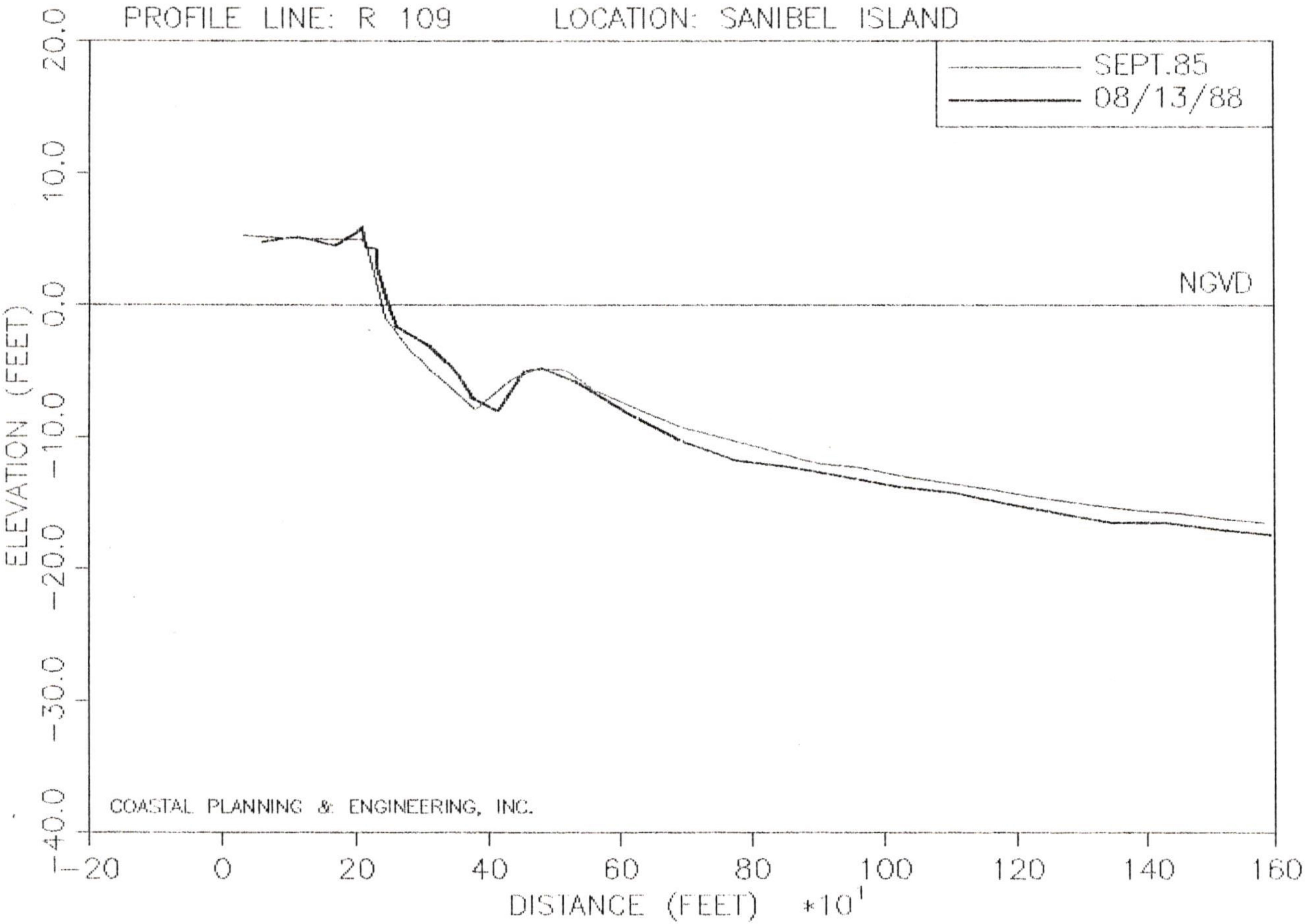


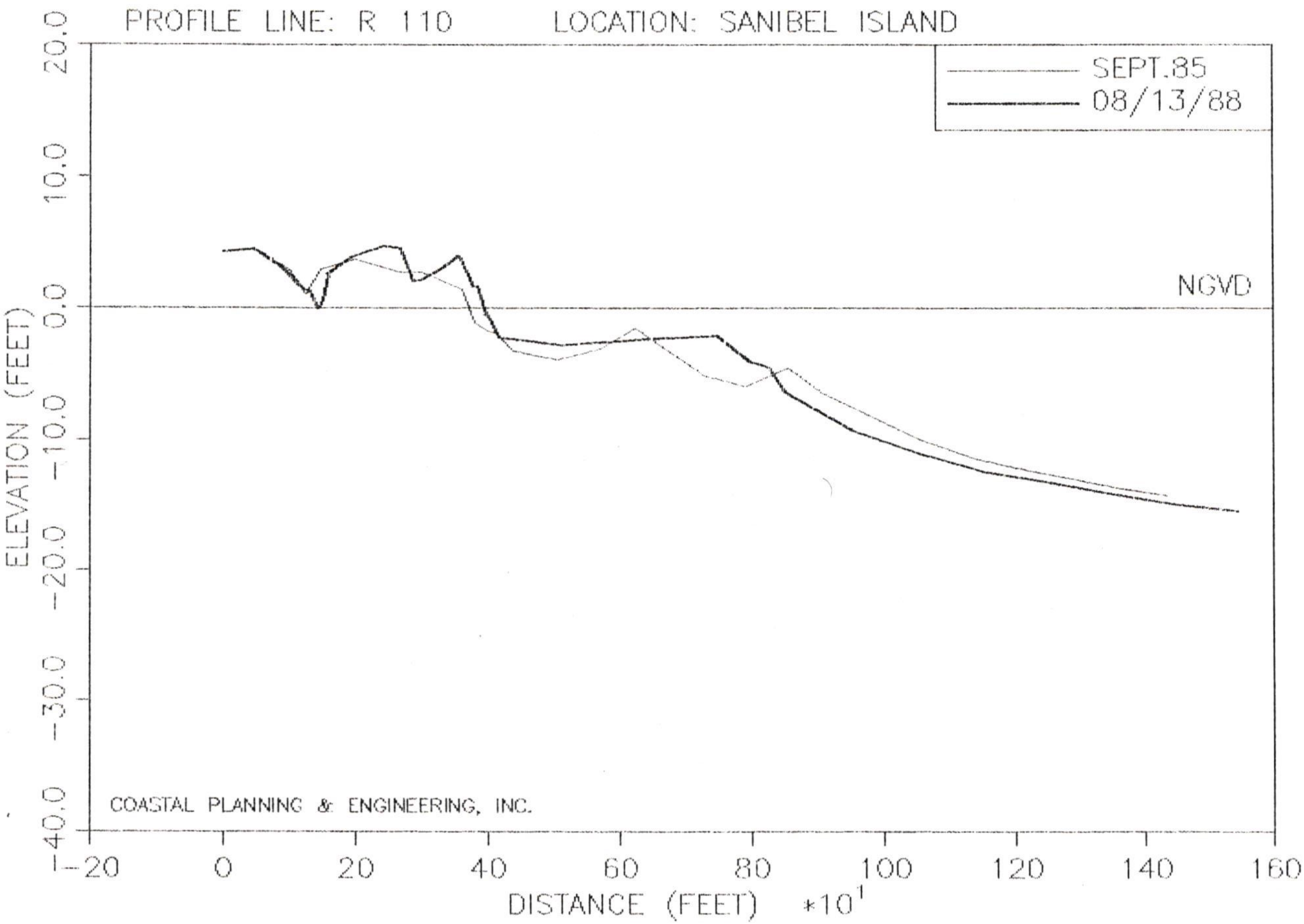
PROFILE LINE: R105
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R106
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

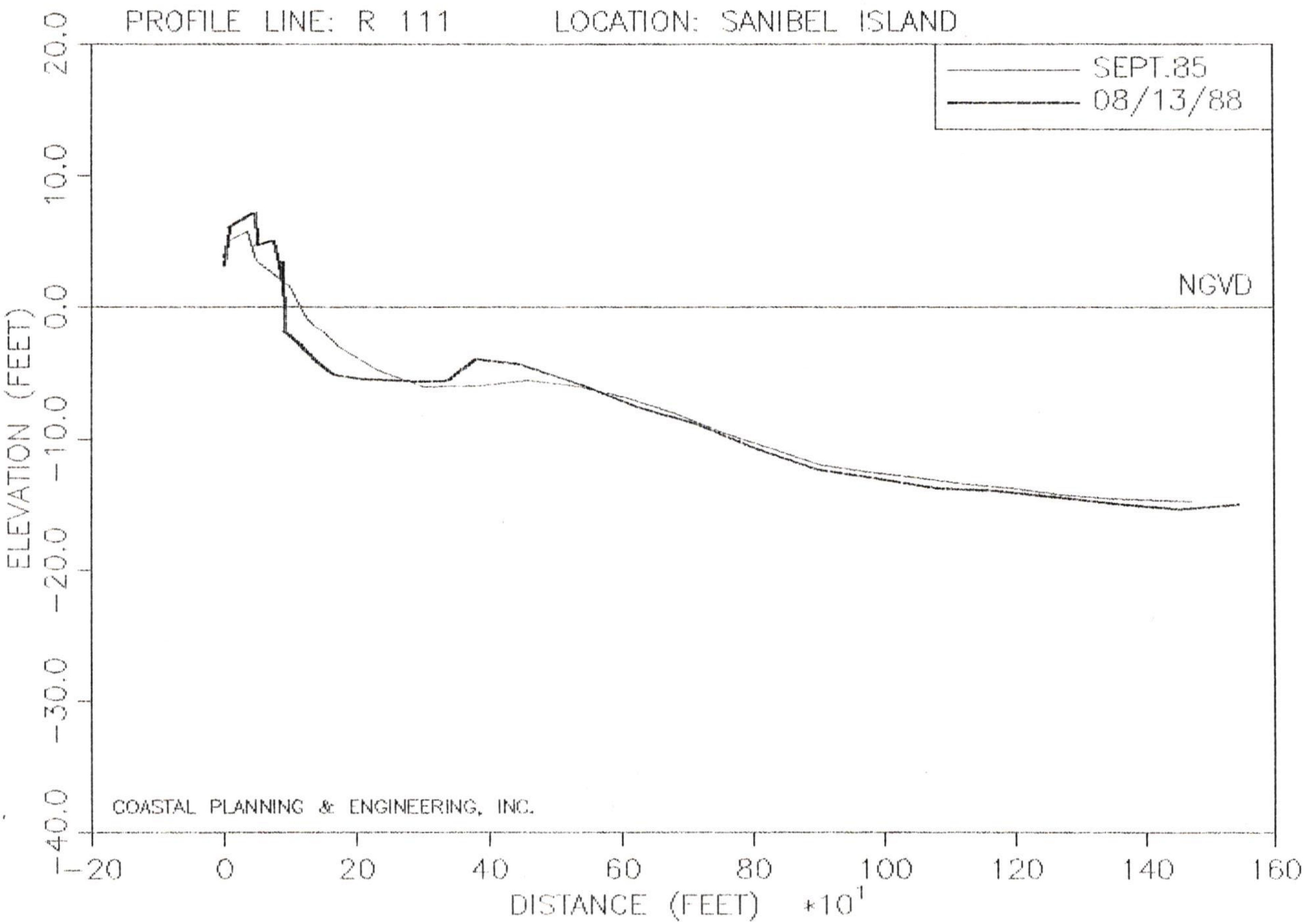

PROFILE LINE: R107
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10¹
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R108
LOCATION: CAPTIVA ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

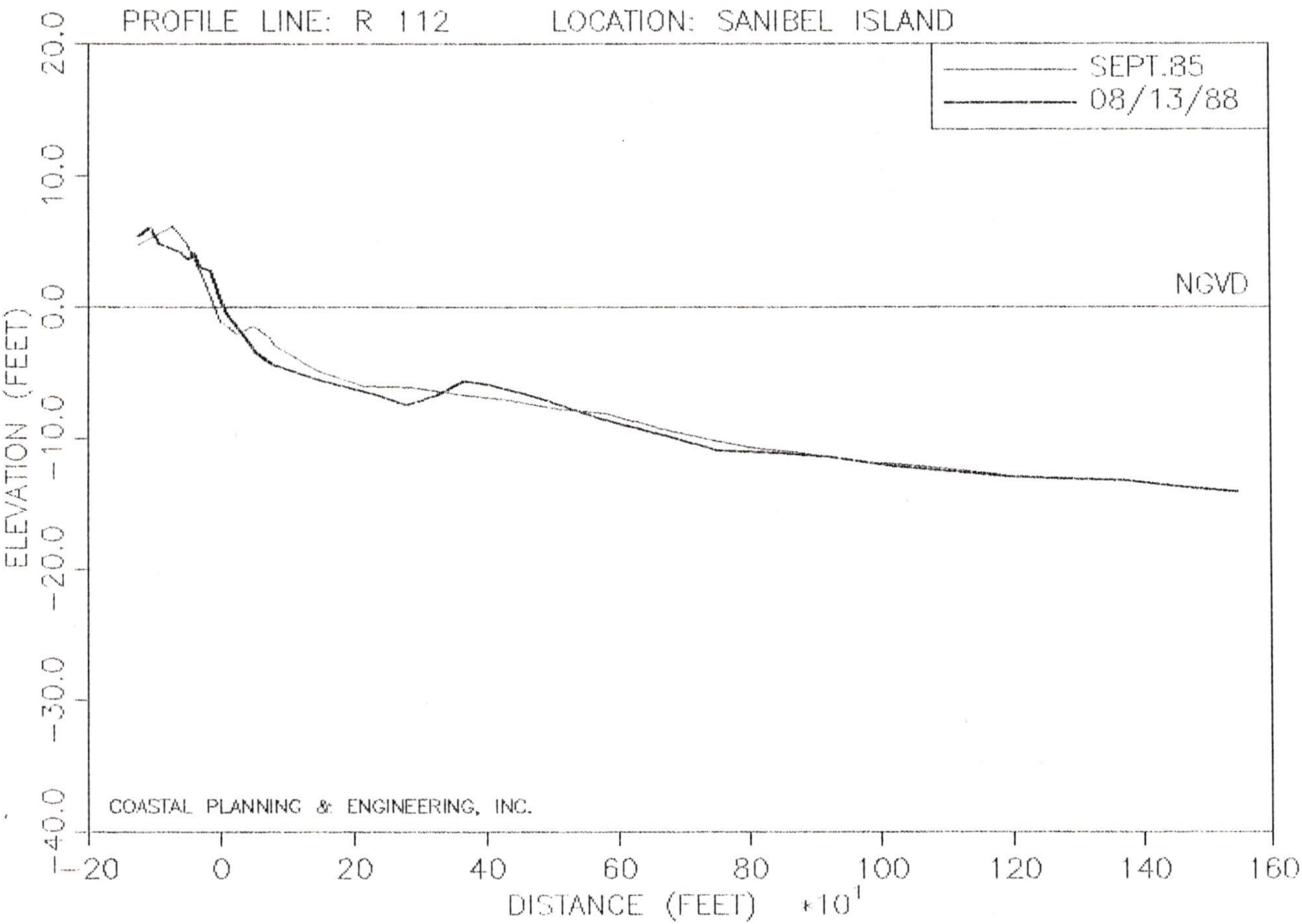

PROFILE LINE: R 109
LOCATION: SANIBEL ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



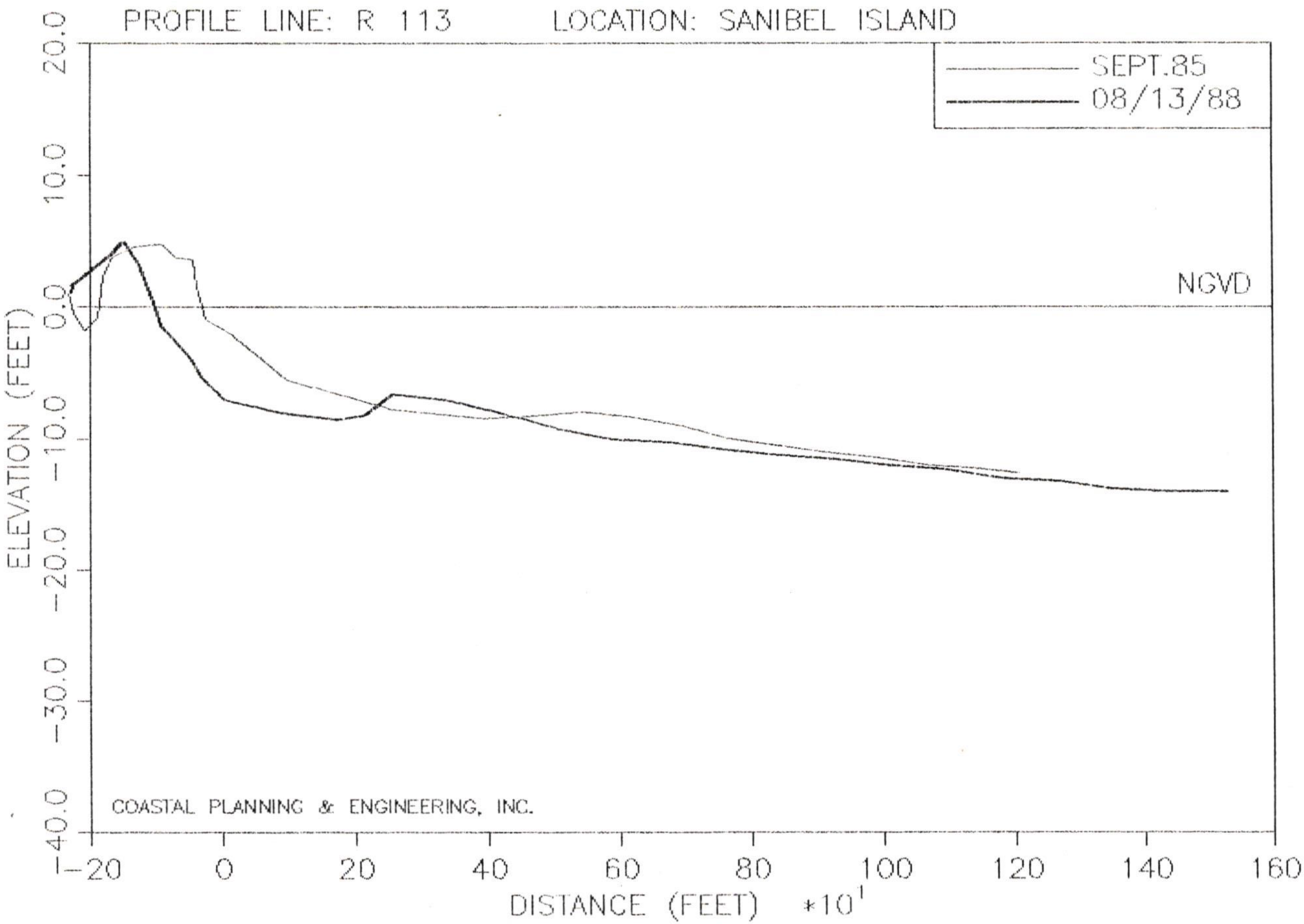
PROFILE LINE: R 110
LOCATION: SANIBEL ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



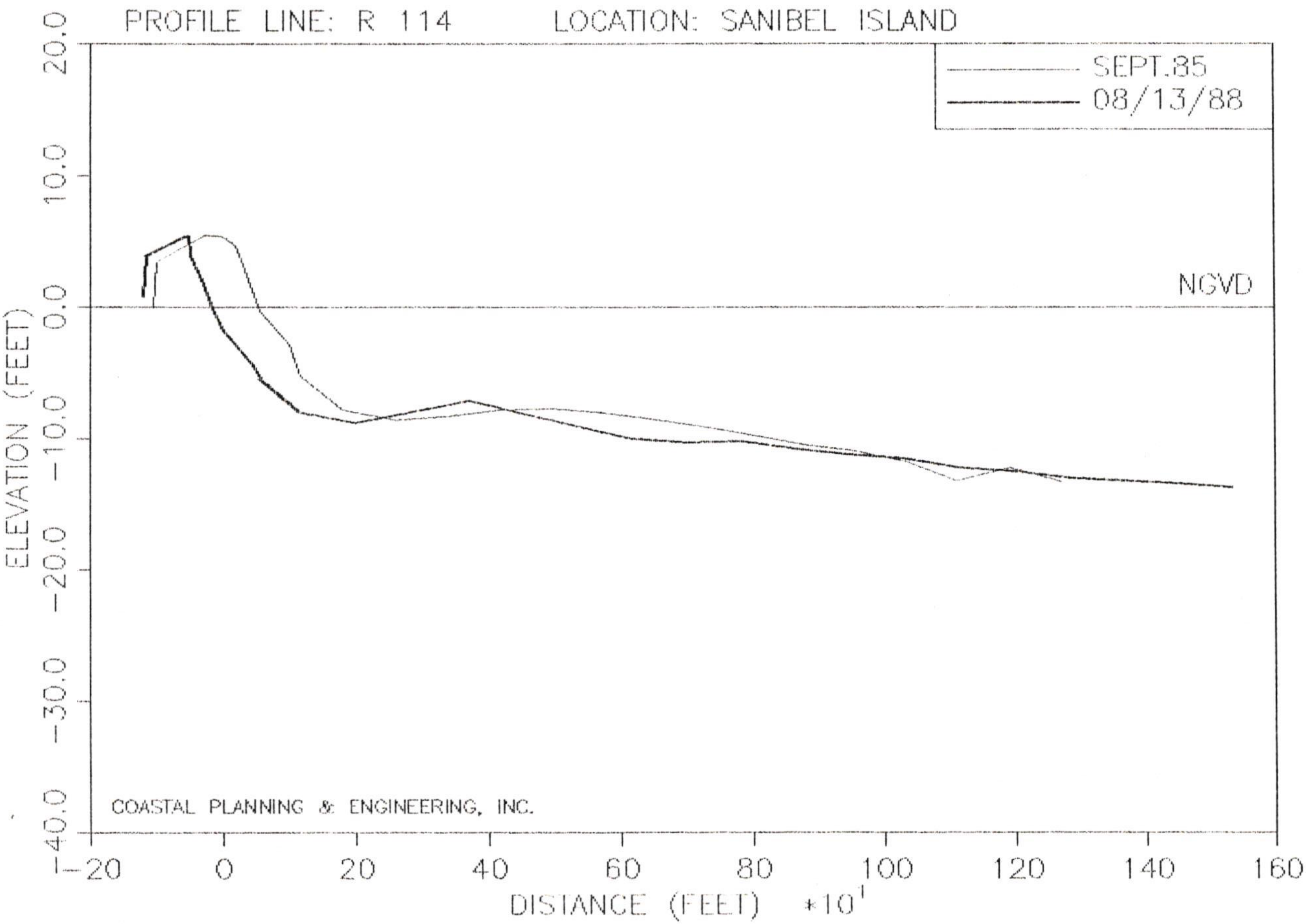
PROFILE LINE: R 111
LOCATION: SANIBEL ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



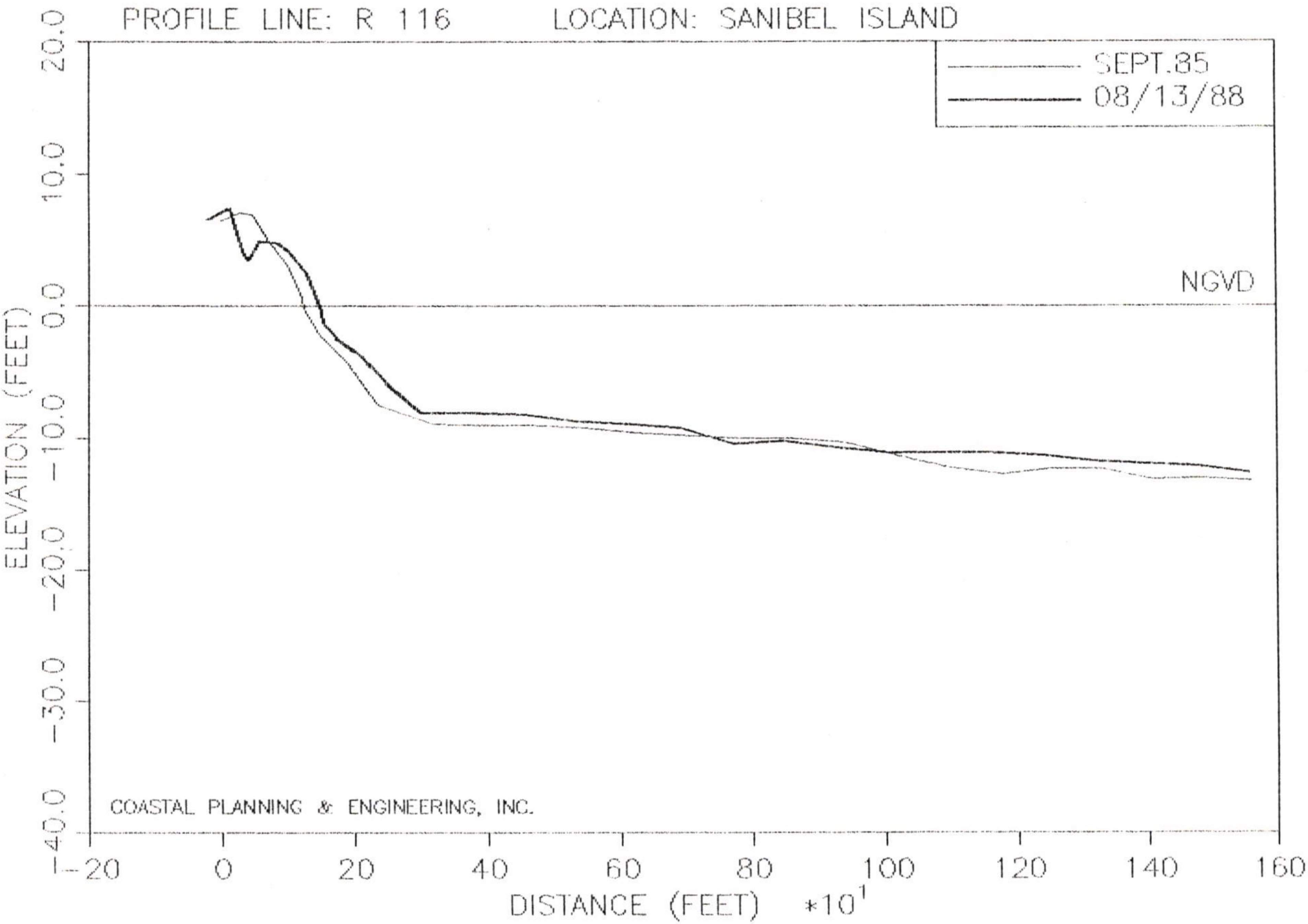
PROFILE LINE: R 112
LOCATION: SANIBEL ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

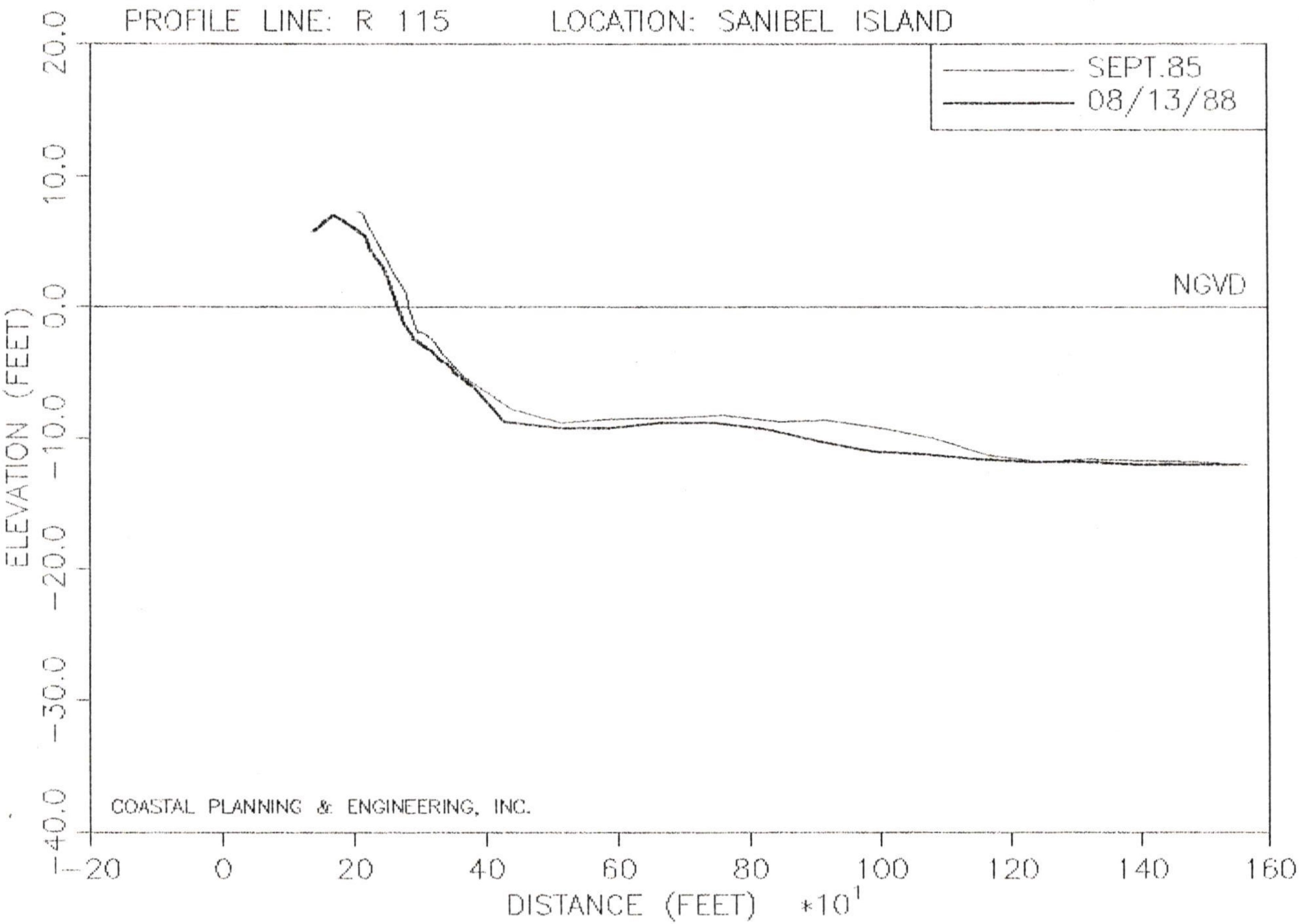


PROFILE LINE: R 113
LOCATION: SANIBEL ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



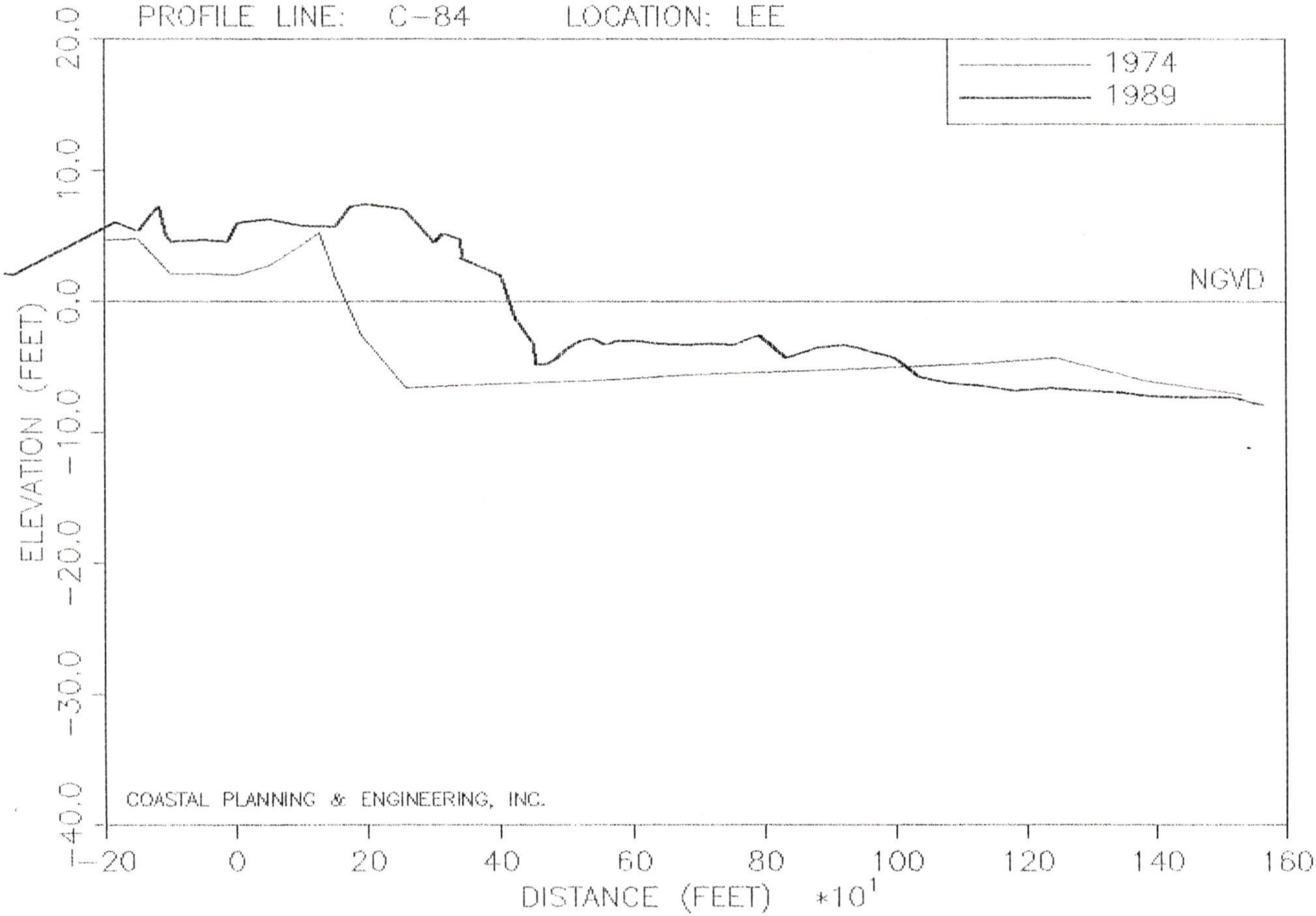
PROFILE LINE: R 114
LOCATION: SANIBEL ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]


PROFILE LINE: R 116
LOCATION: SANIBEL ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

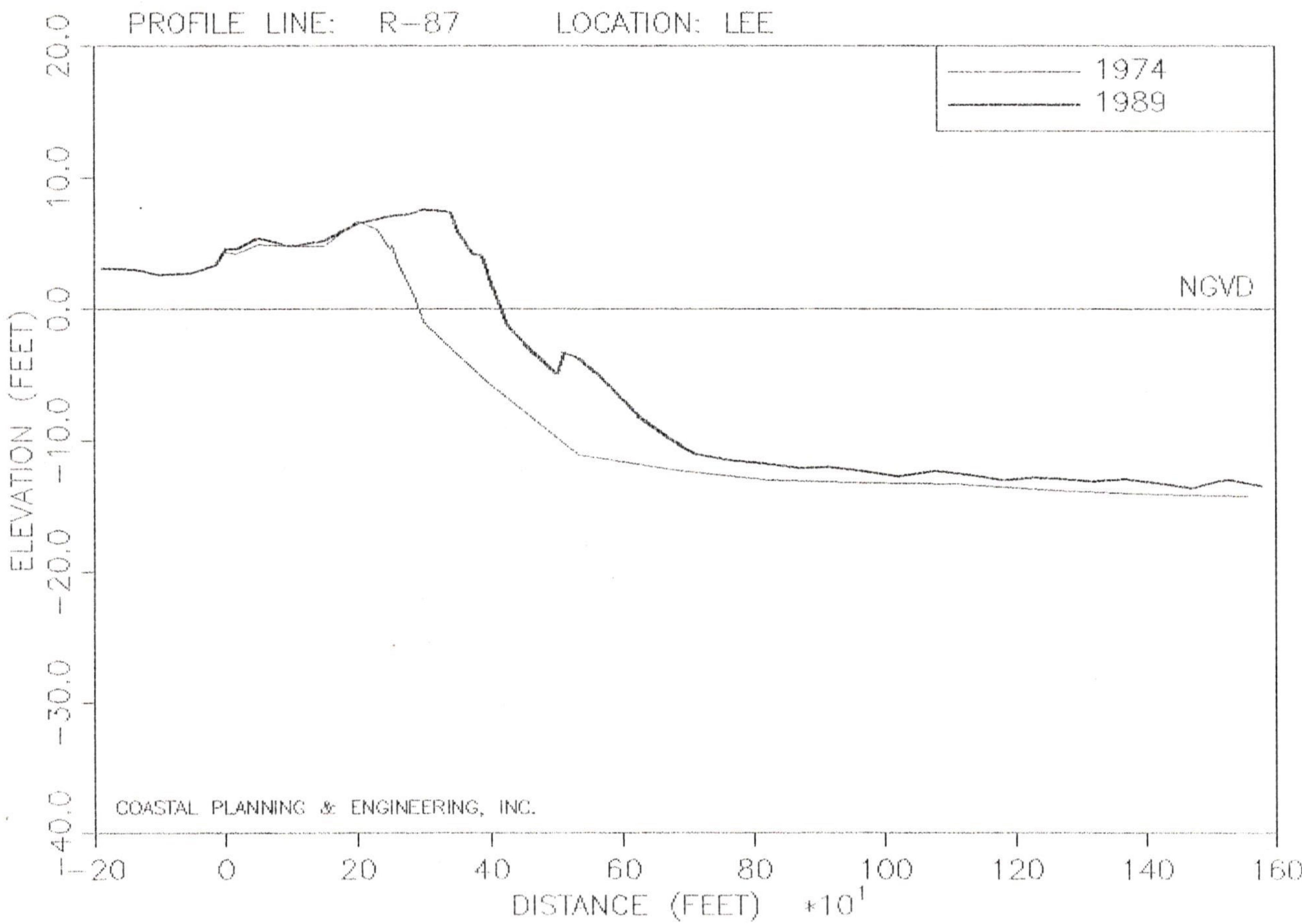

PROFILE LINE: R 115
LOCATION: SANIBEL ISLAND
SEPT.85
08/13/88
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

Comparative Beach Profile Plots

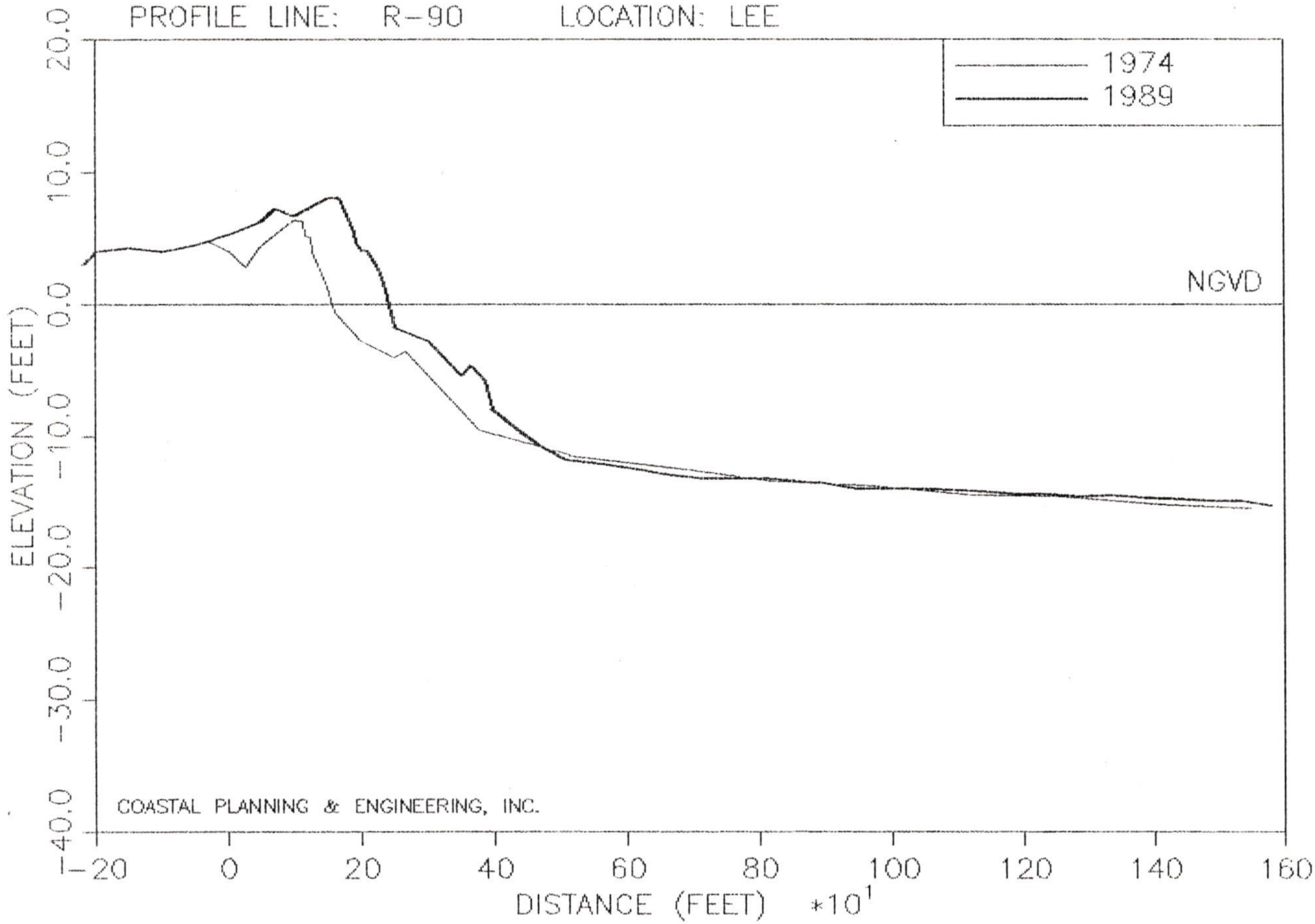
1974 vs. 1989



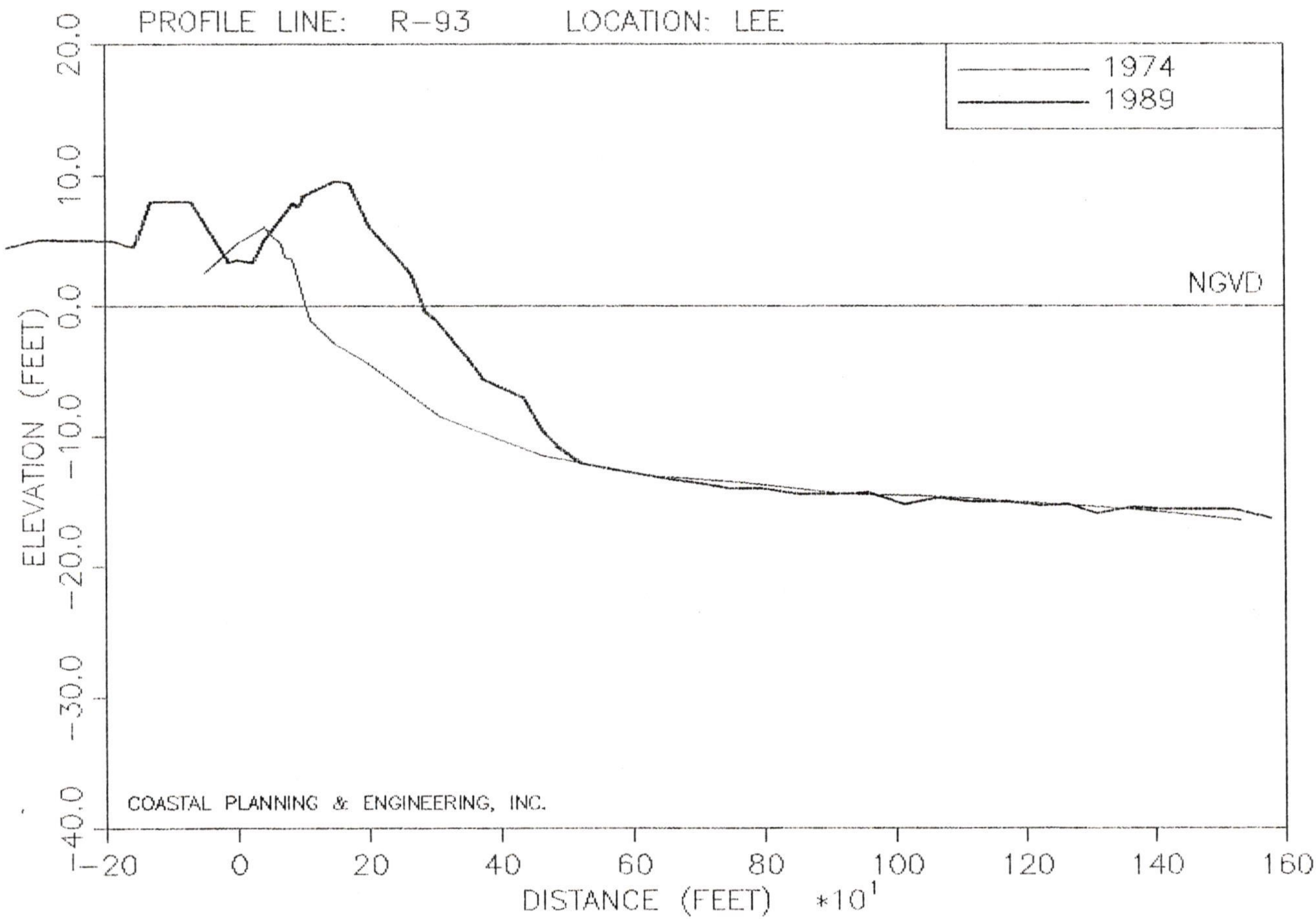
PROFILE LINE: C-84 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

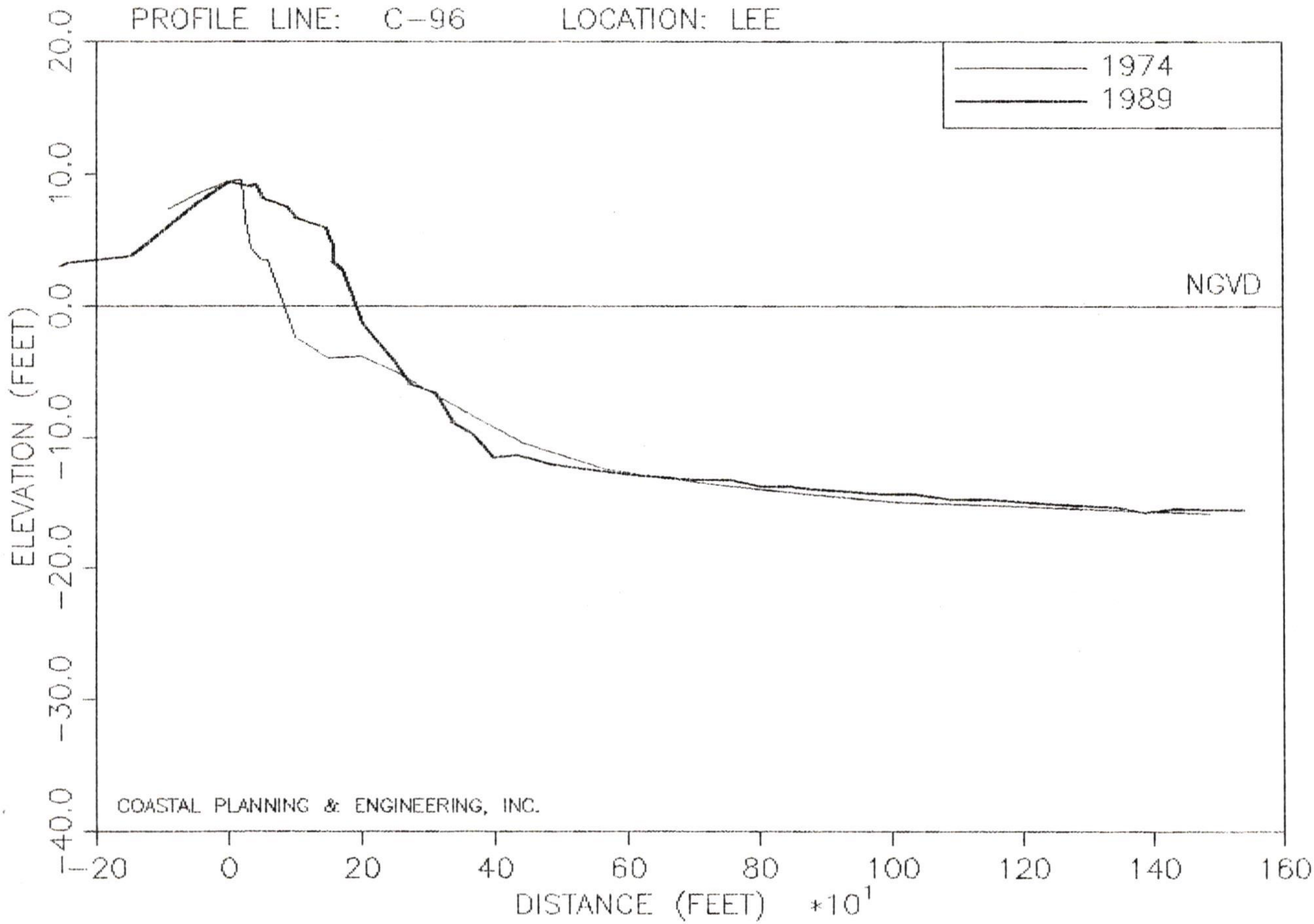


PROFILE LINE: R-87 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

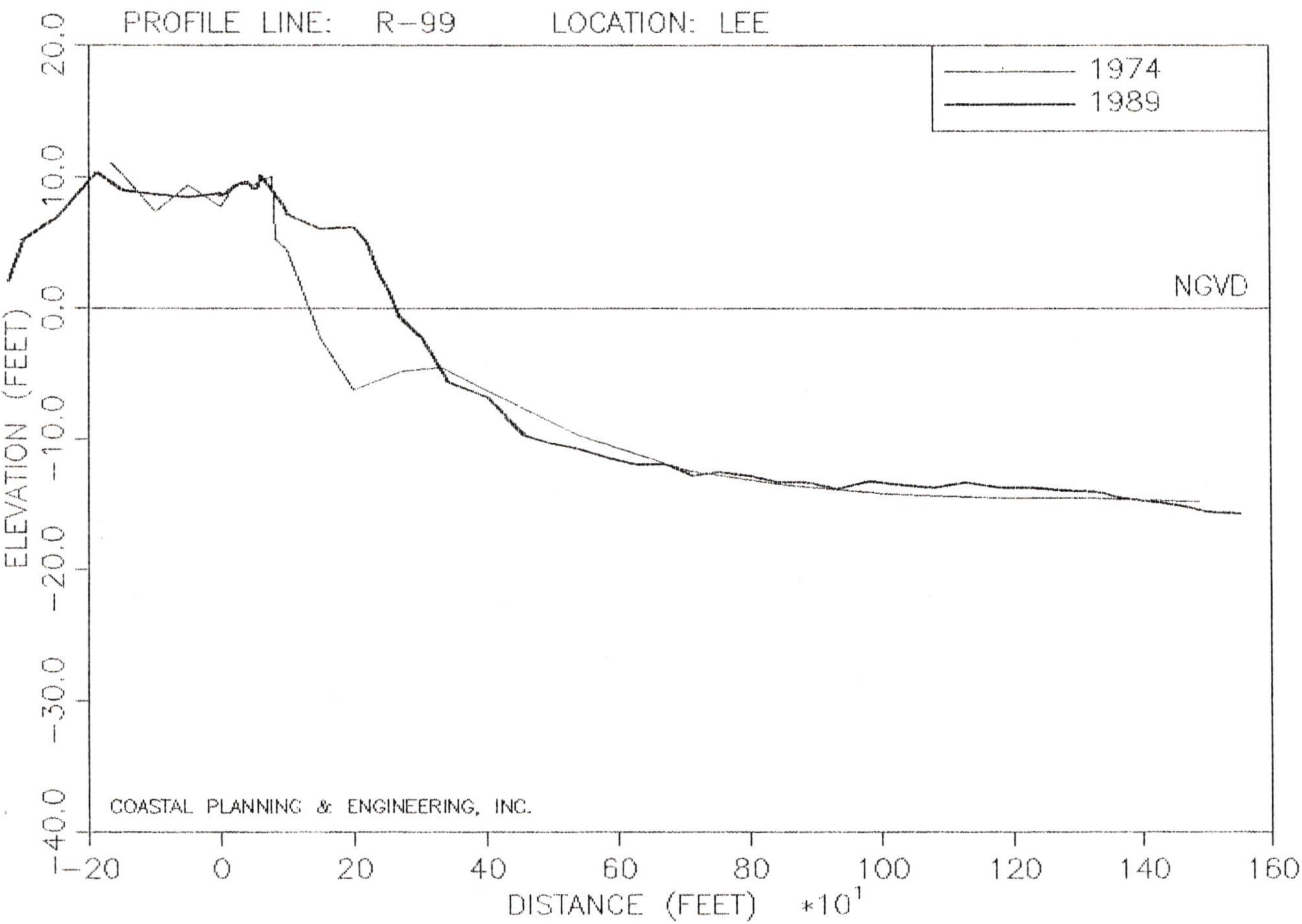


PROFILE LINE: R-90 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

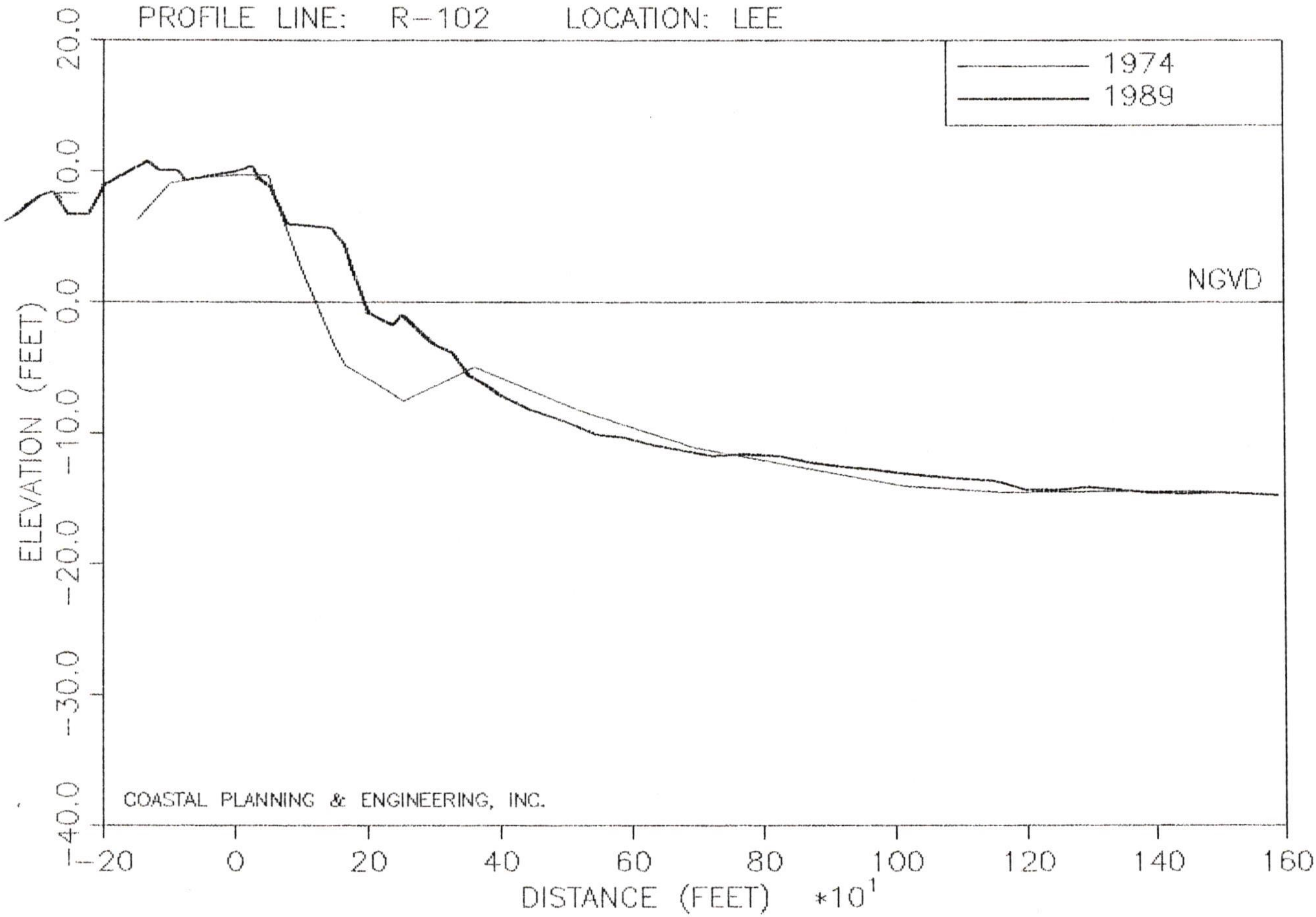

PROFILE LINE: R-93
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10¹

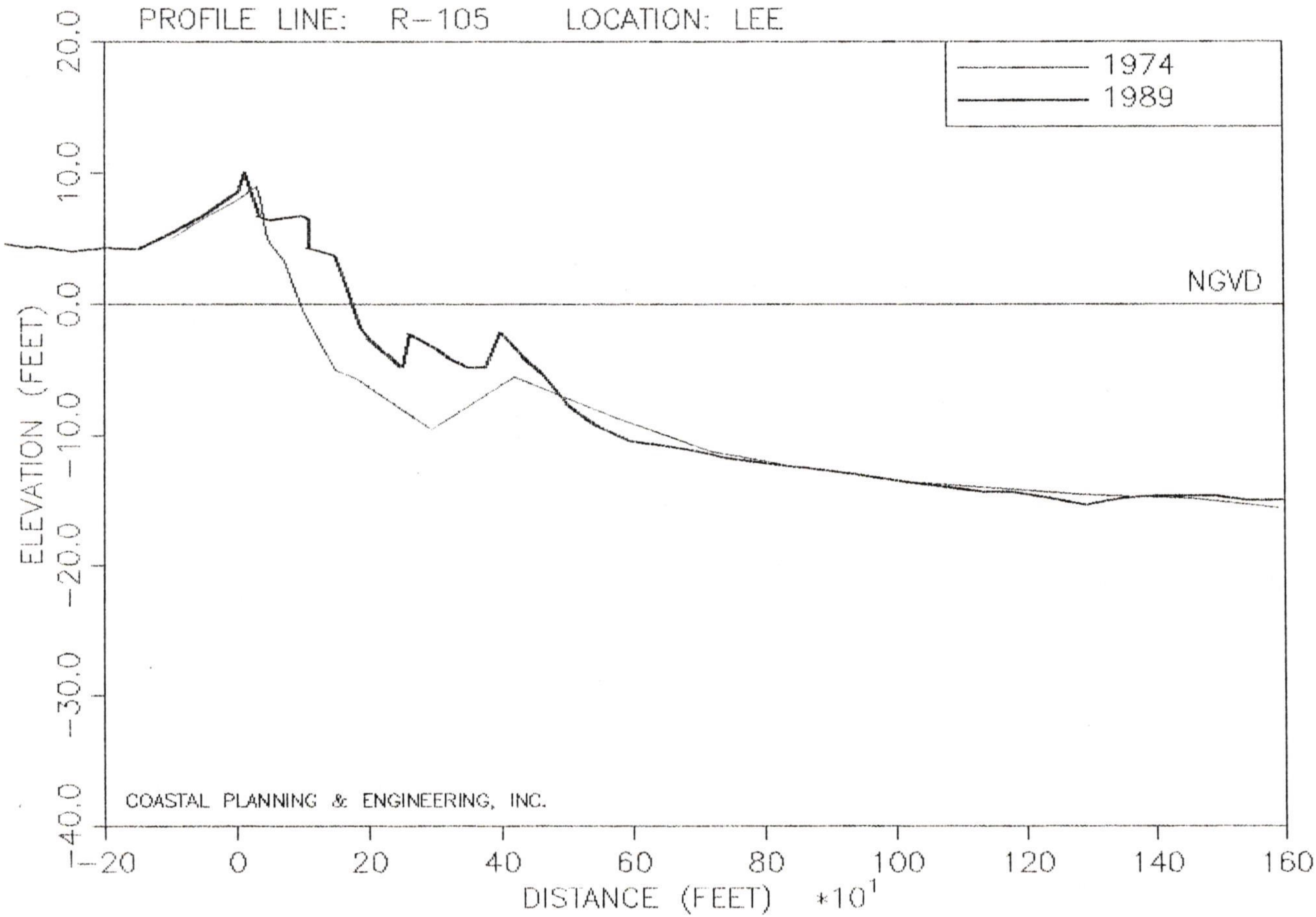


PROFILE LINE: C-96
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

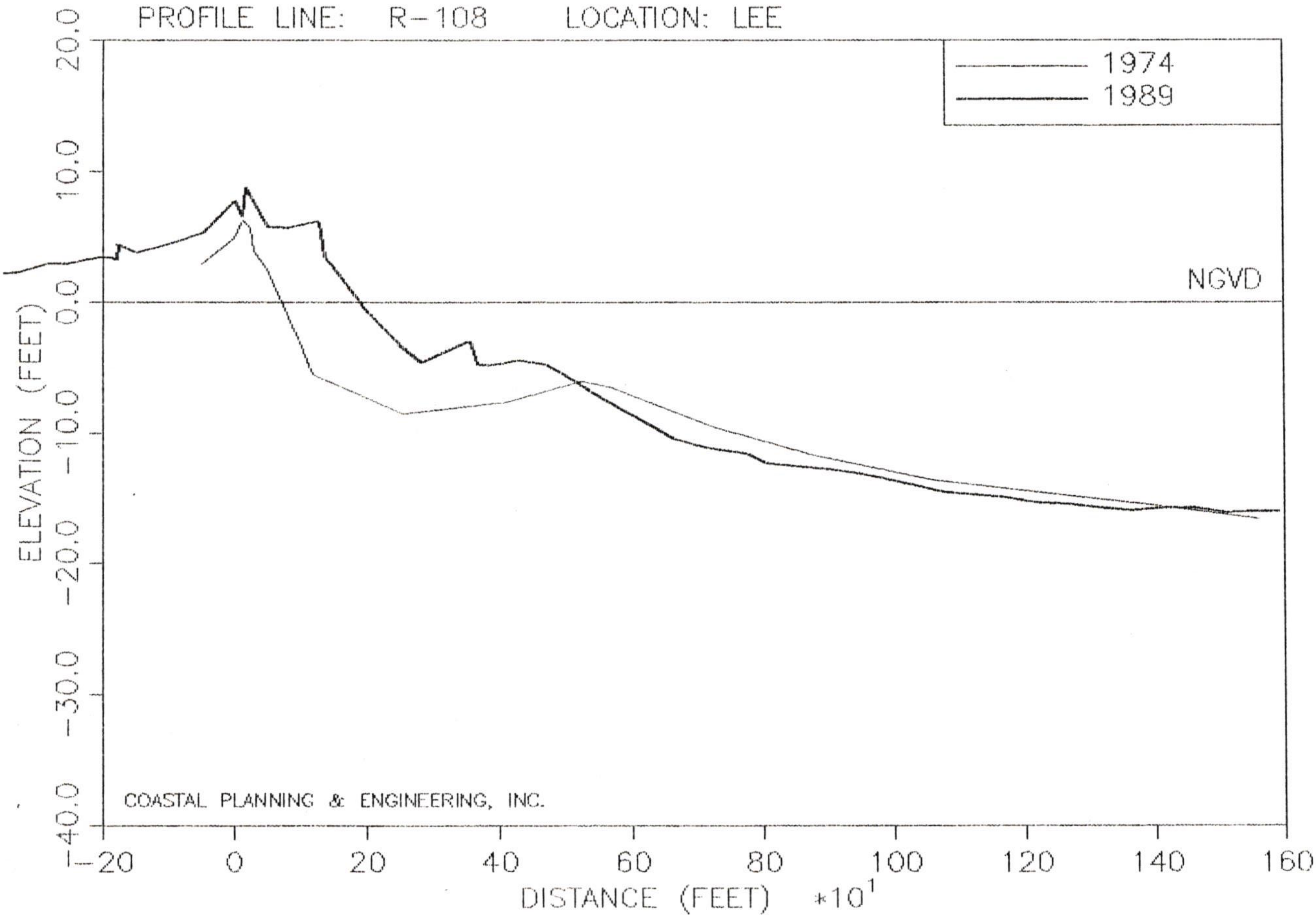


PROFILE LINE: R-99
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

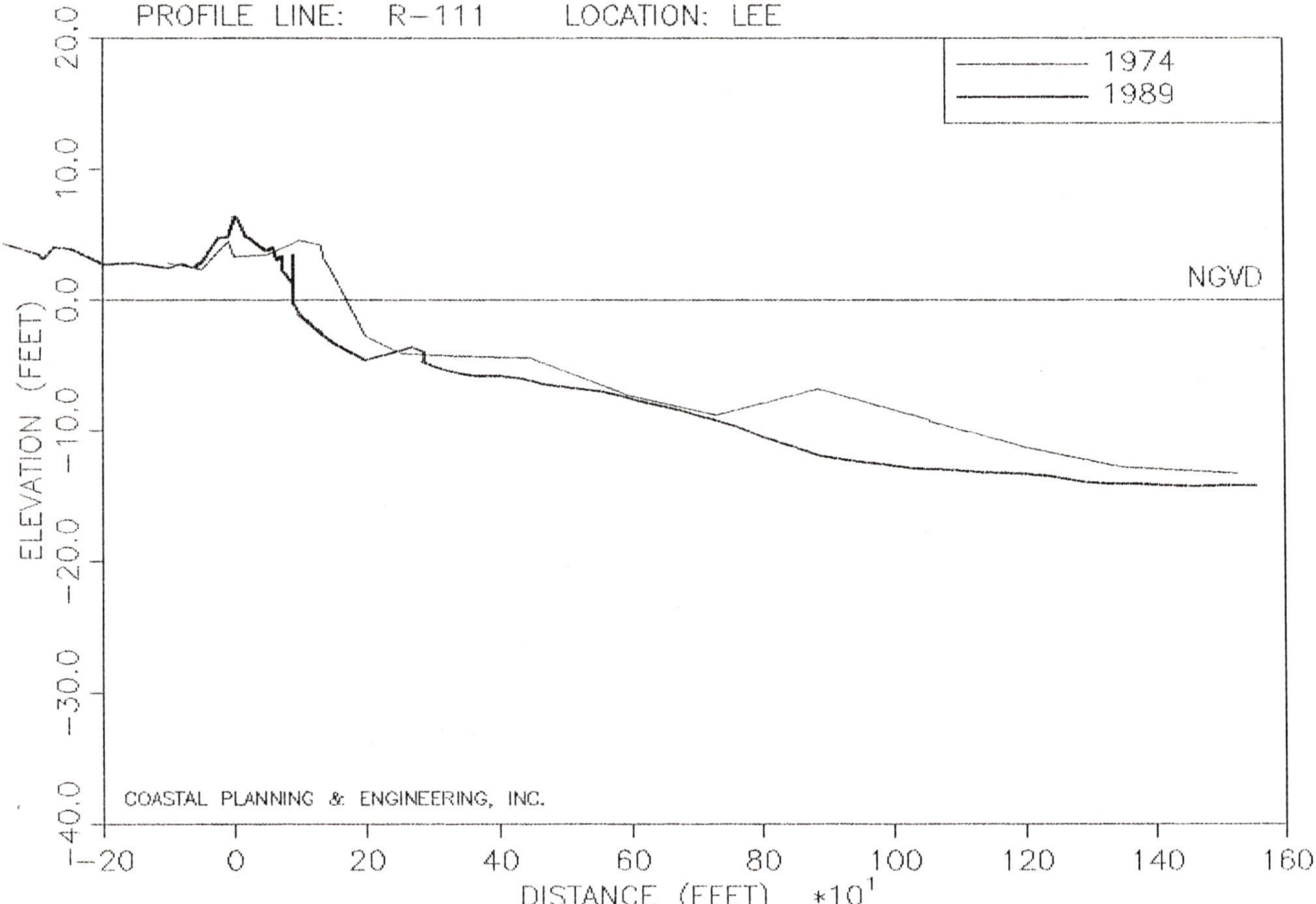

PROFILE LINE: R-102 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



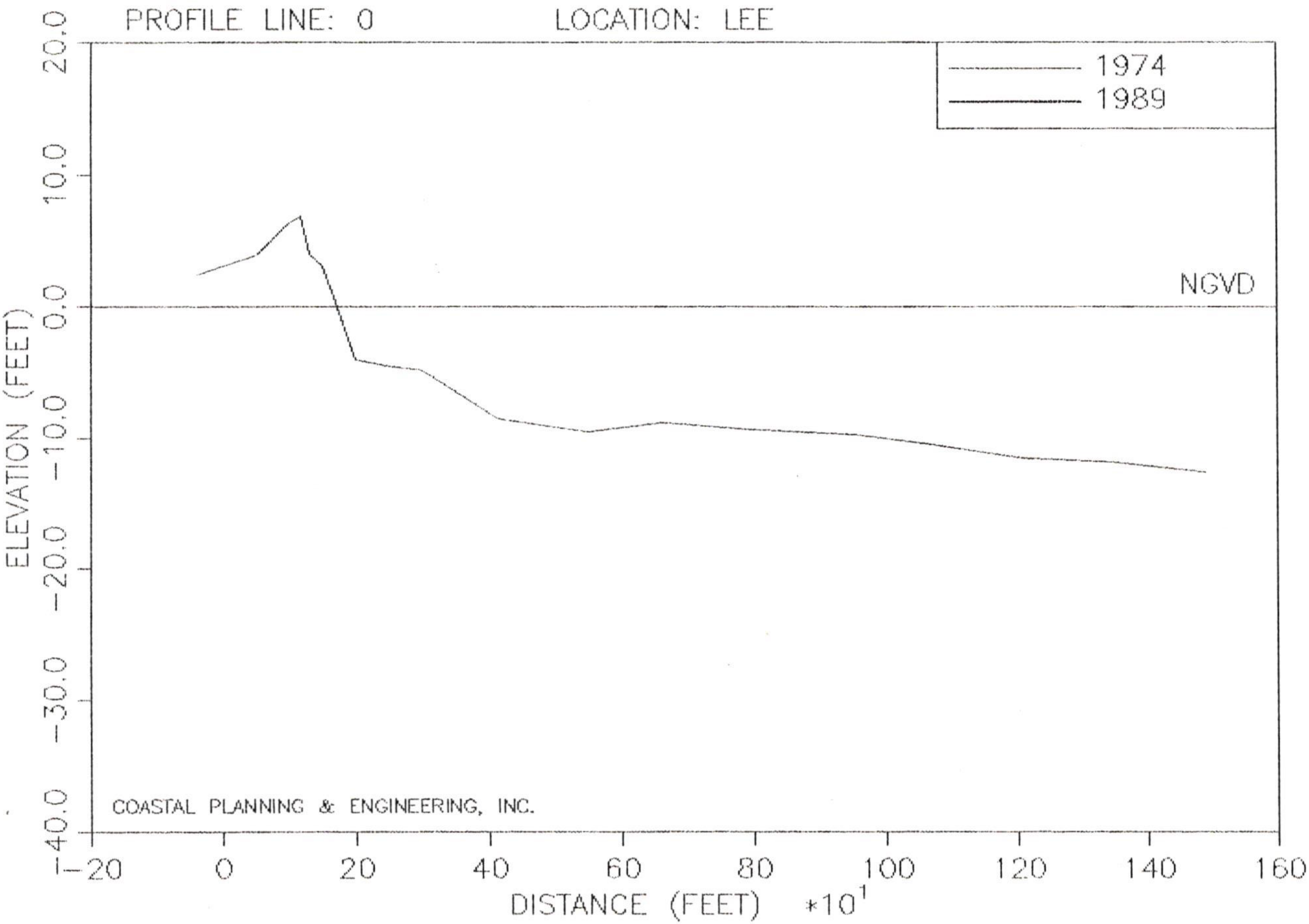
PROFILE LINE: R-105 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



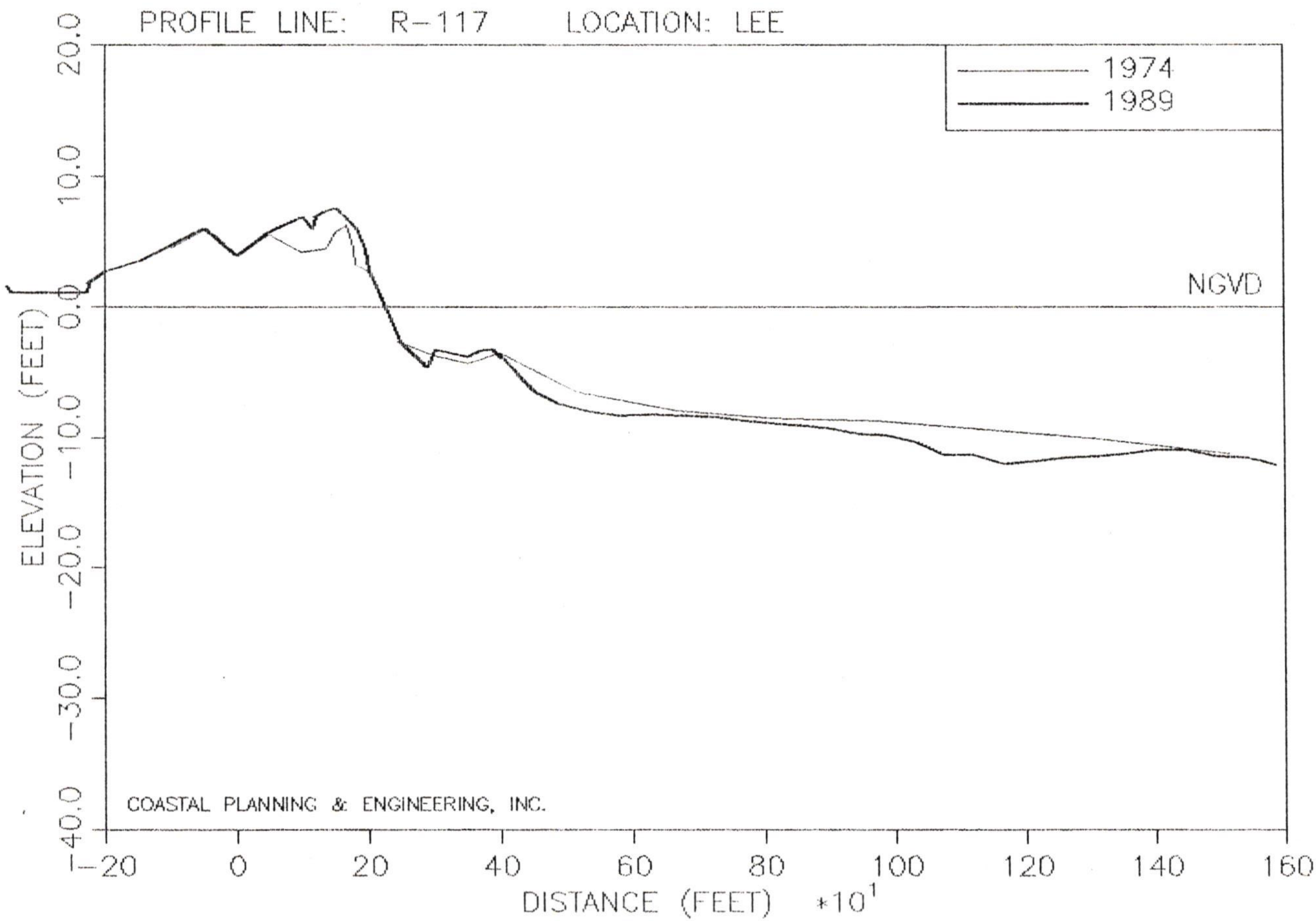
PROFILE LINE: R-108 LOCATION: LEE
1974
1989
NGVD
COASTAL PLANNING & ENGINEERING, INC.
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



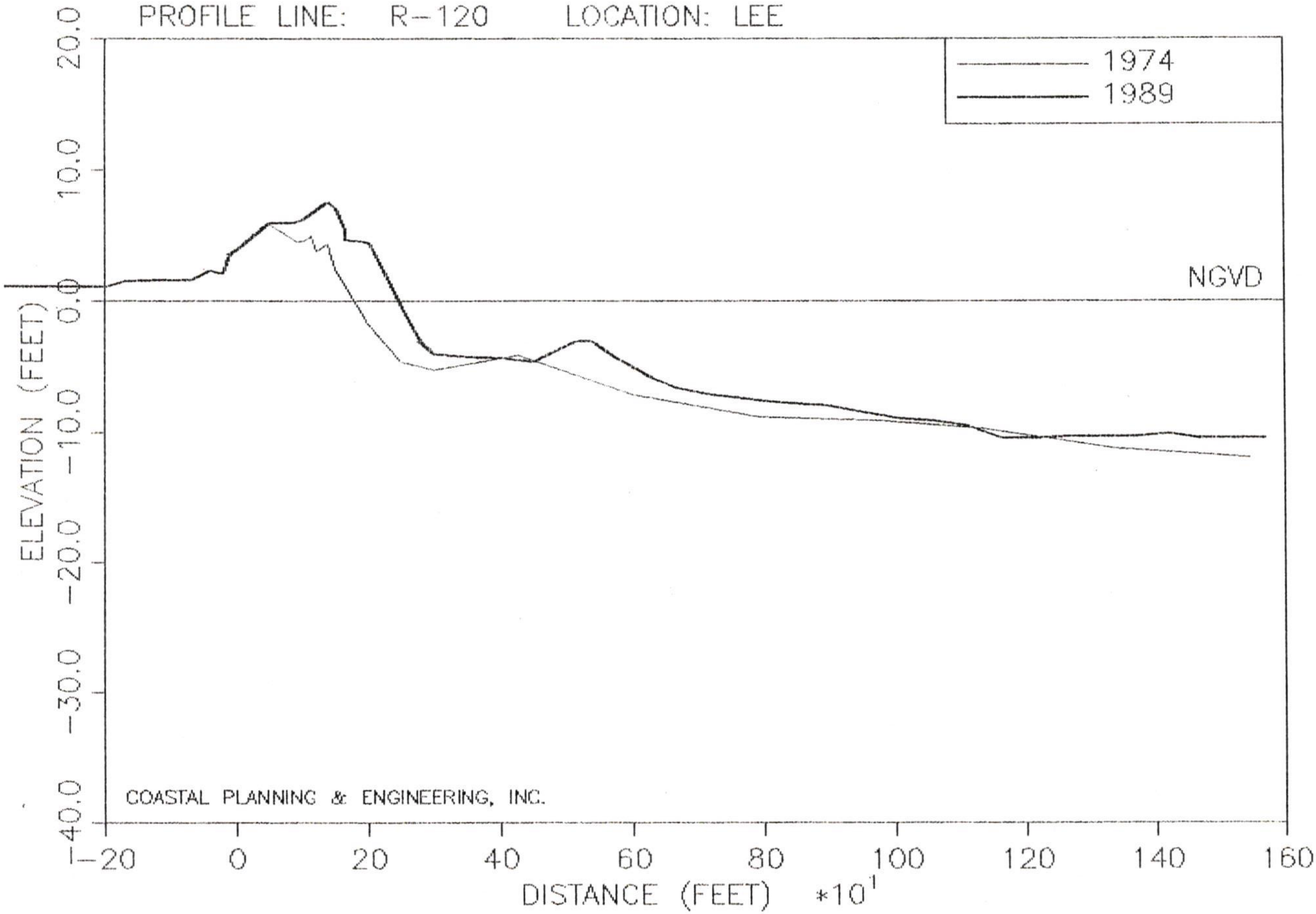
PROFILE LINE: R-111 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

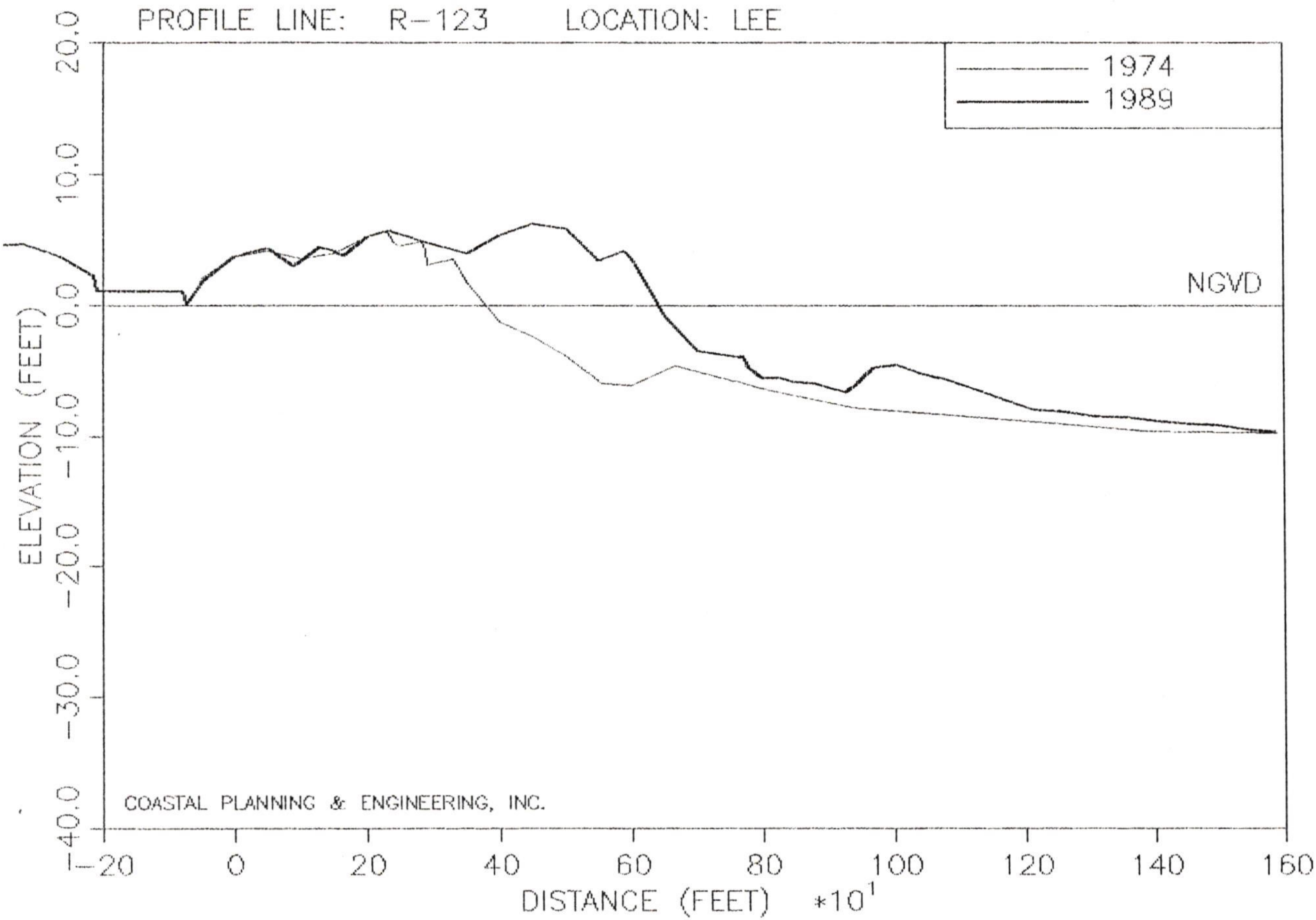


PROFILE LINE: 0
LOCATION: LEE
1974
1989
NGVD
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
ELEVATION (FEET)
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

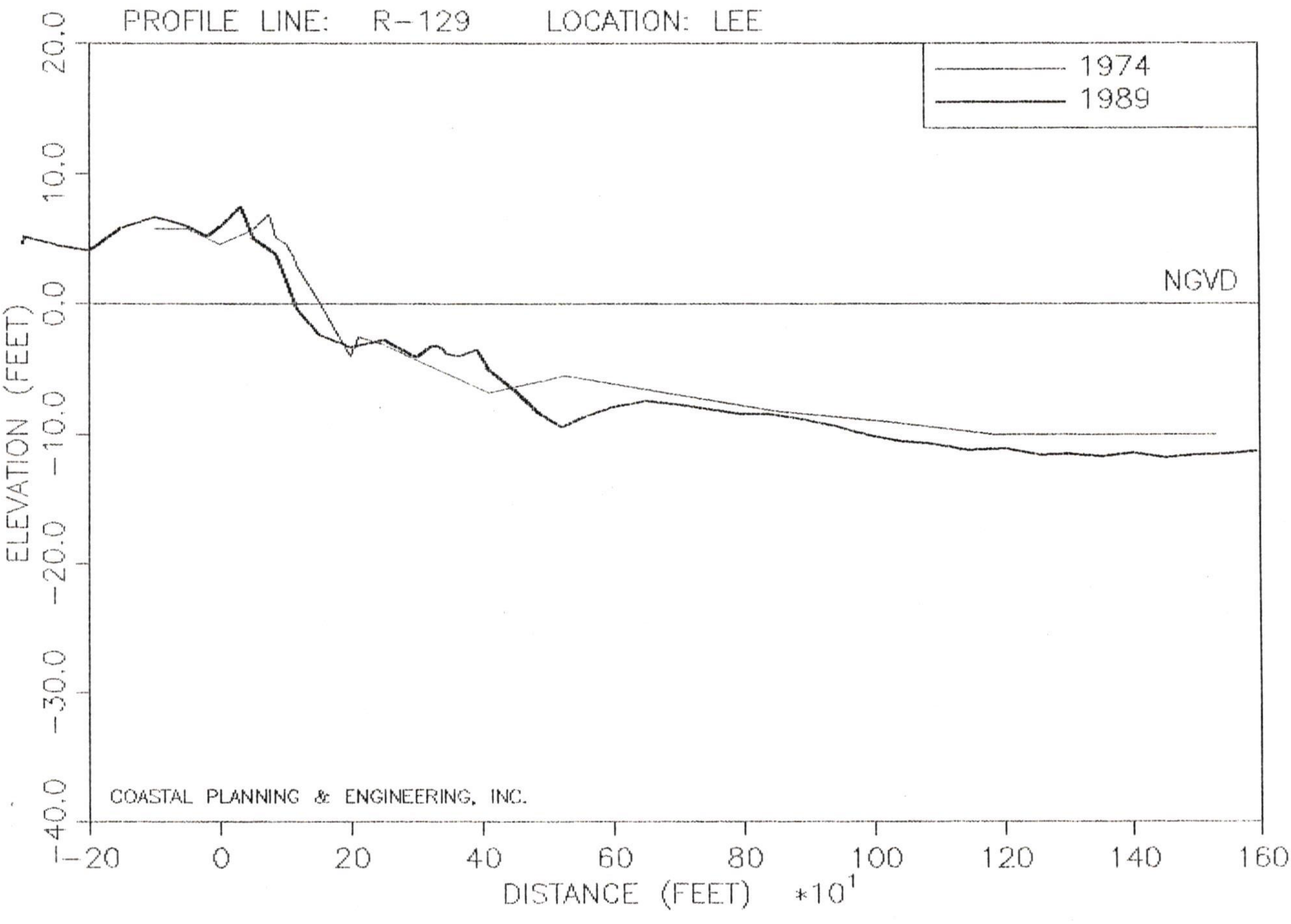


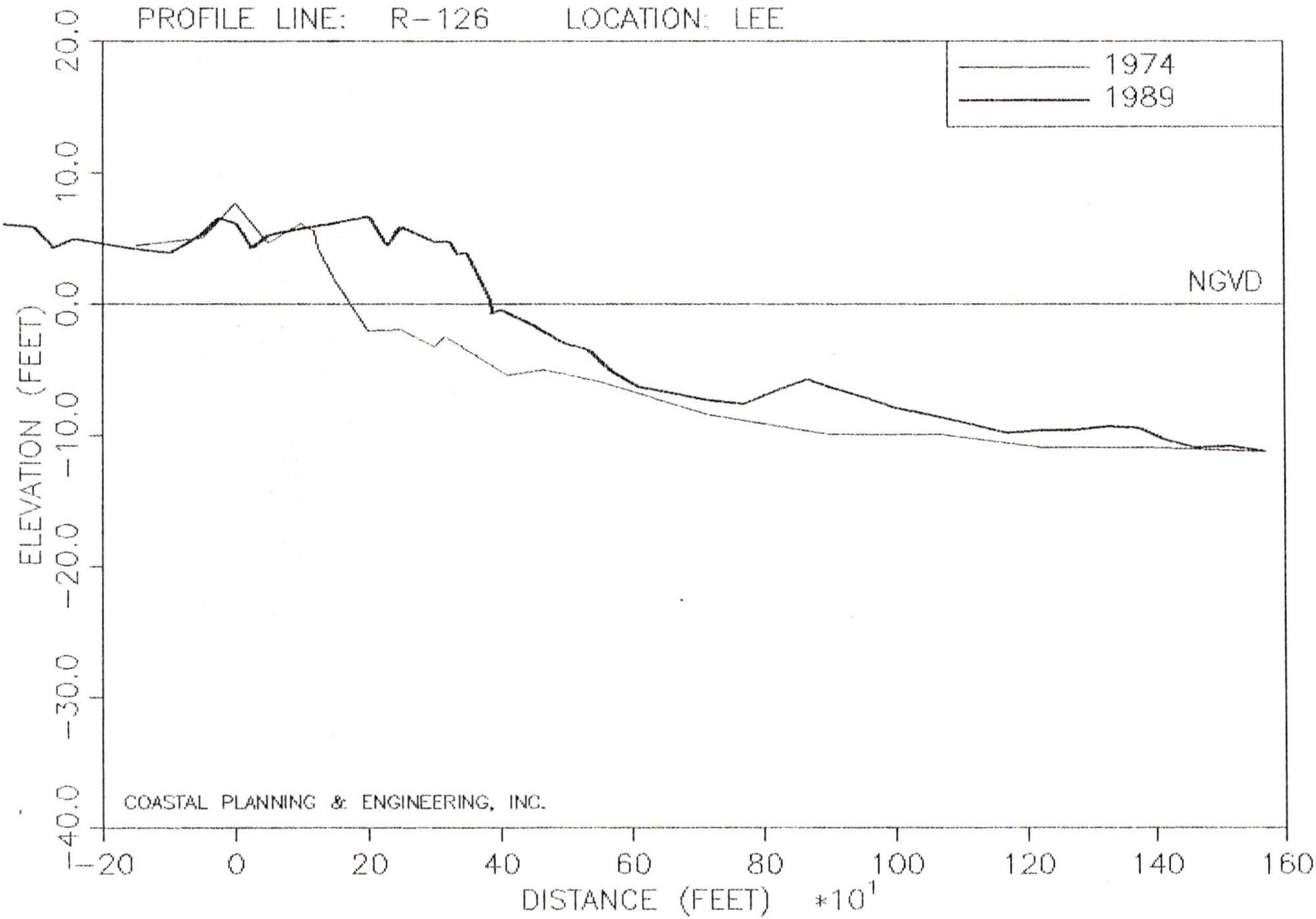
PROFILE LINE: R-117 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]


PROFILE LINE: R-120 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1



PROFILE LINE: R-123 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

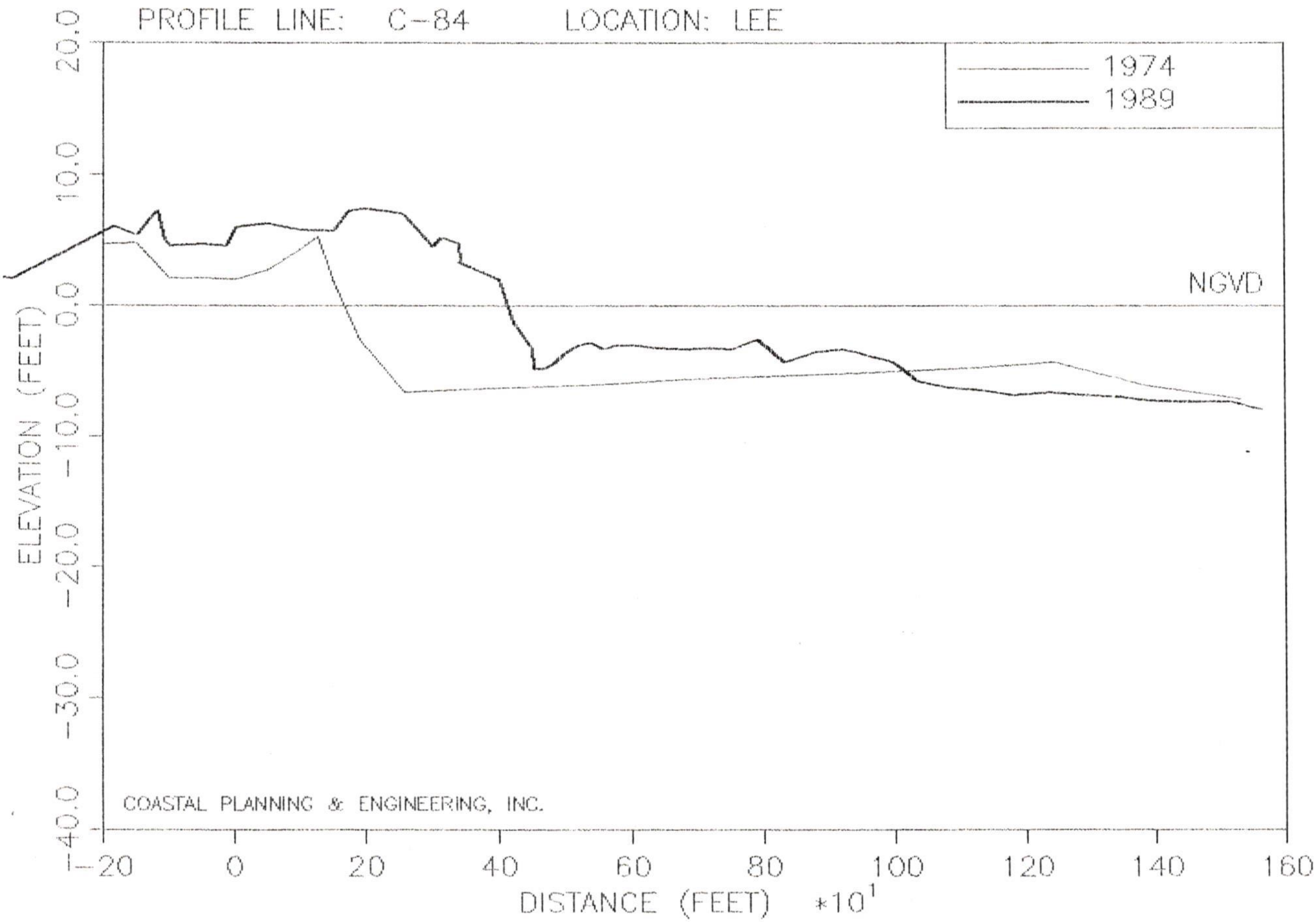

PROFILE LINE: R-129 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

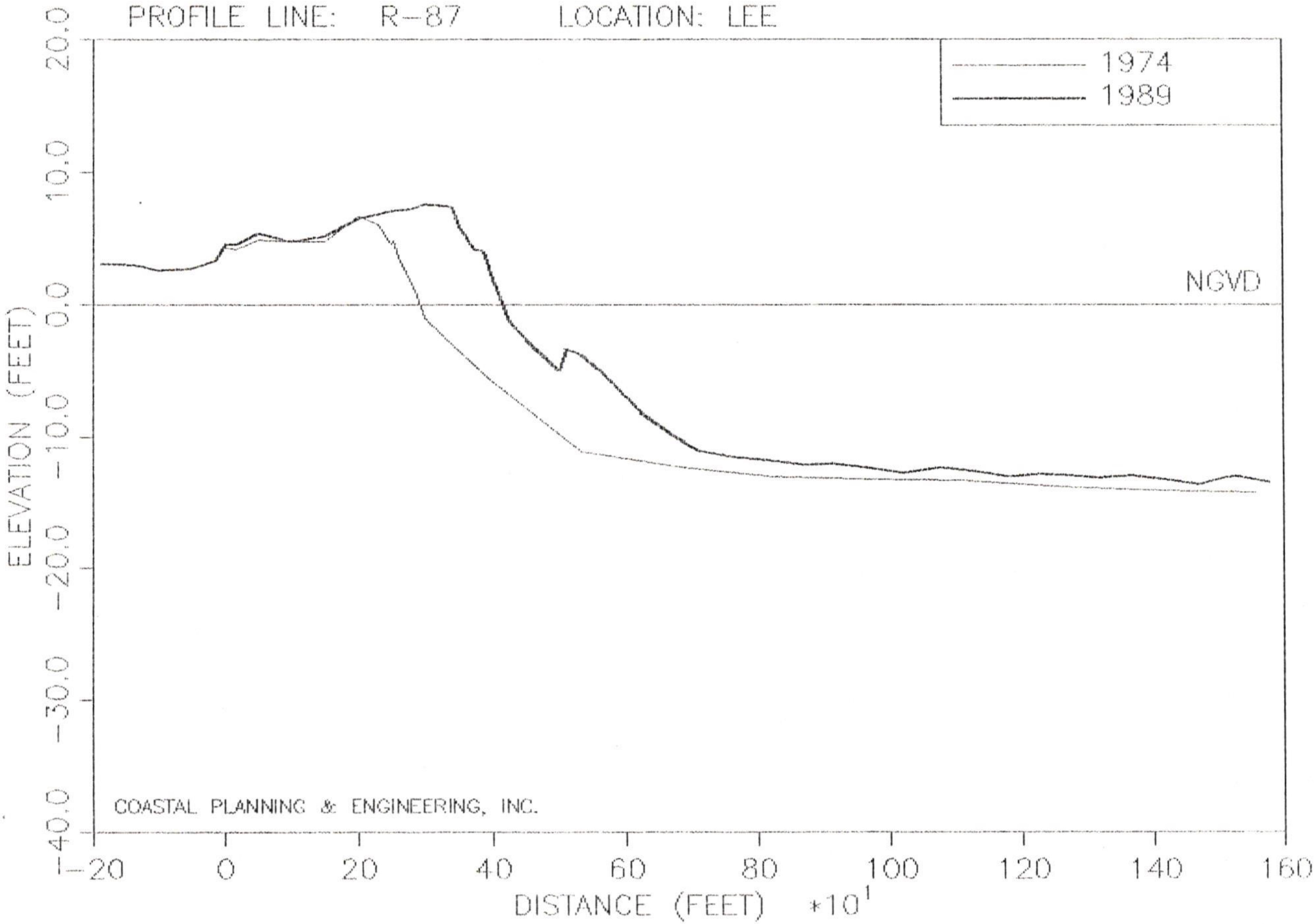


PROFILE LINE: R-126 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

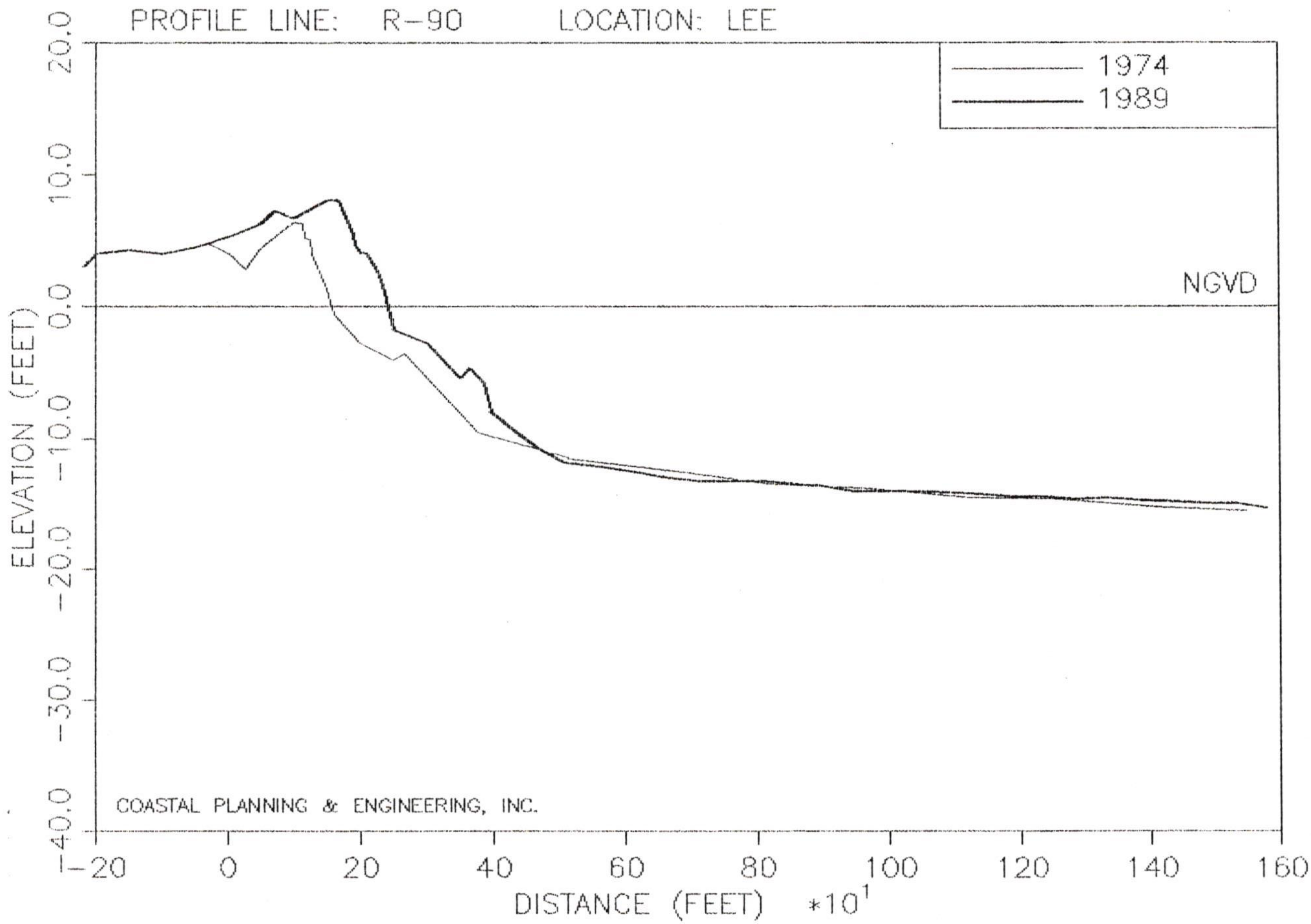
Comparative Beach Profile Plots

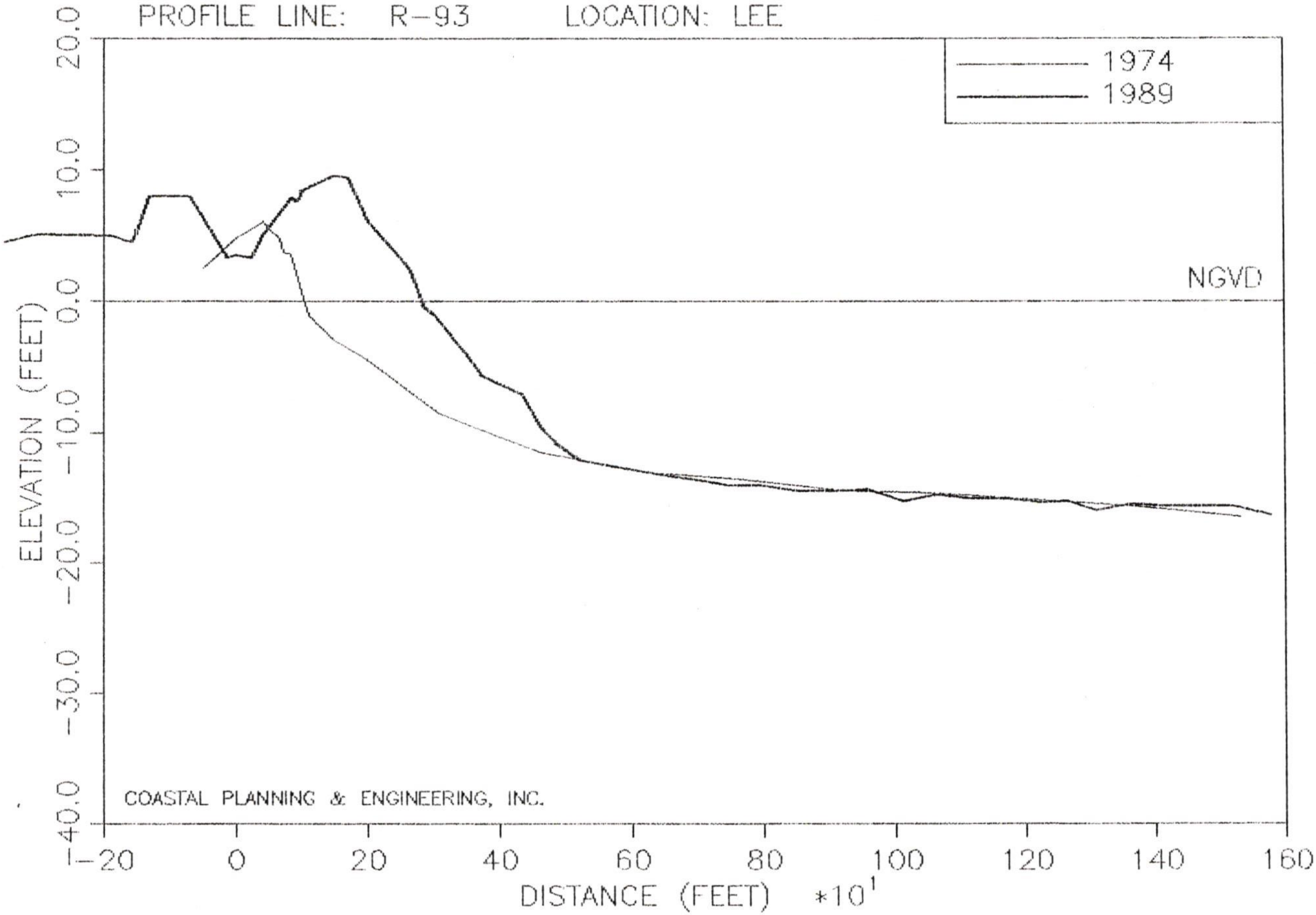
1974 vs. 1989


PROFILE LINE: C-84
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

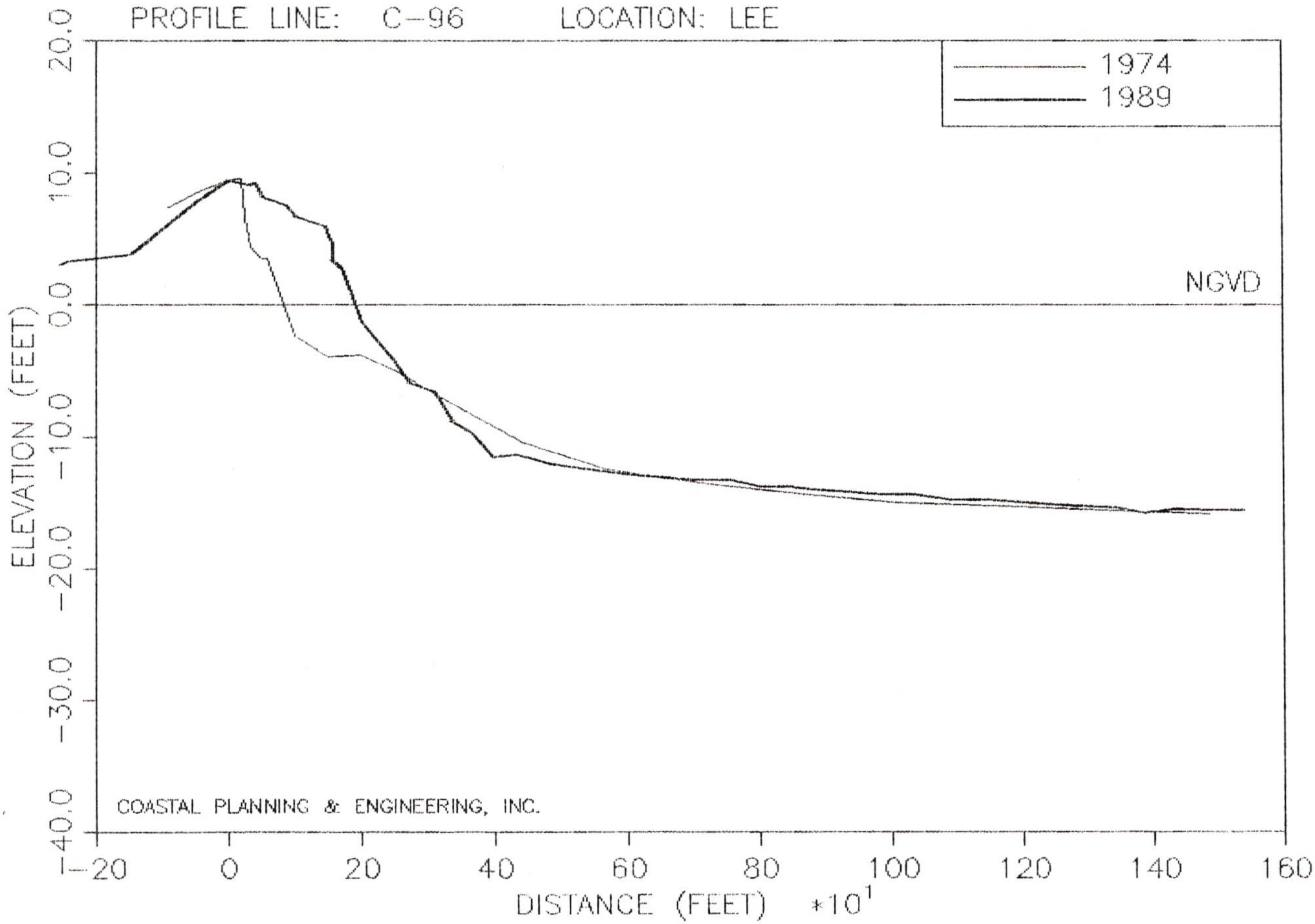


PROFILE LINE: R-87
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

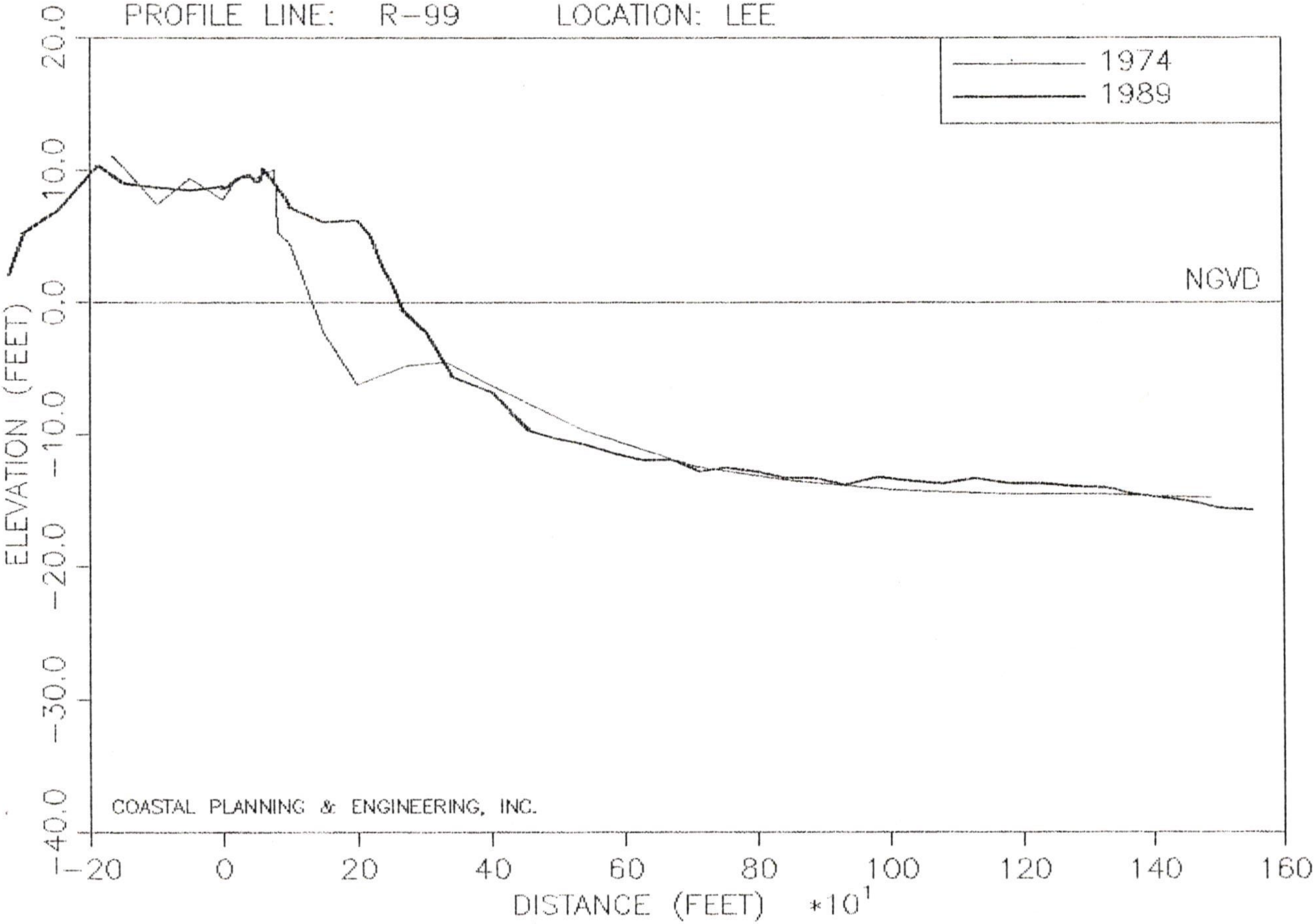

PROFILE LINE: R-90
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



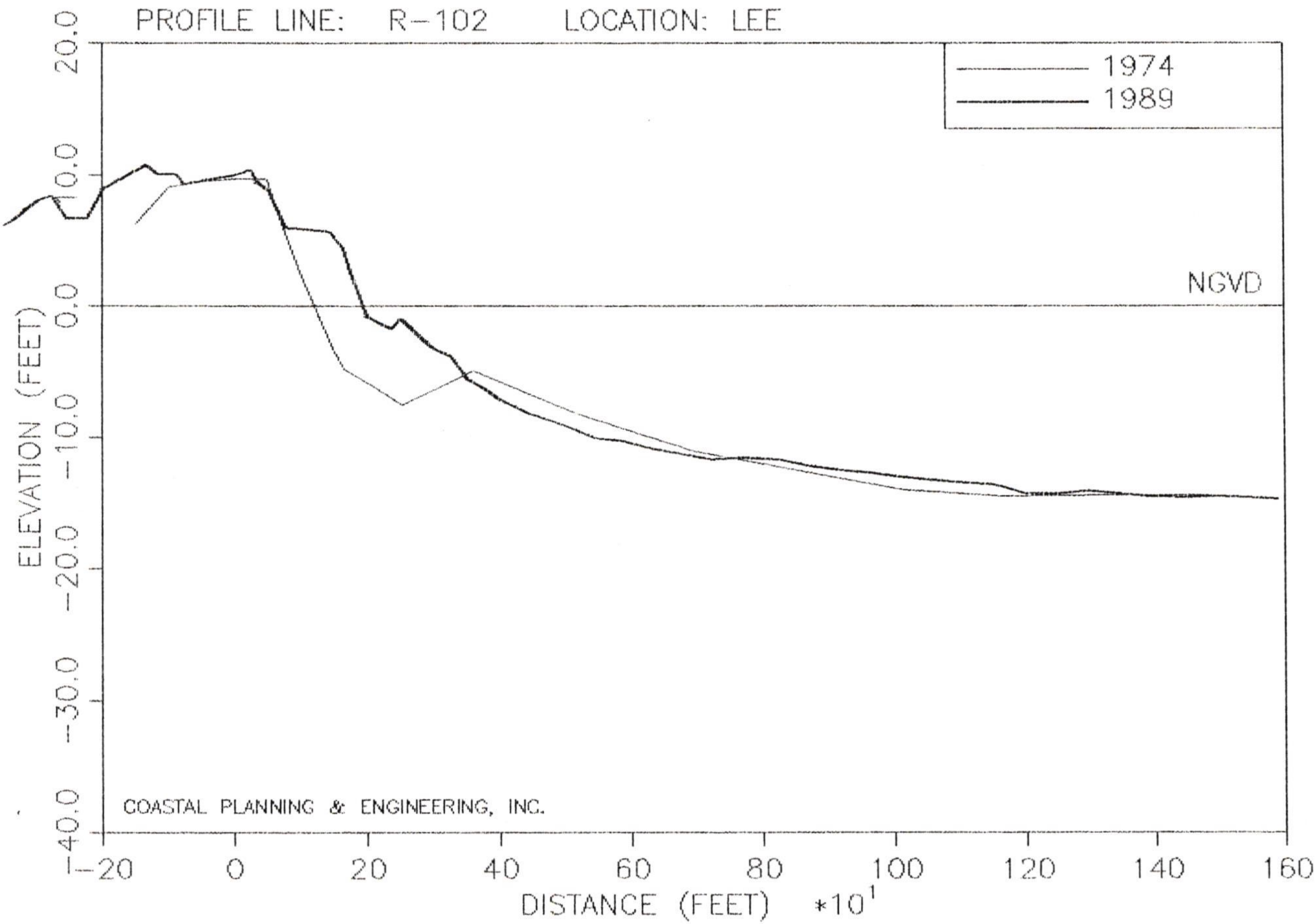
PROFILE LINE: R-93
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

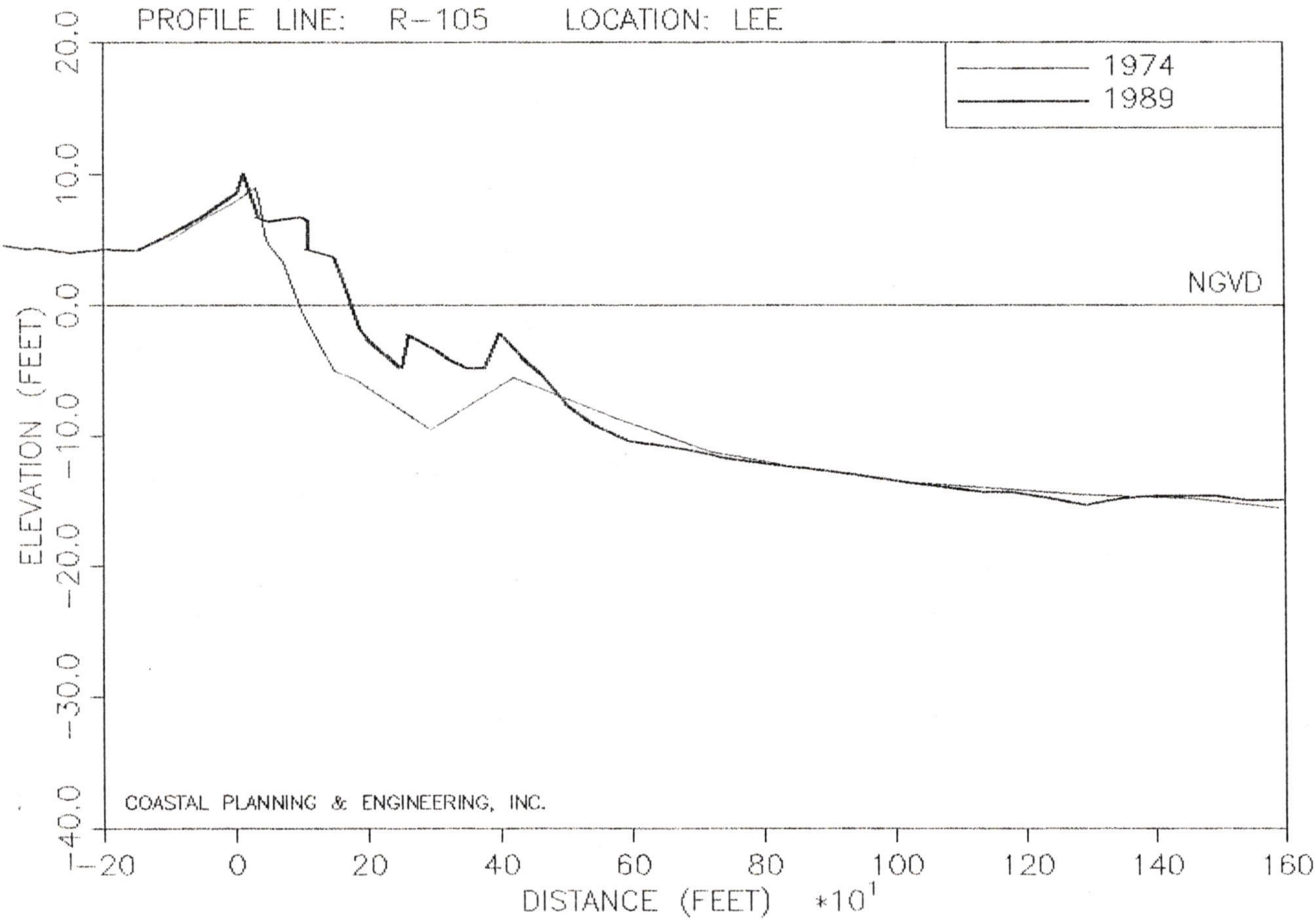


PROFILE LINE: C-96
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

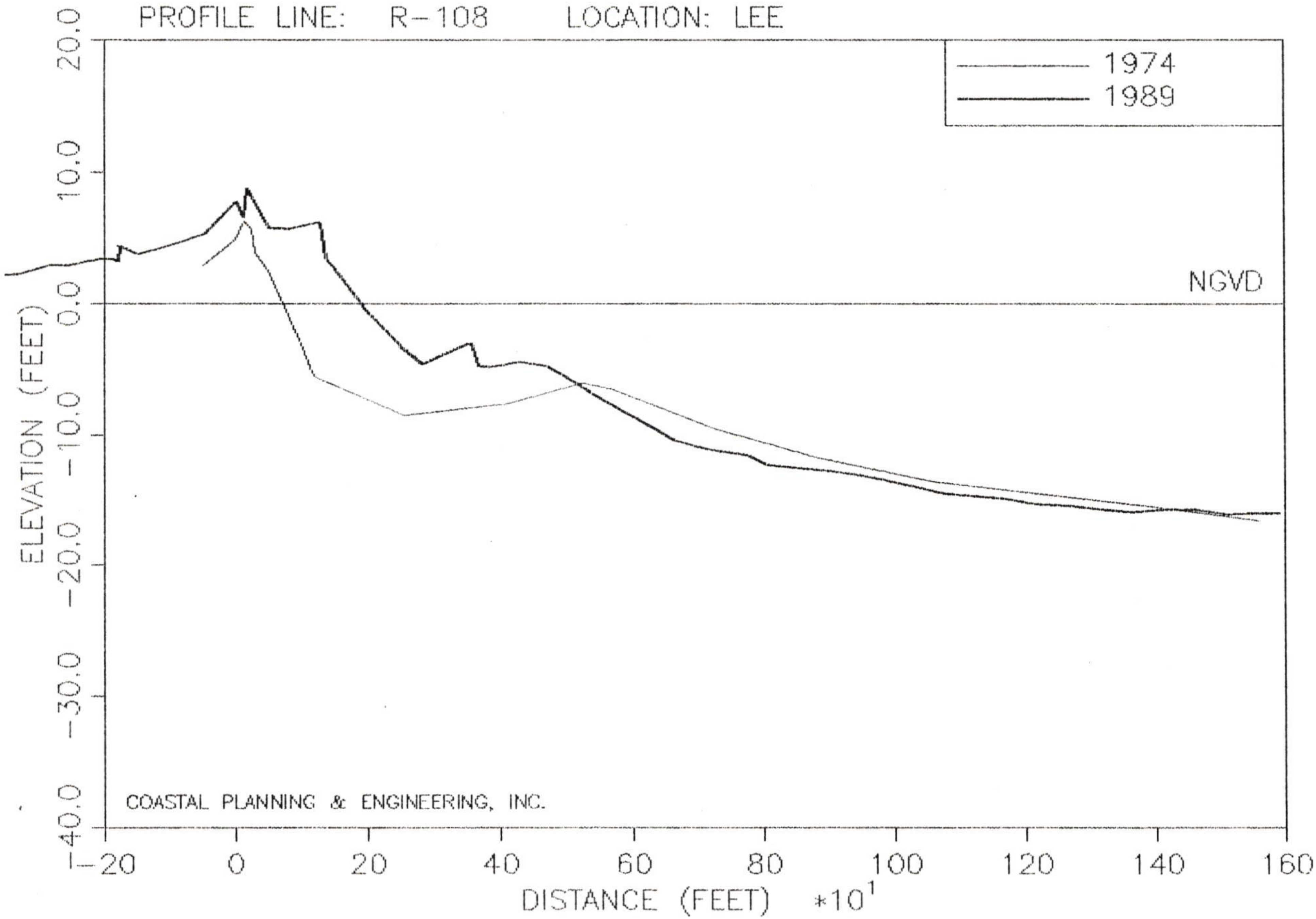


PROFILE LINE: R-99
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
DISTANCE (FEET) *10[1]
-20
0
20
40
60
80
100
120
140
160
COASTAL PLANNING & ENGINEERING, INC.

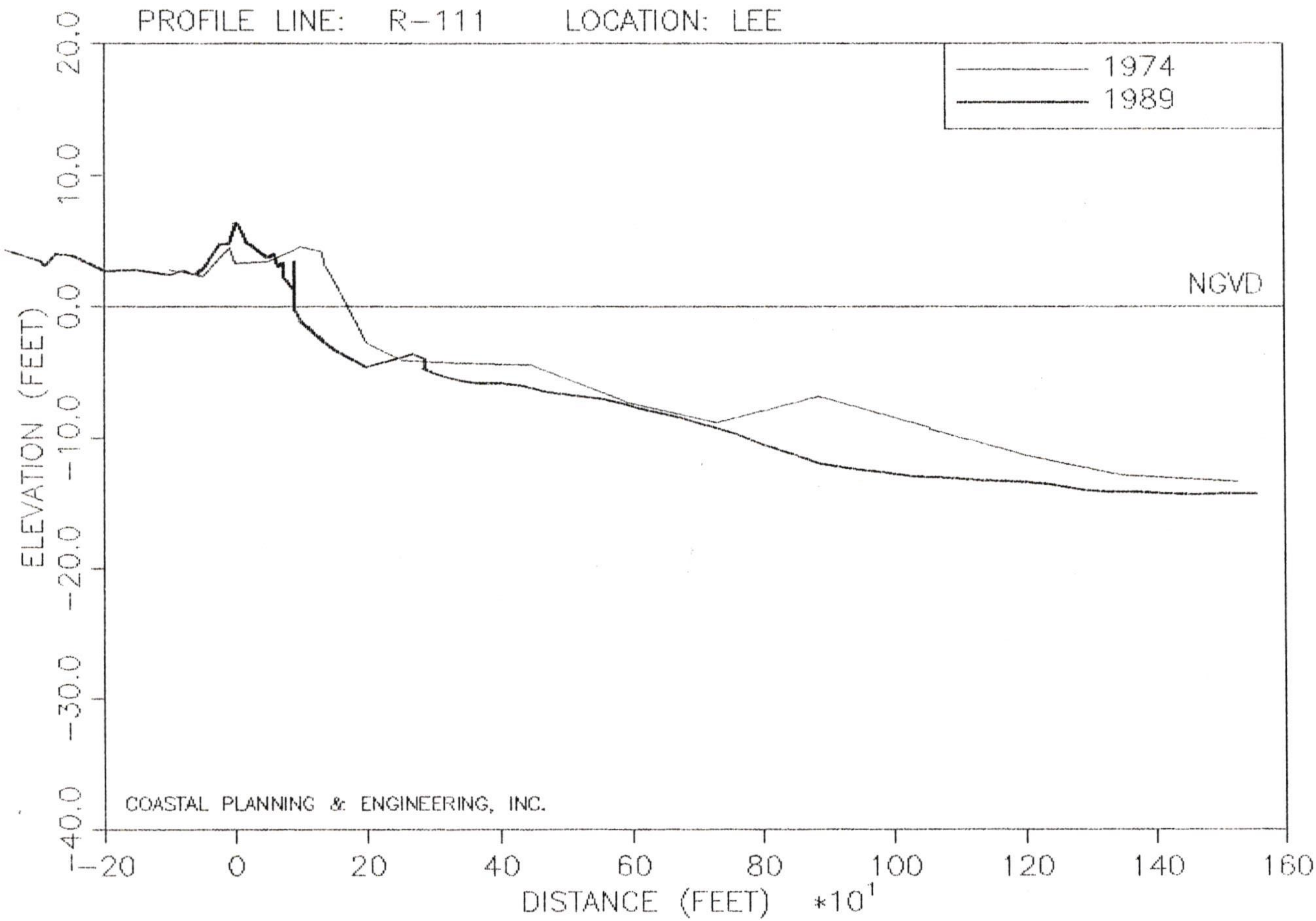

PROFILE LINE: R-102 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



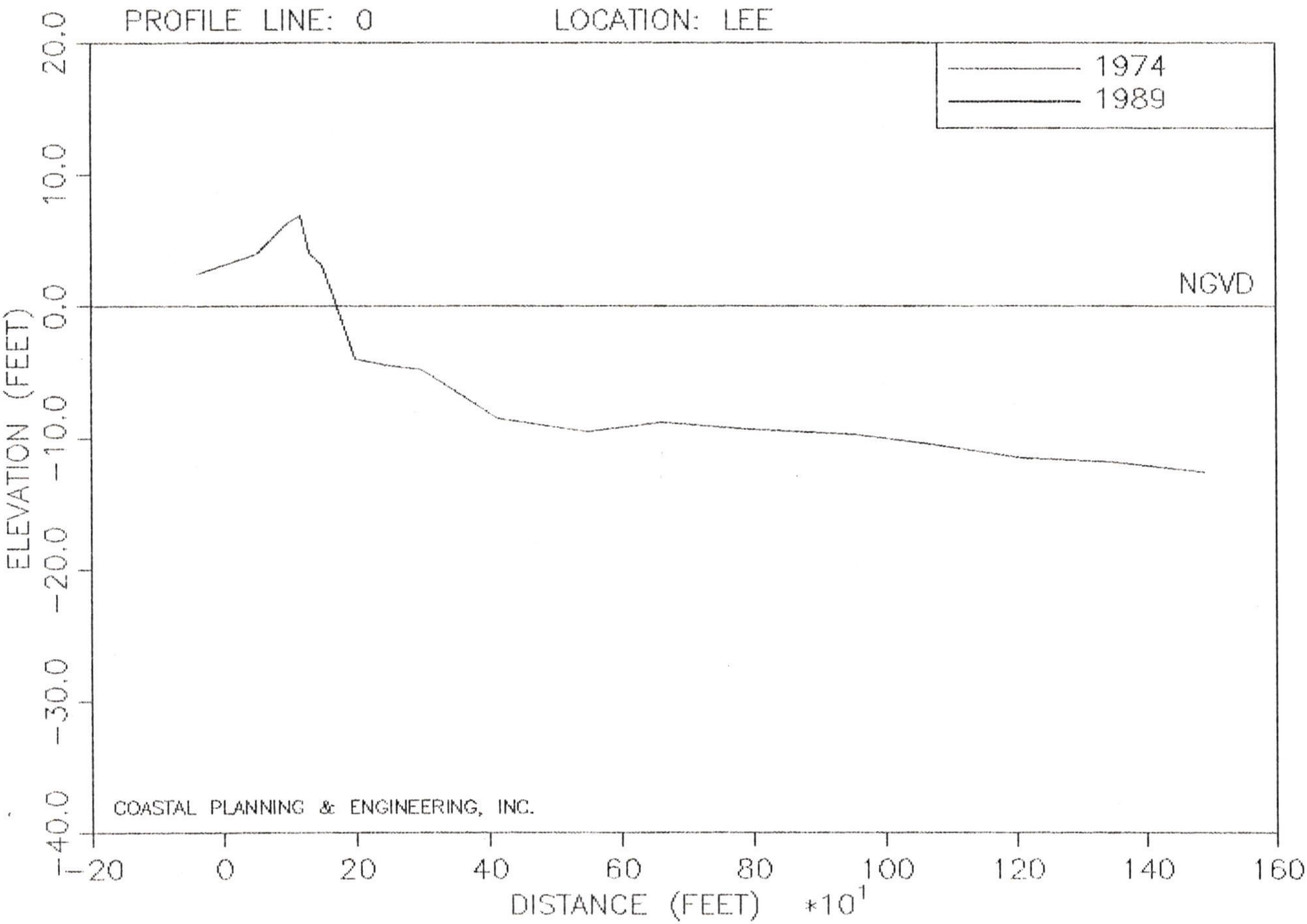
PROFILE LINE: R-105 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

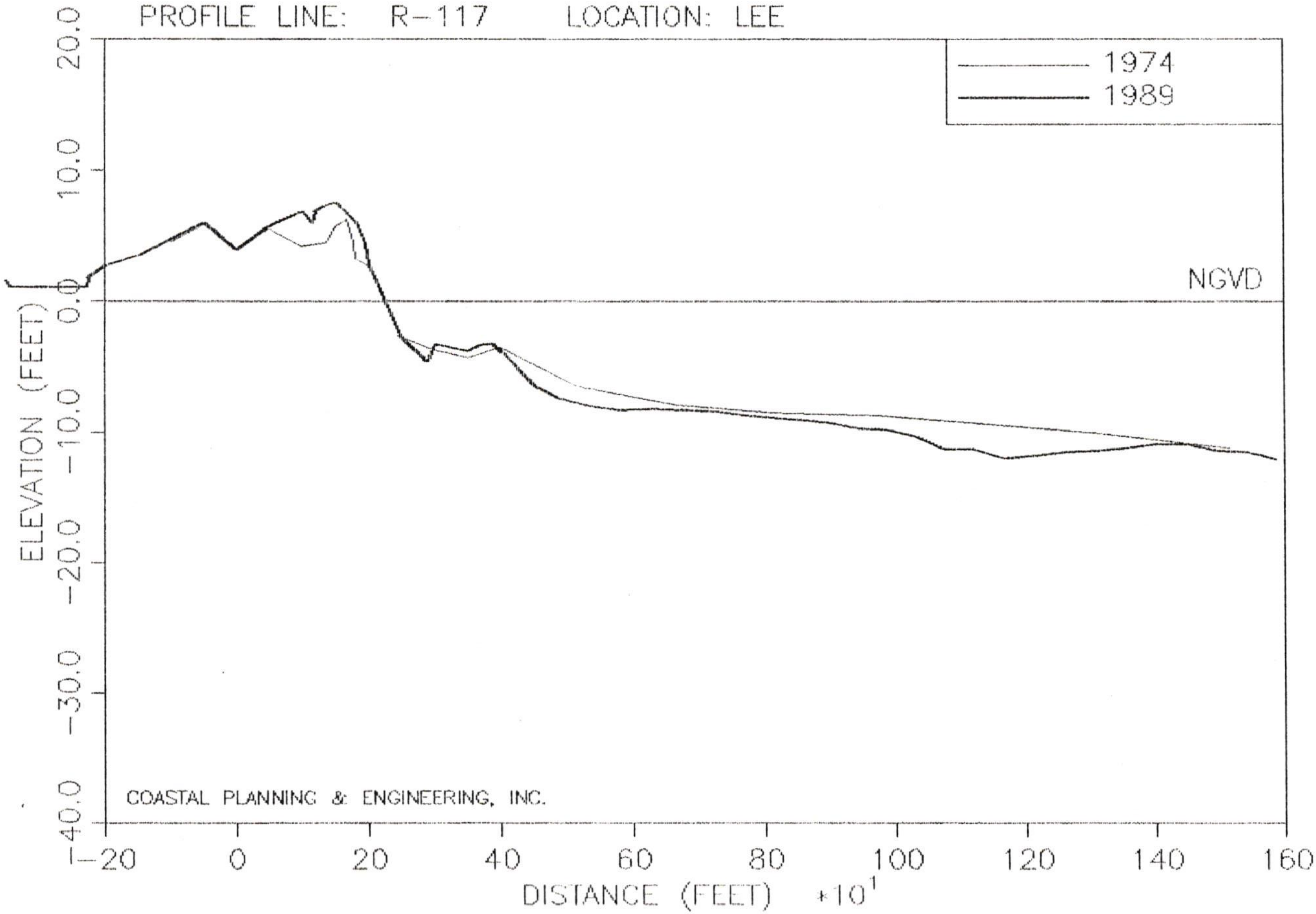


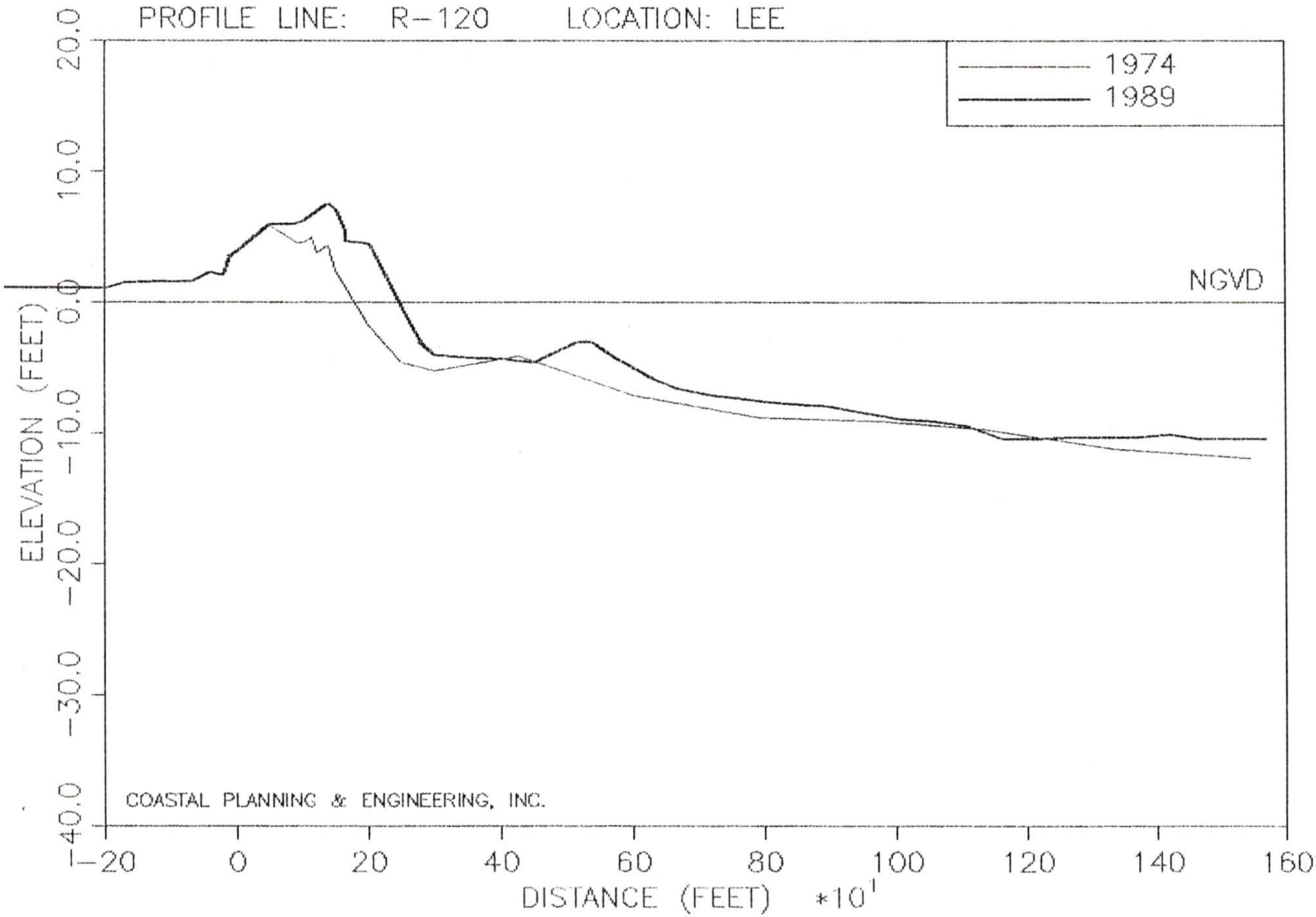
PROFILE LINE: R-108 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

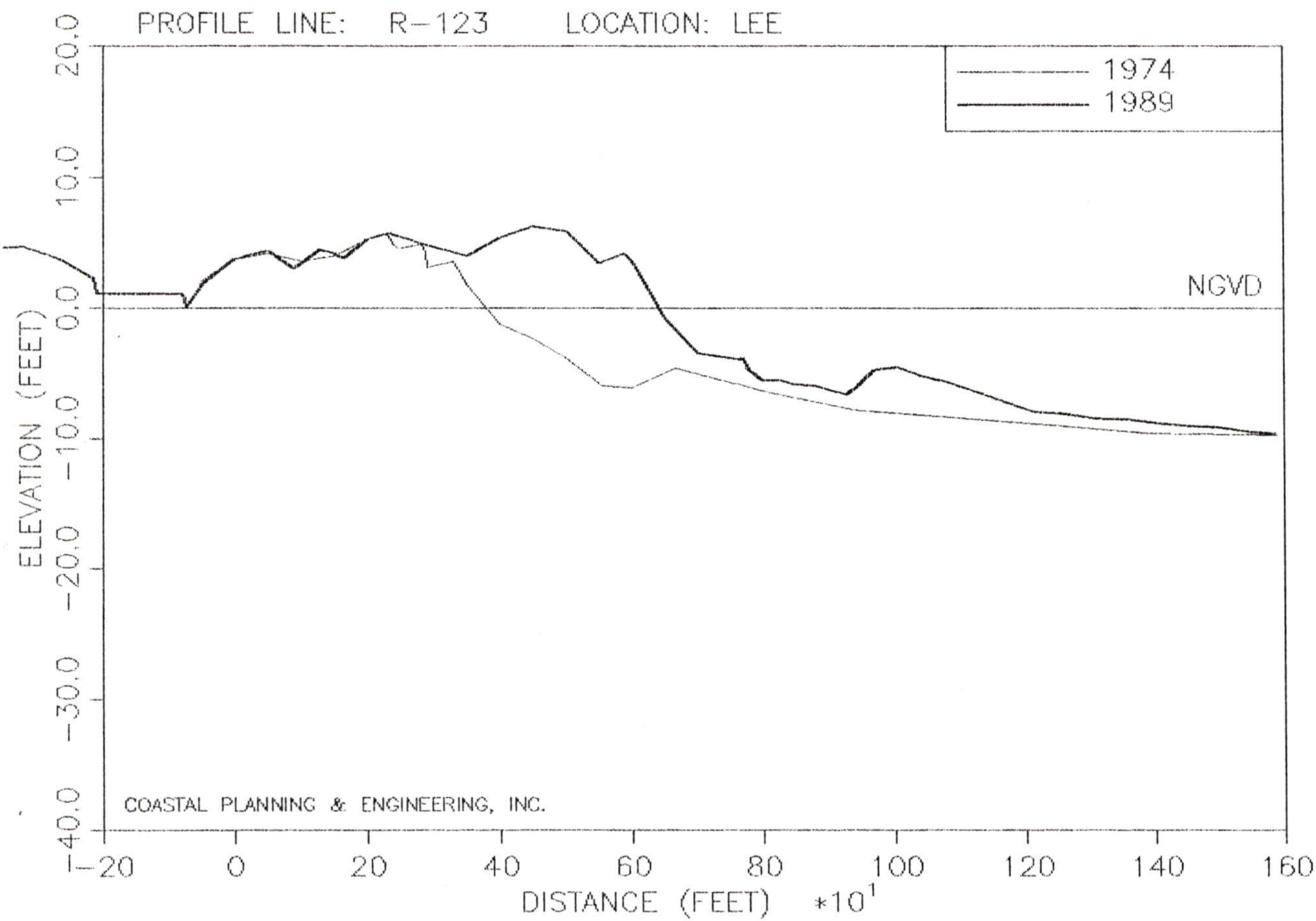


PROFILE LINE: R-111 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

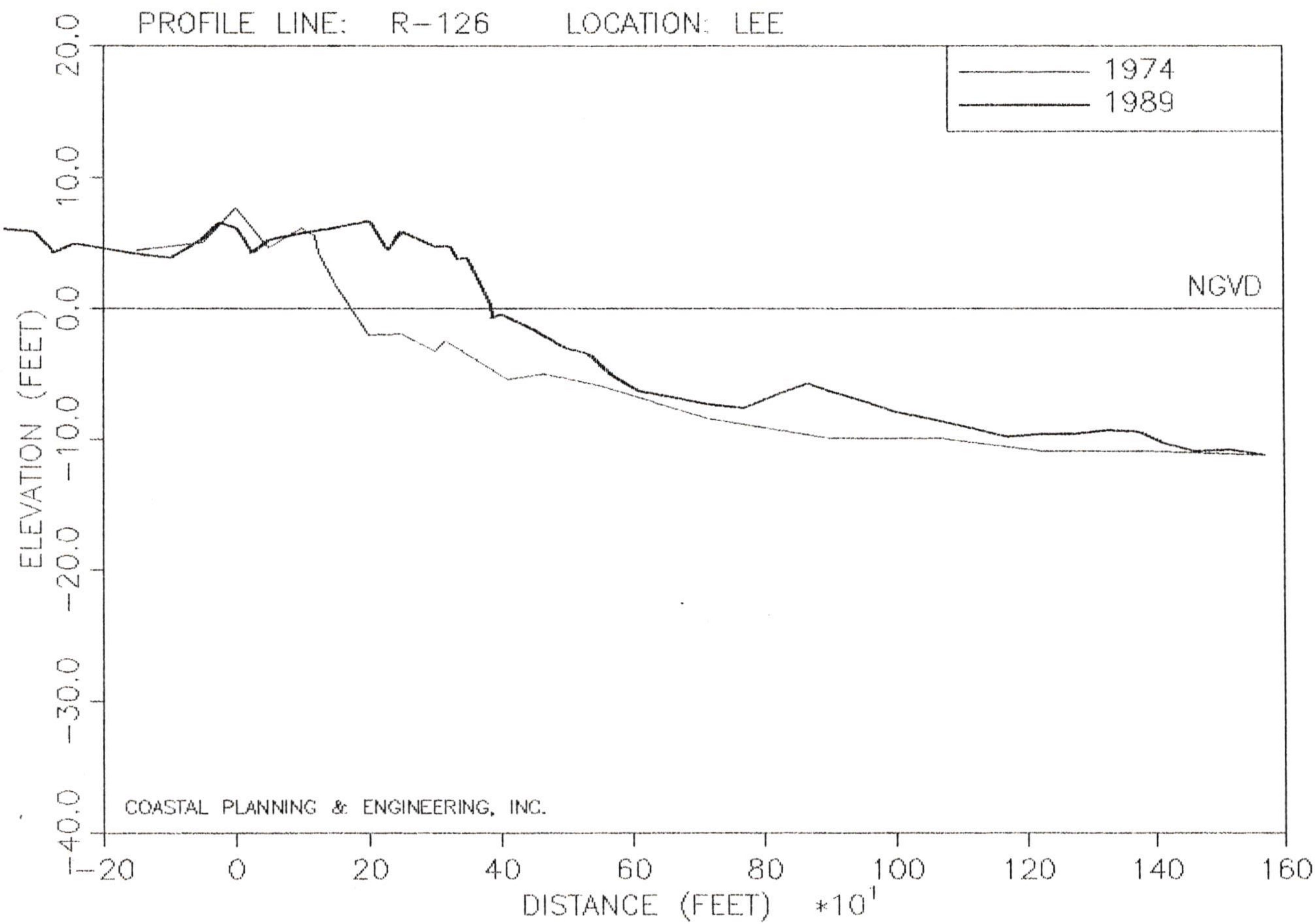

PROFILE LINE: 0
LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

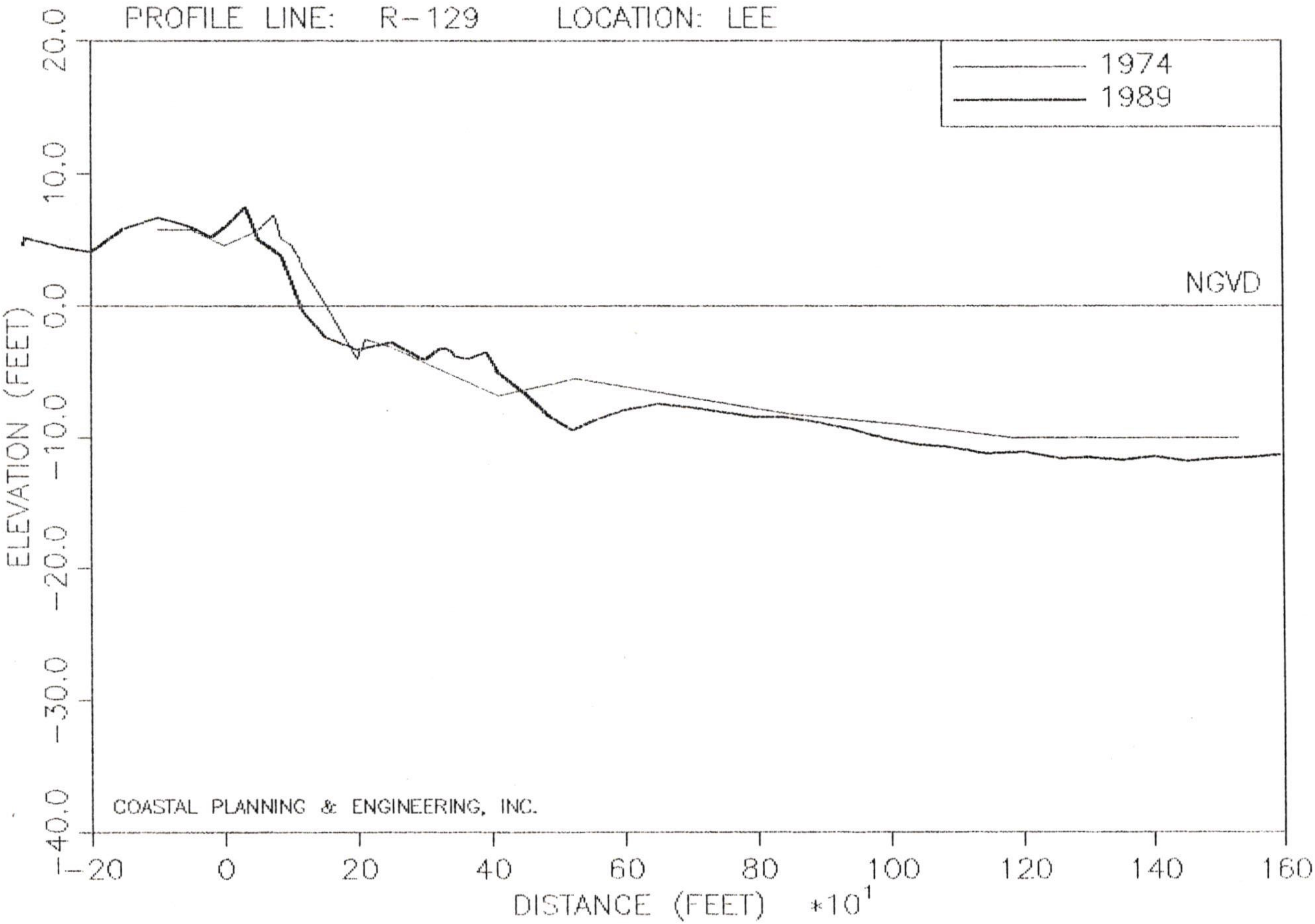

PROFILE LINE: R-117 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R-120 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



PROFILE LINE: R-123 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

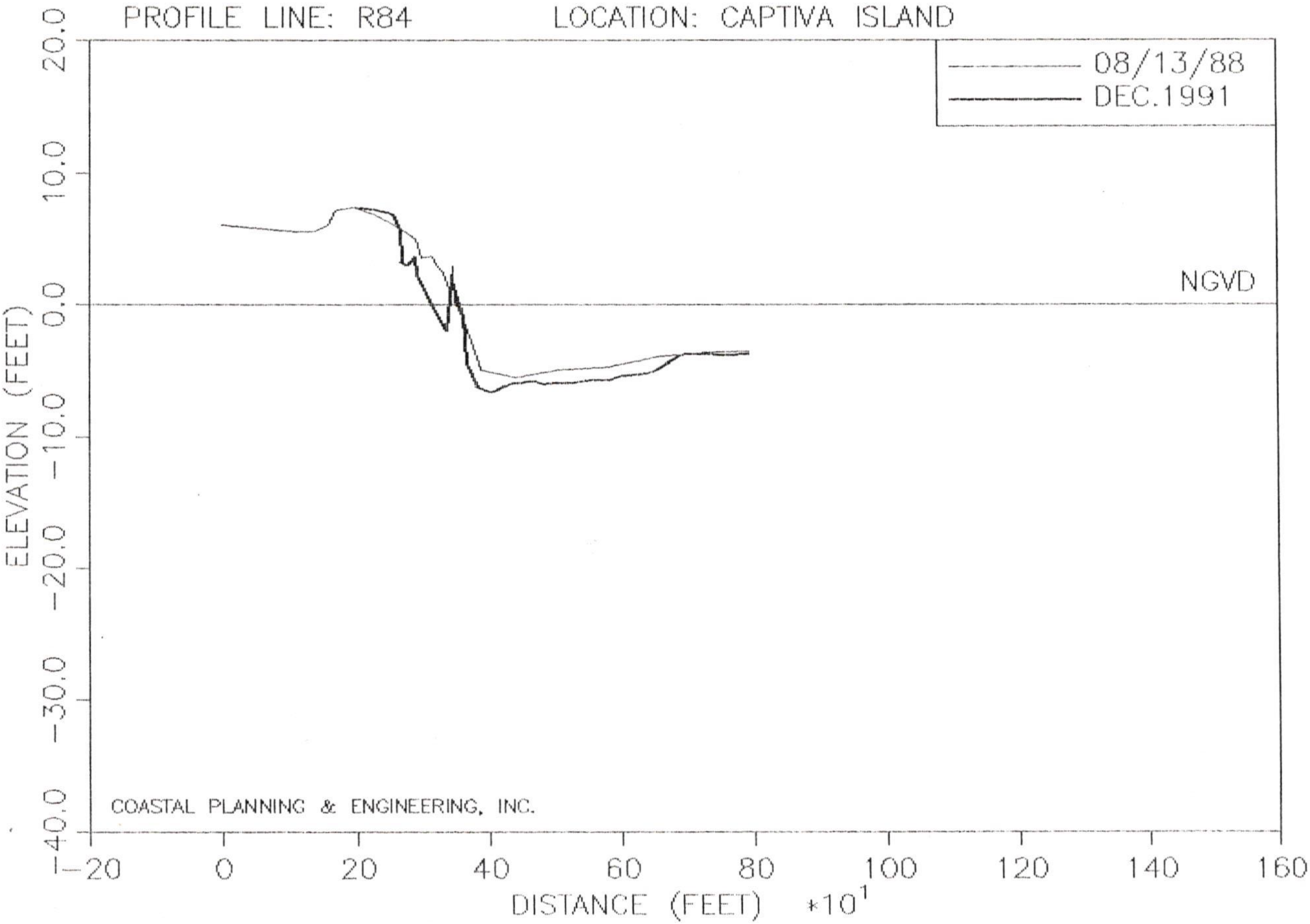

PROFILE LINE: R-126 LOCATION: LEE
1974
1989
NGVD
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
ELEVATION (FEET)
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.



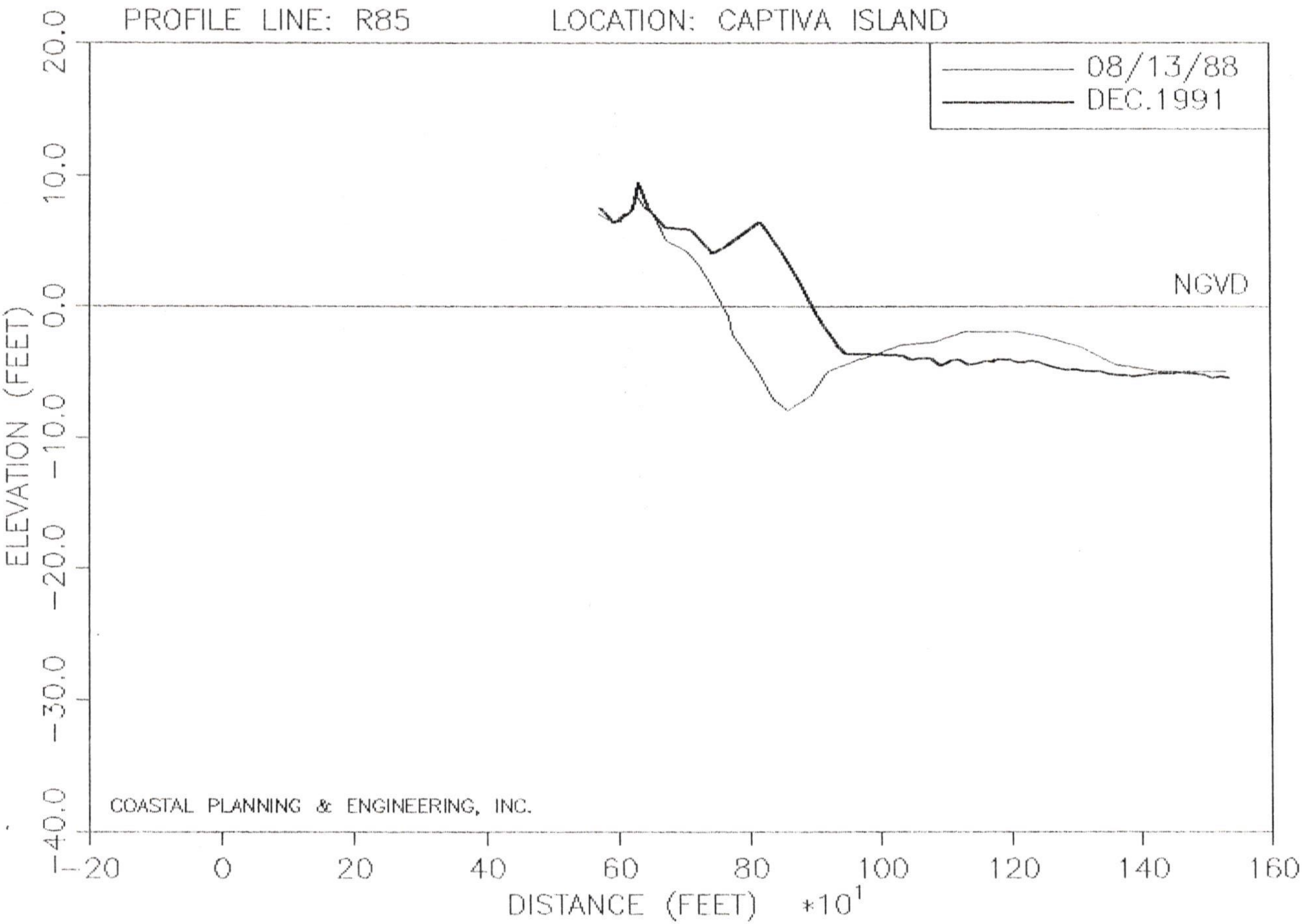
PROFILE LINE: R-129 LOCATION: LEE
1974
1989
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

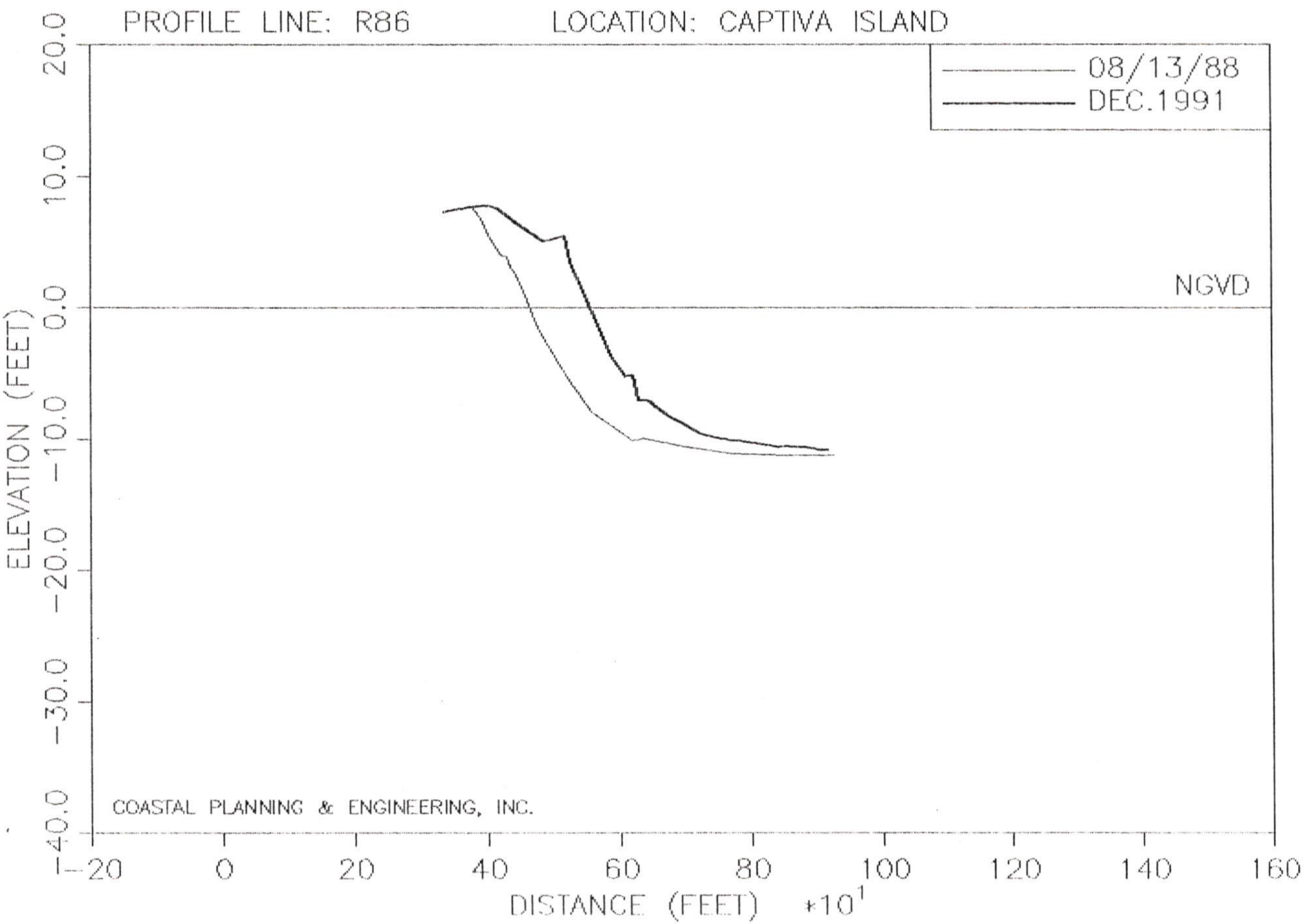
Comparative Beach Profile Plots

August 13, 1988 vs. December 1991

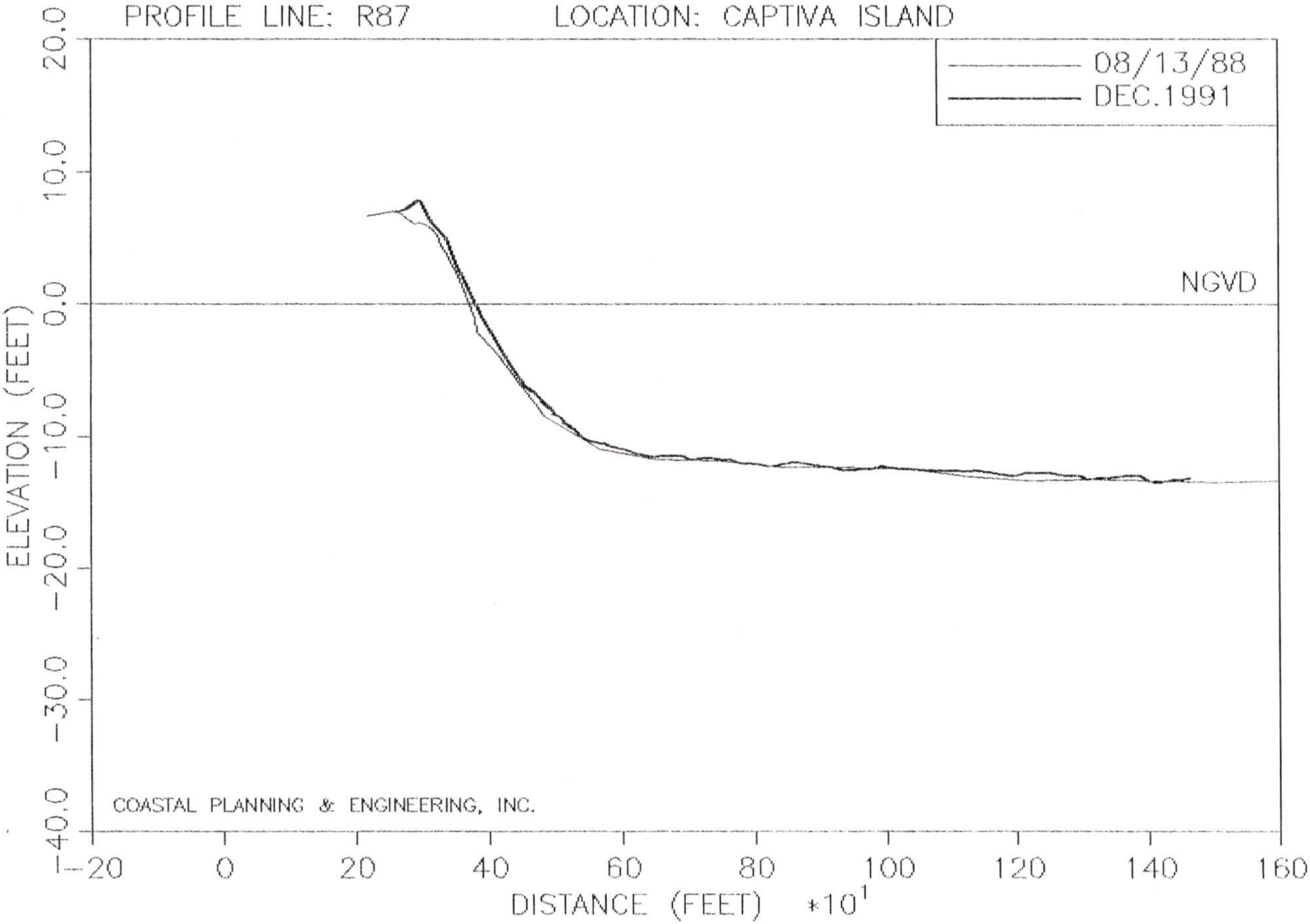


PROFILE LINE: R84
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

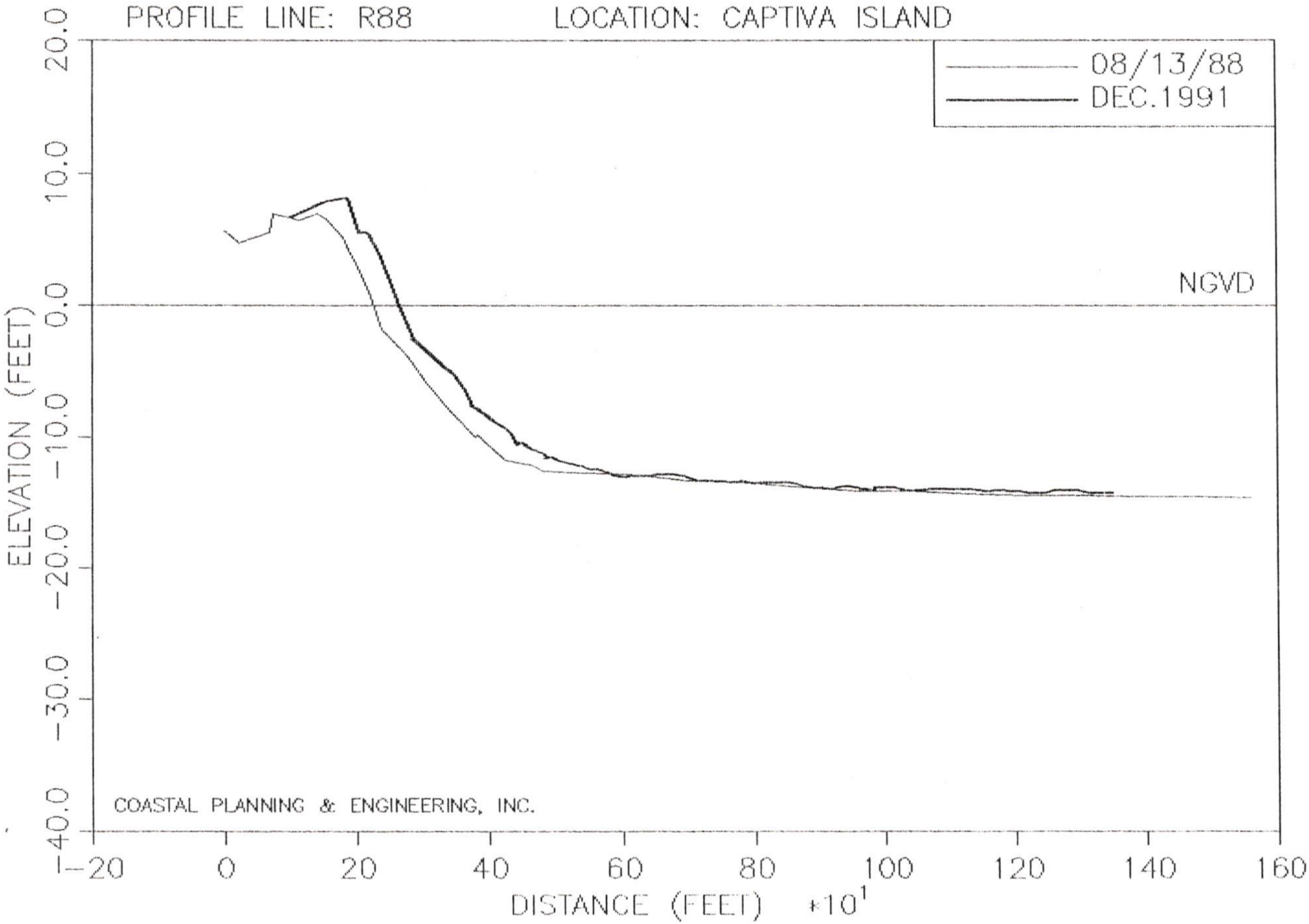

PROFILE LINE: R85
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

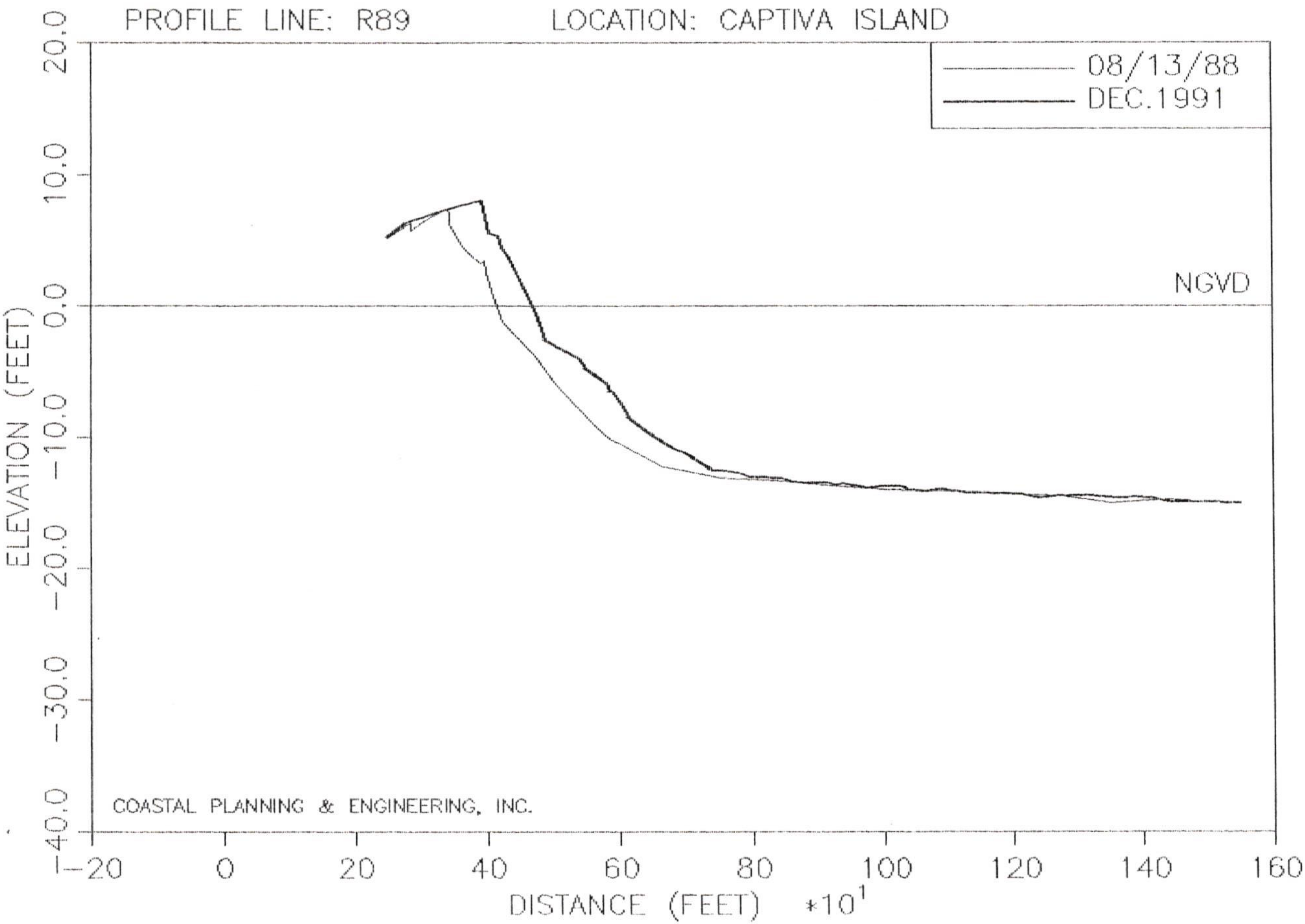


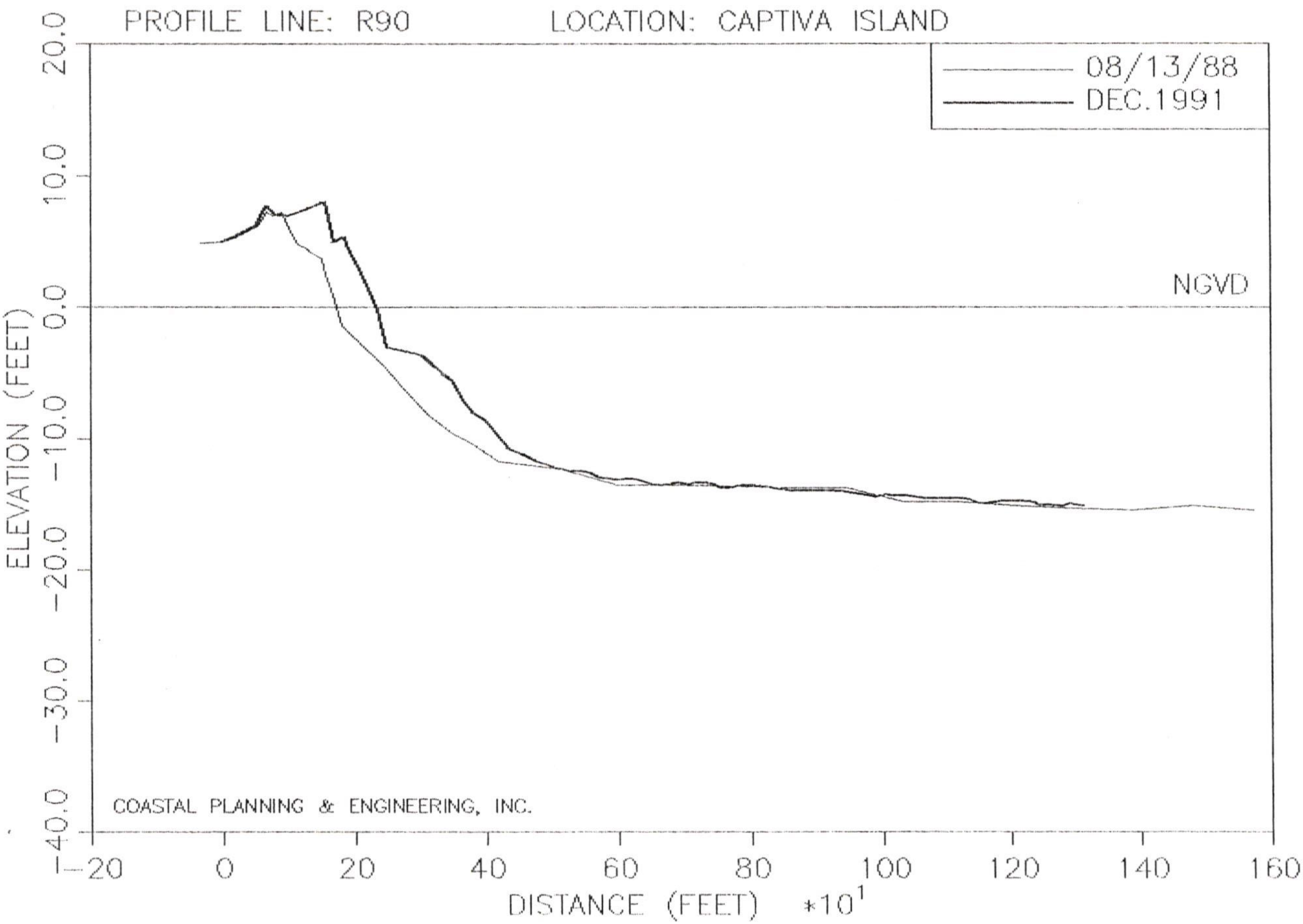
PROFILE LINE: R86
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

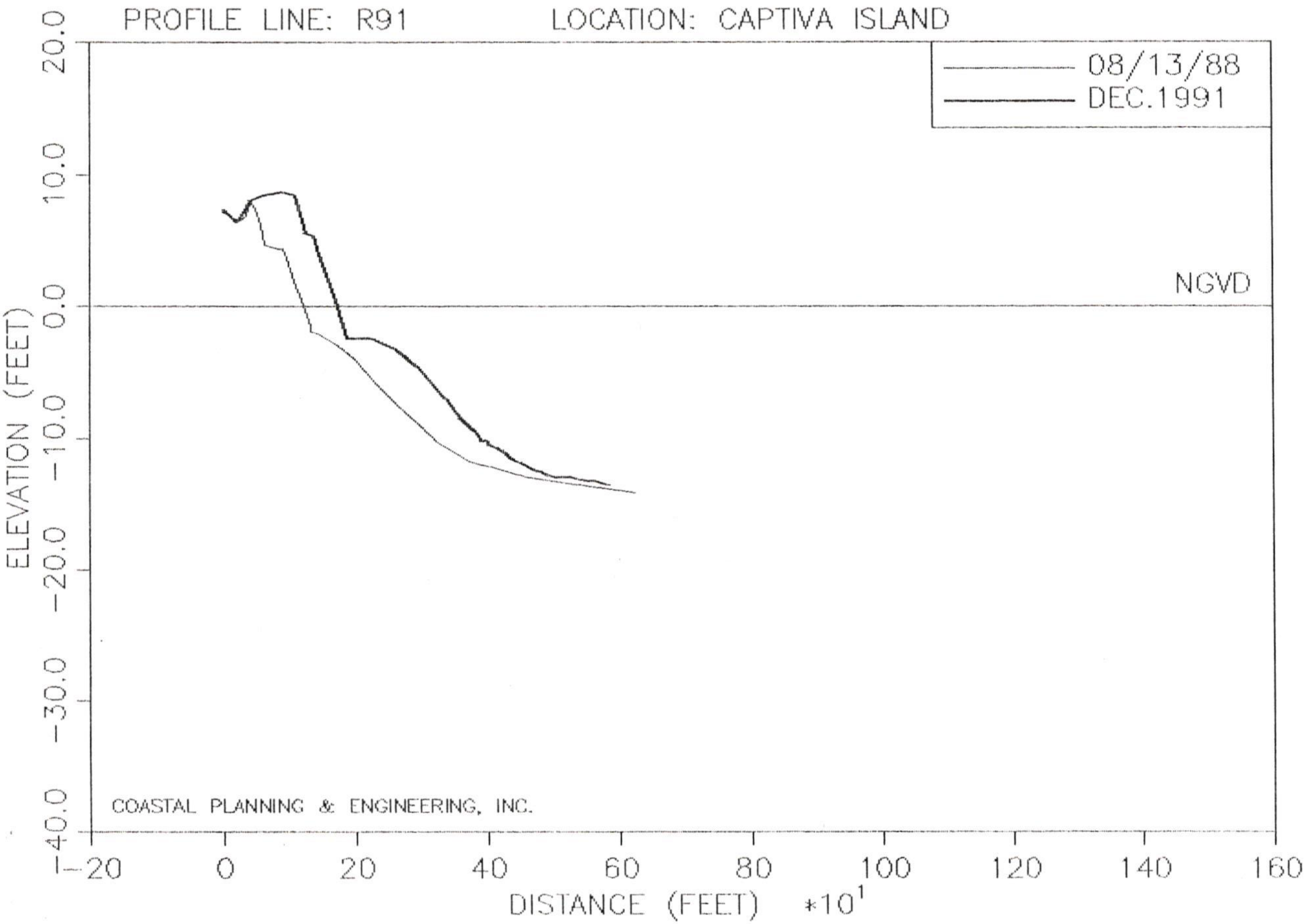


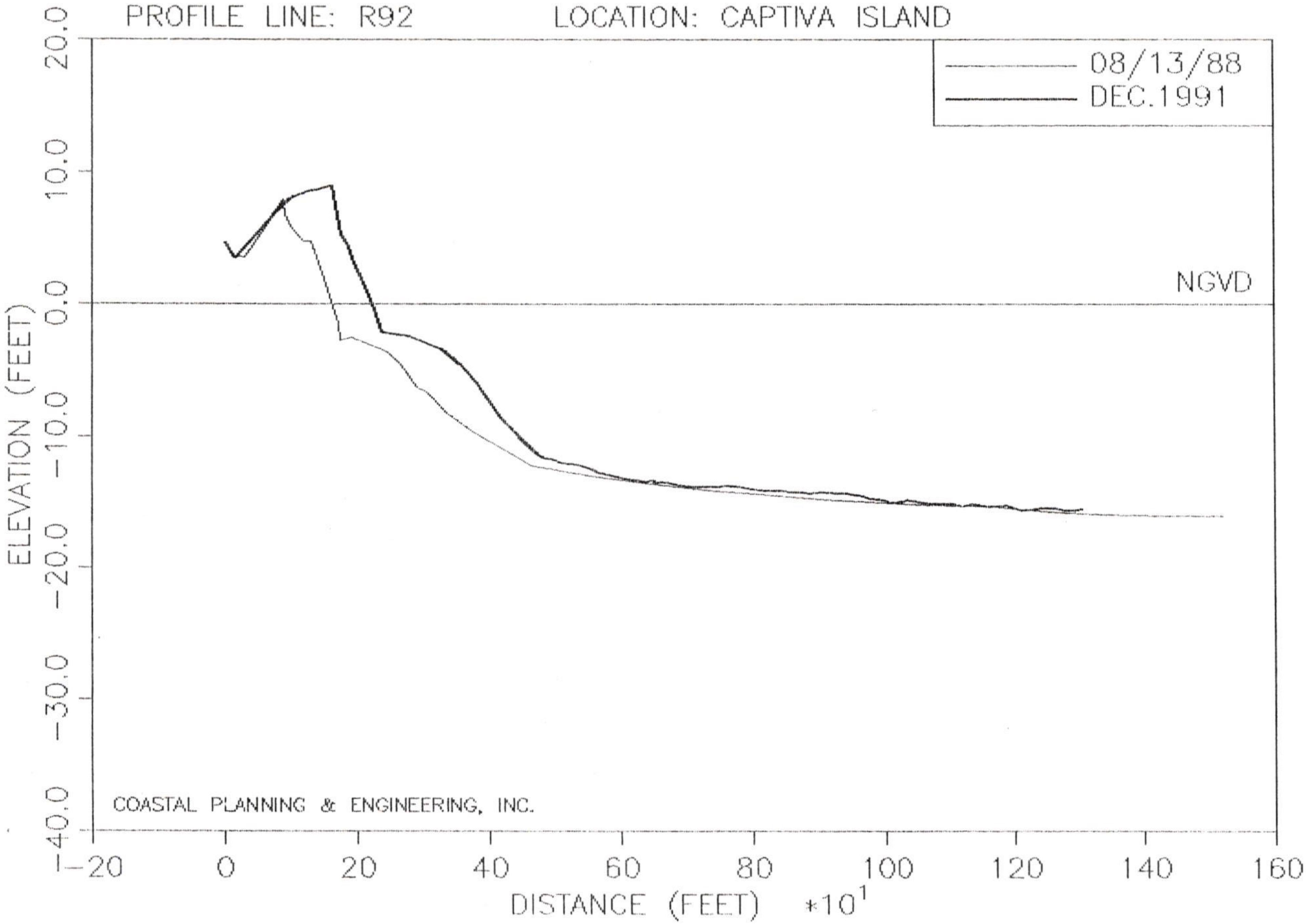
PROFILE LINE: R87
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R88
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

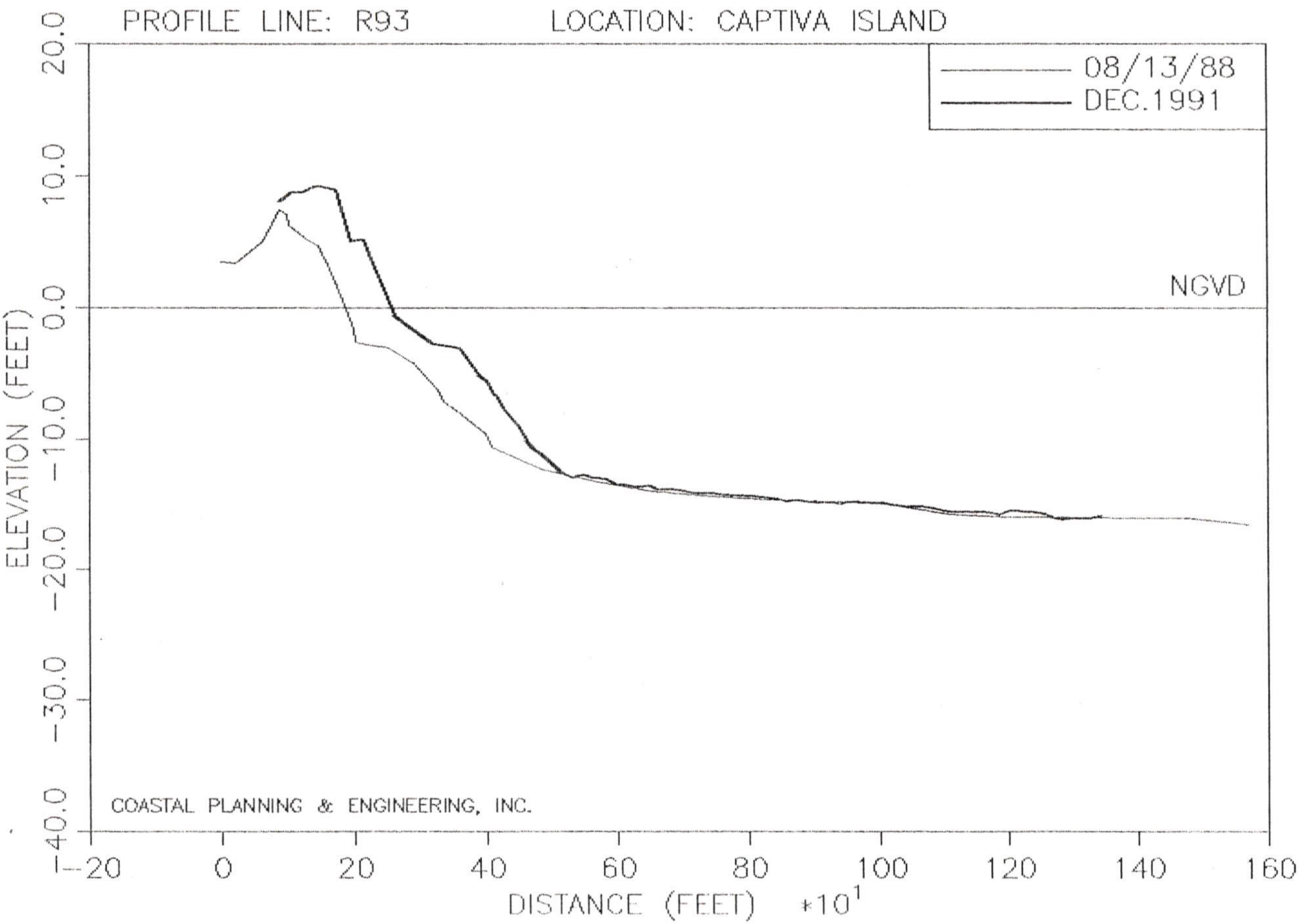

PROFILE LINE: R89
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
COASTAL PLANNING & ENGINEERING, INC.
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

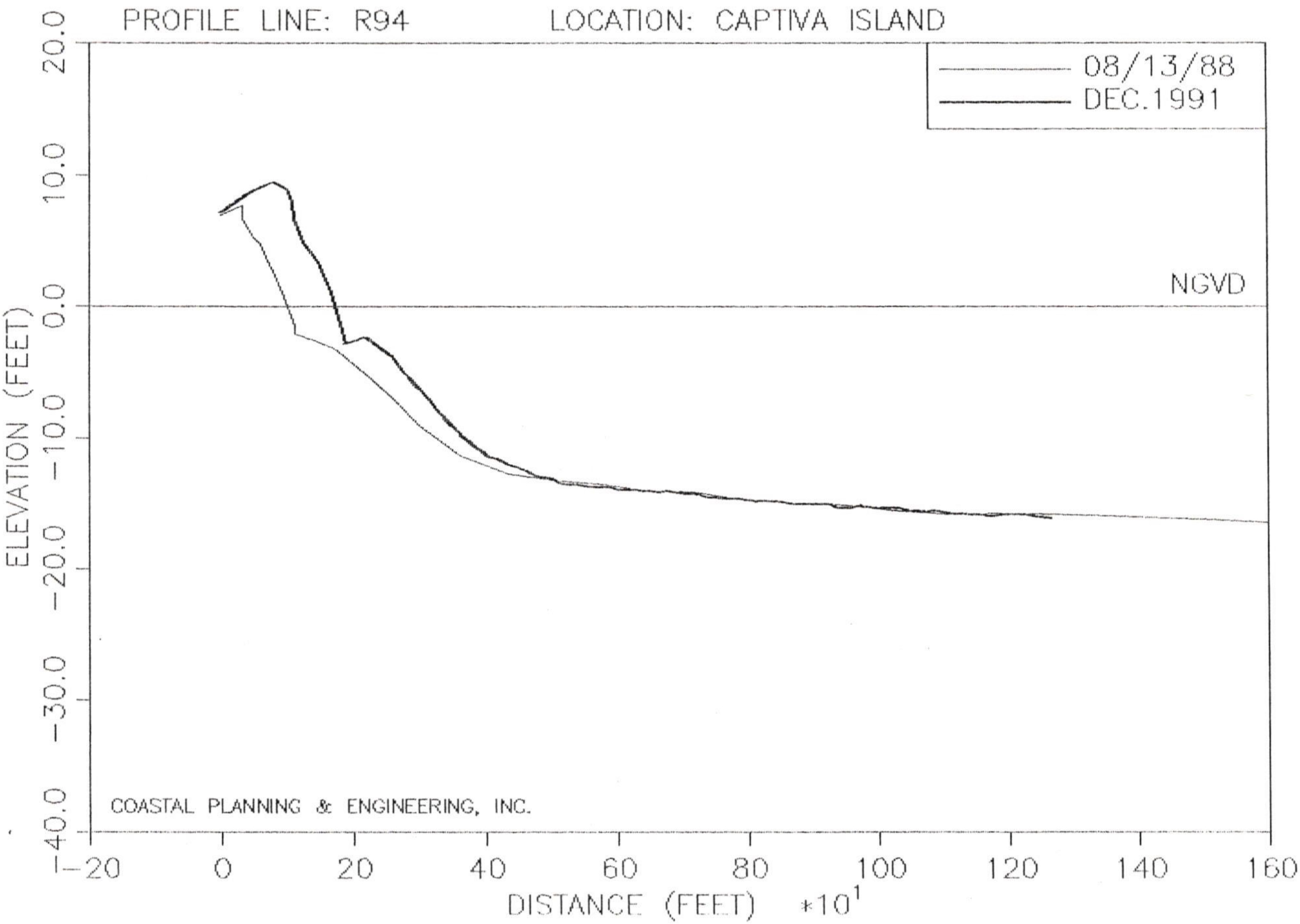

PROFILE LINE: R90
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]


PROFILE LINE: R91
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10¹

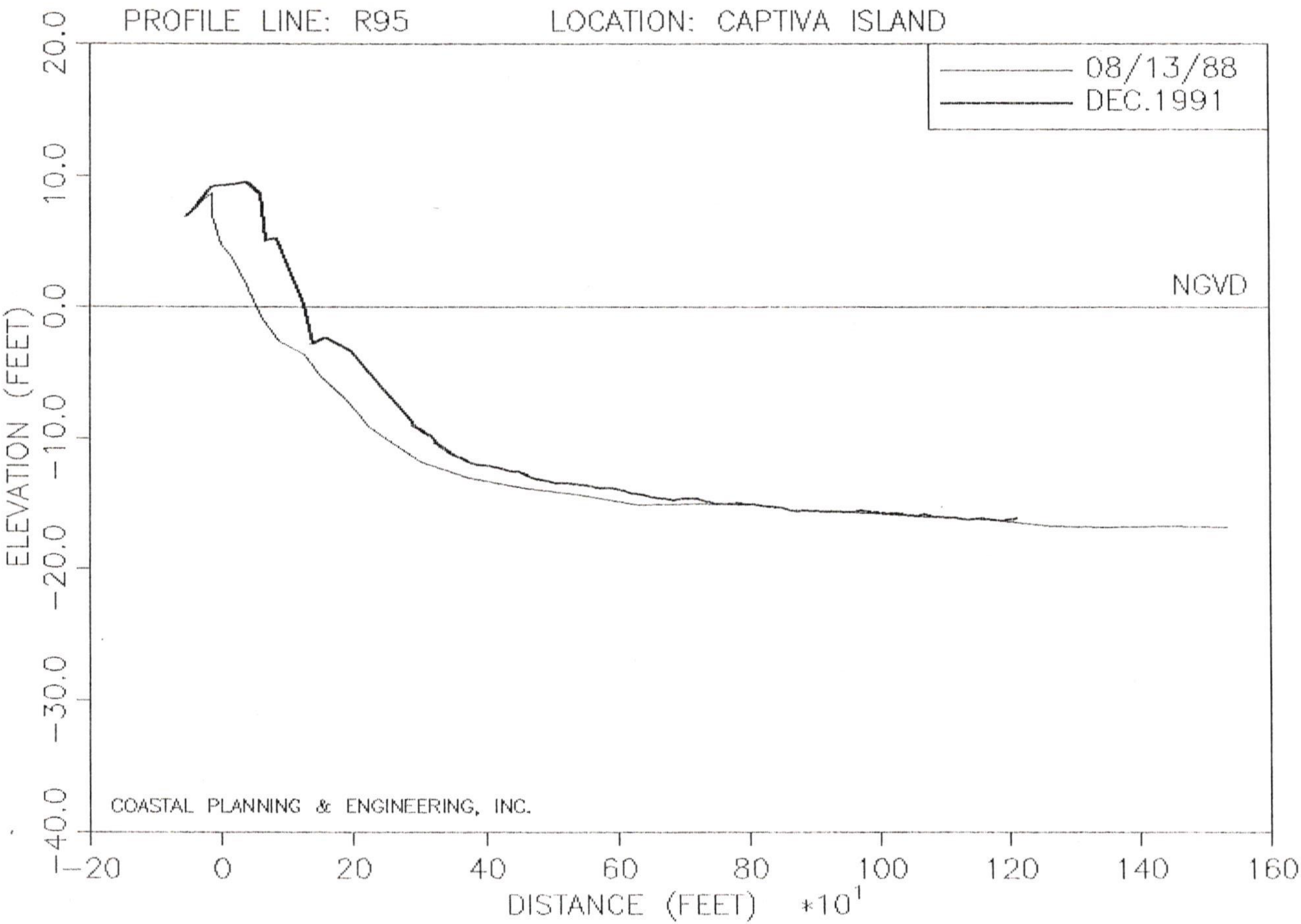


PROFILE LINE: R92
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10¹
COASTAL PLANNING & ENGINEERING, INC.

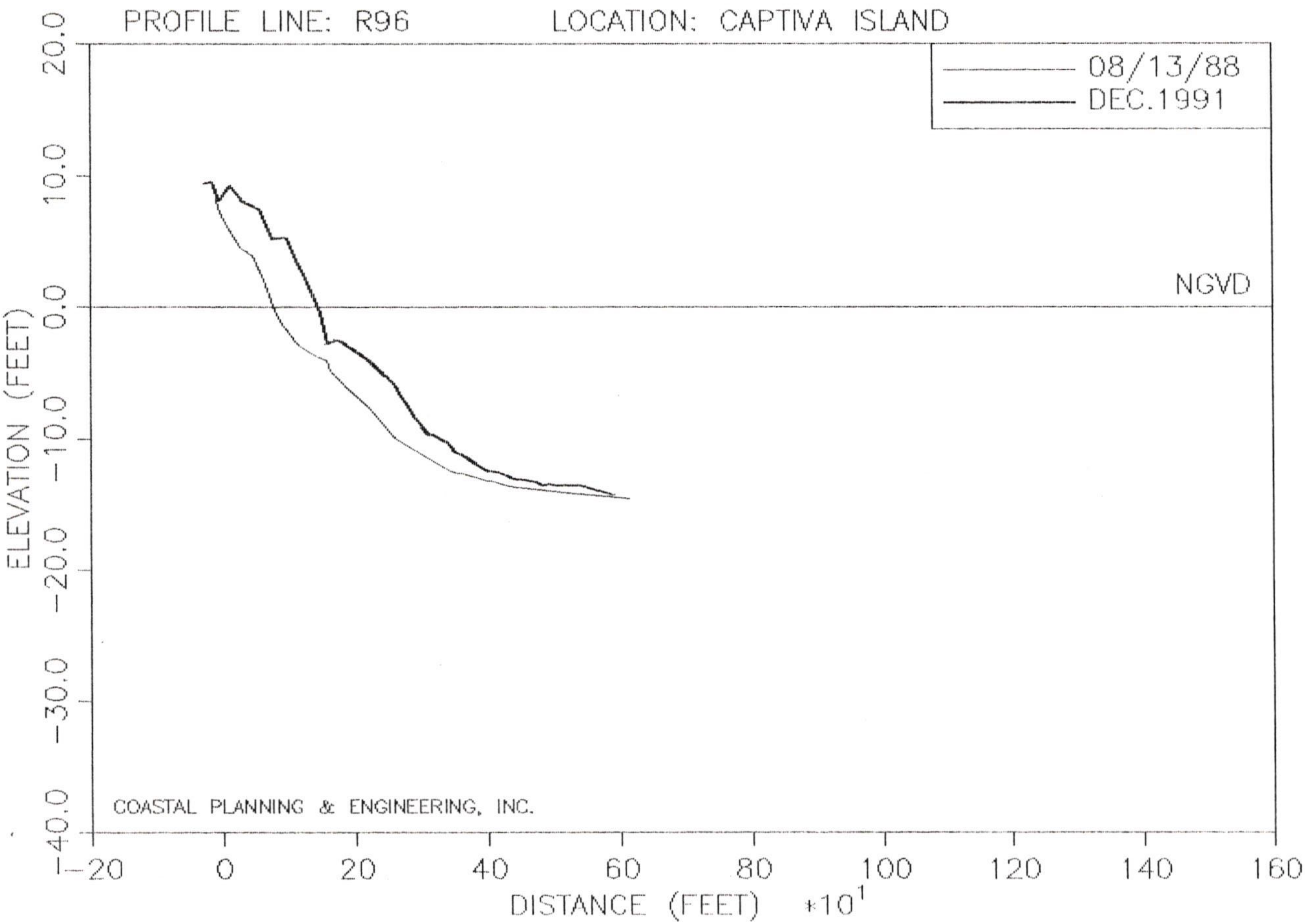

PROFILE LINE: R93
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

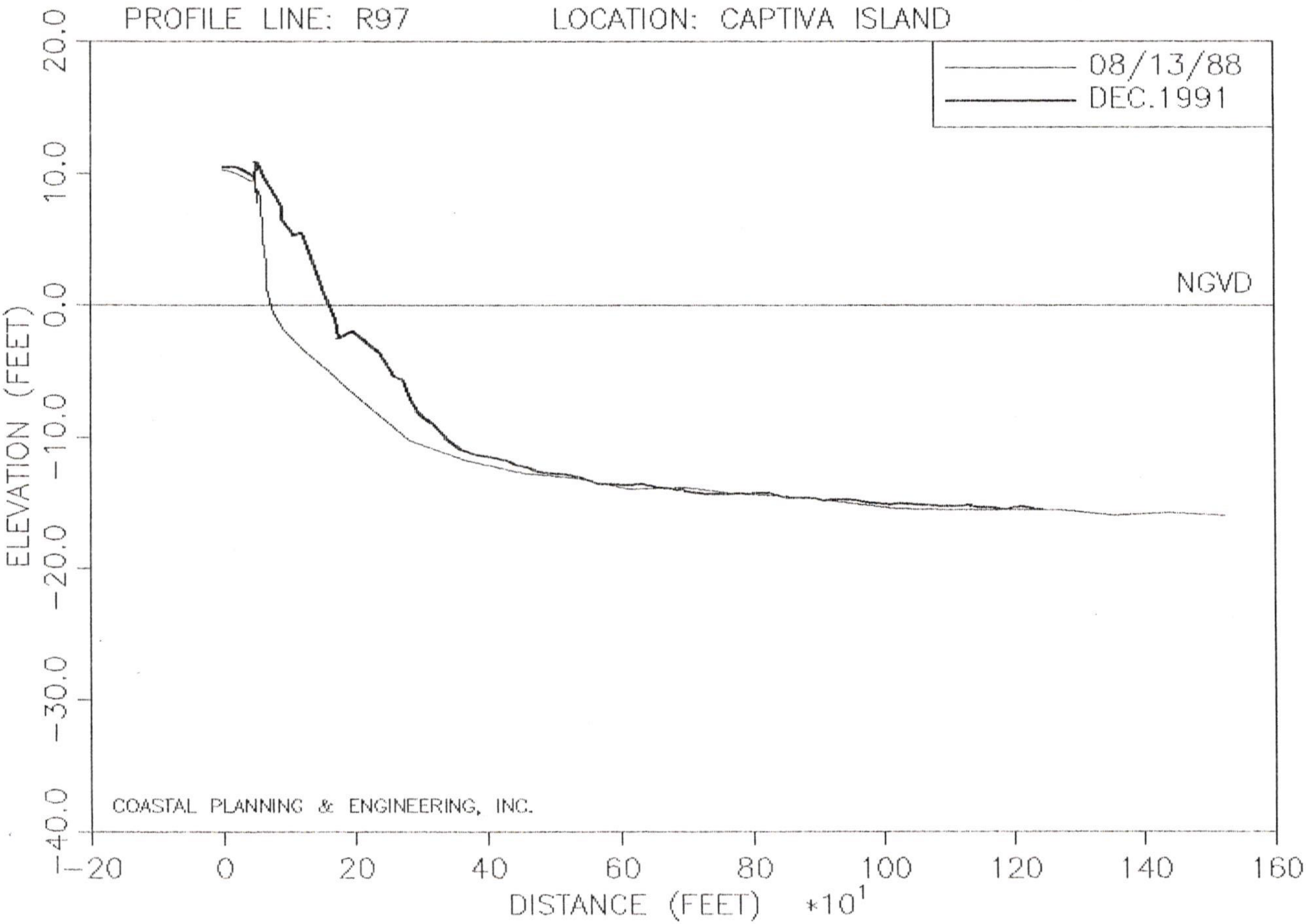


PROFILE LINE: R94
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

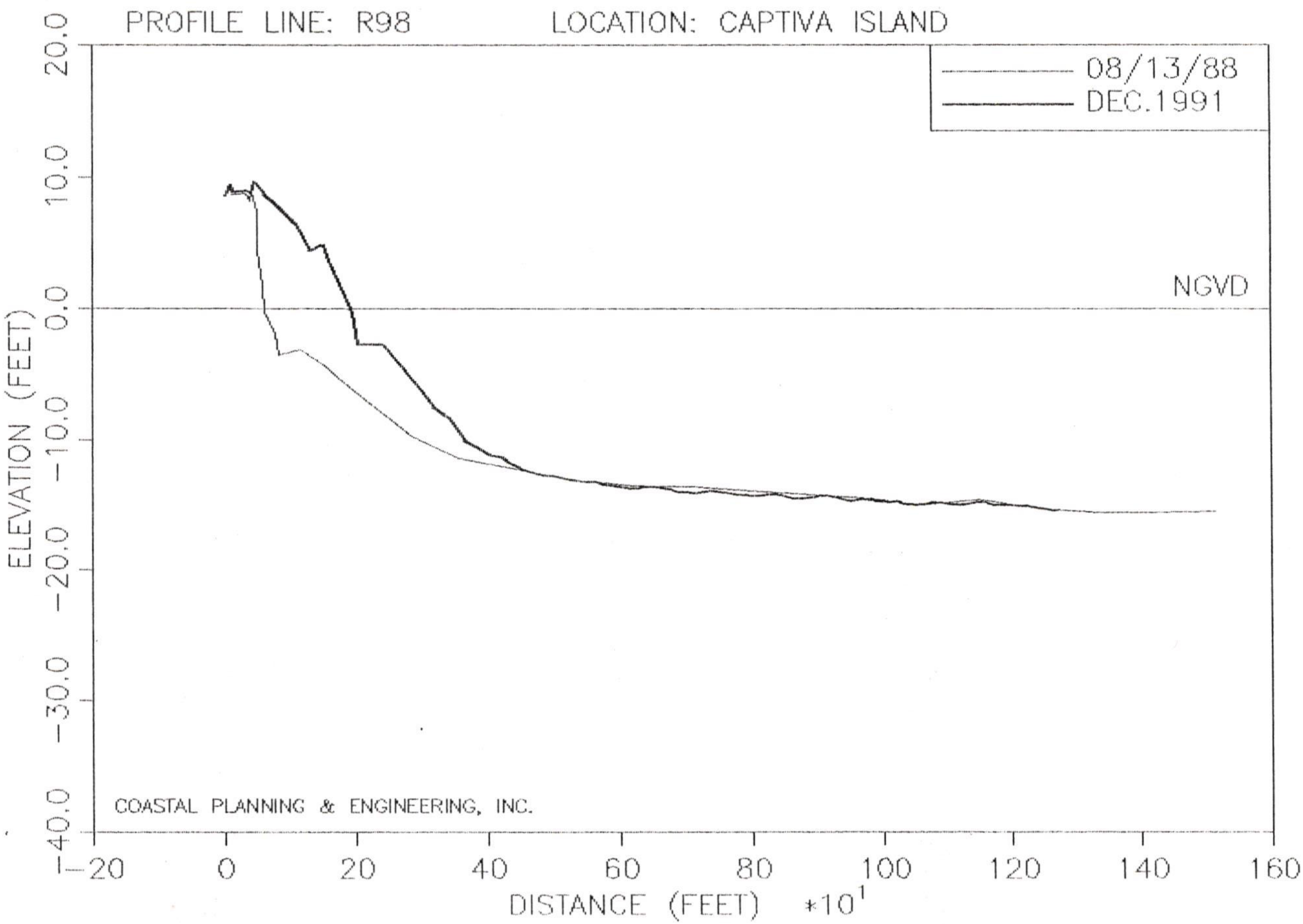


PROFILE LINE: R95
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

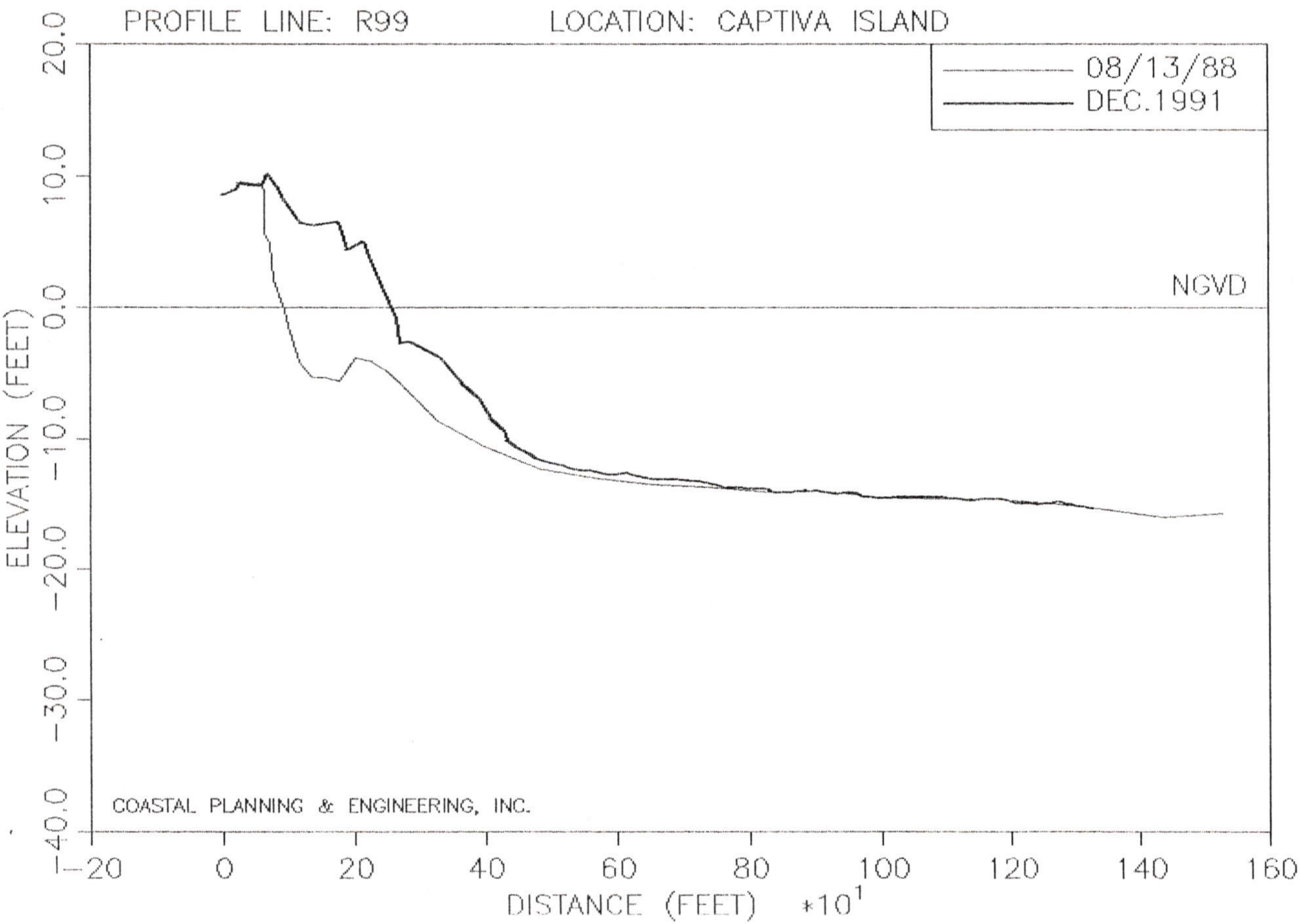

PROFILE LINE: R96
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

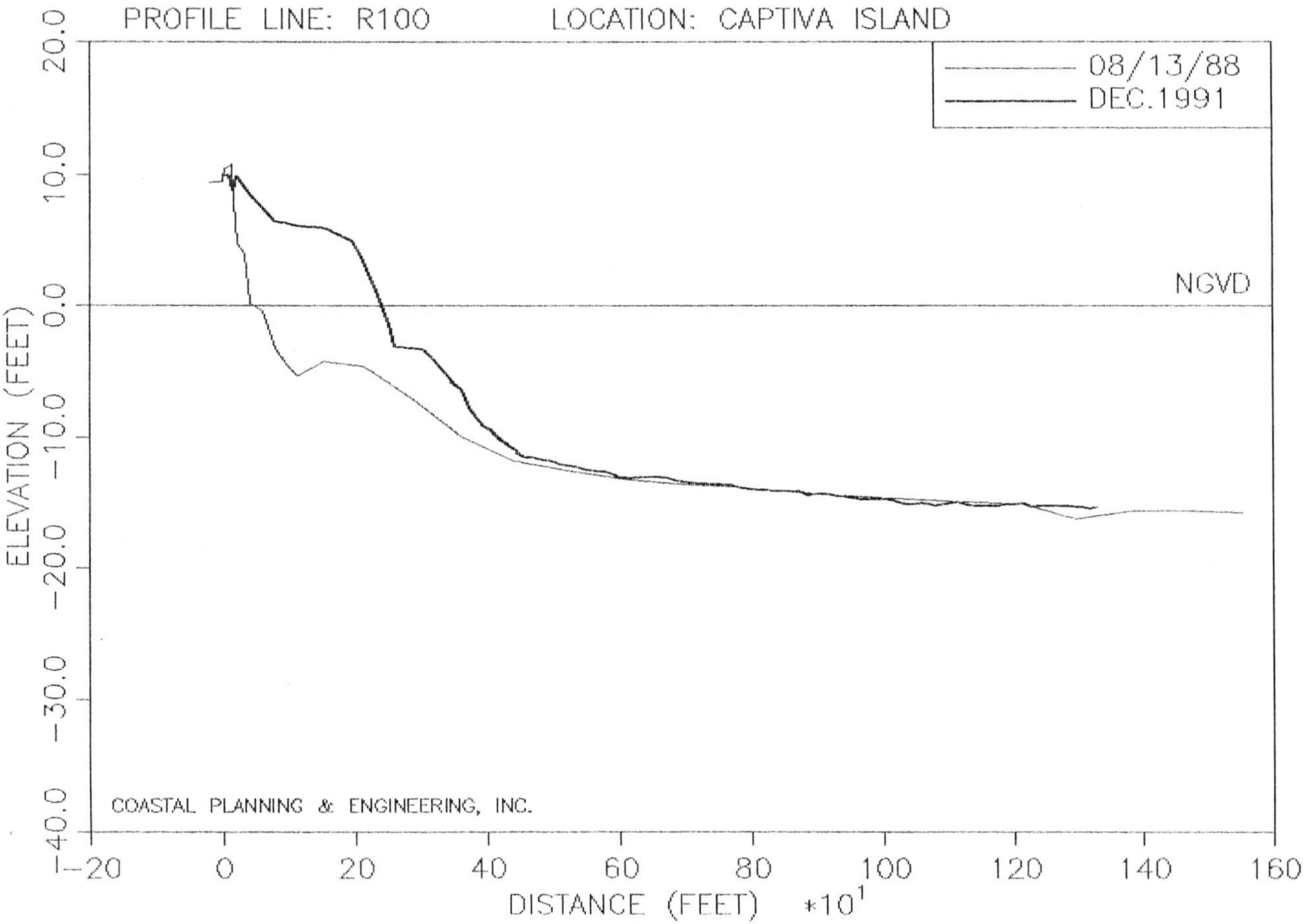


PROFILE LINE: R97
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

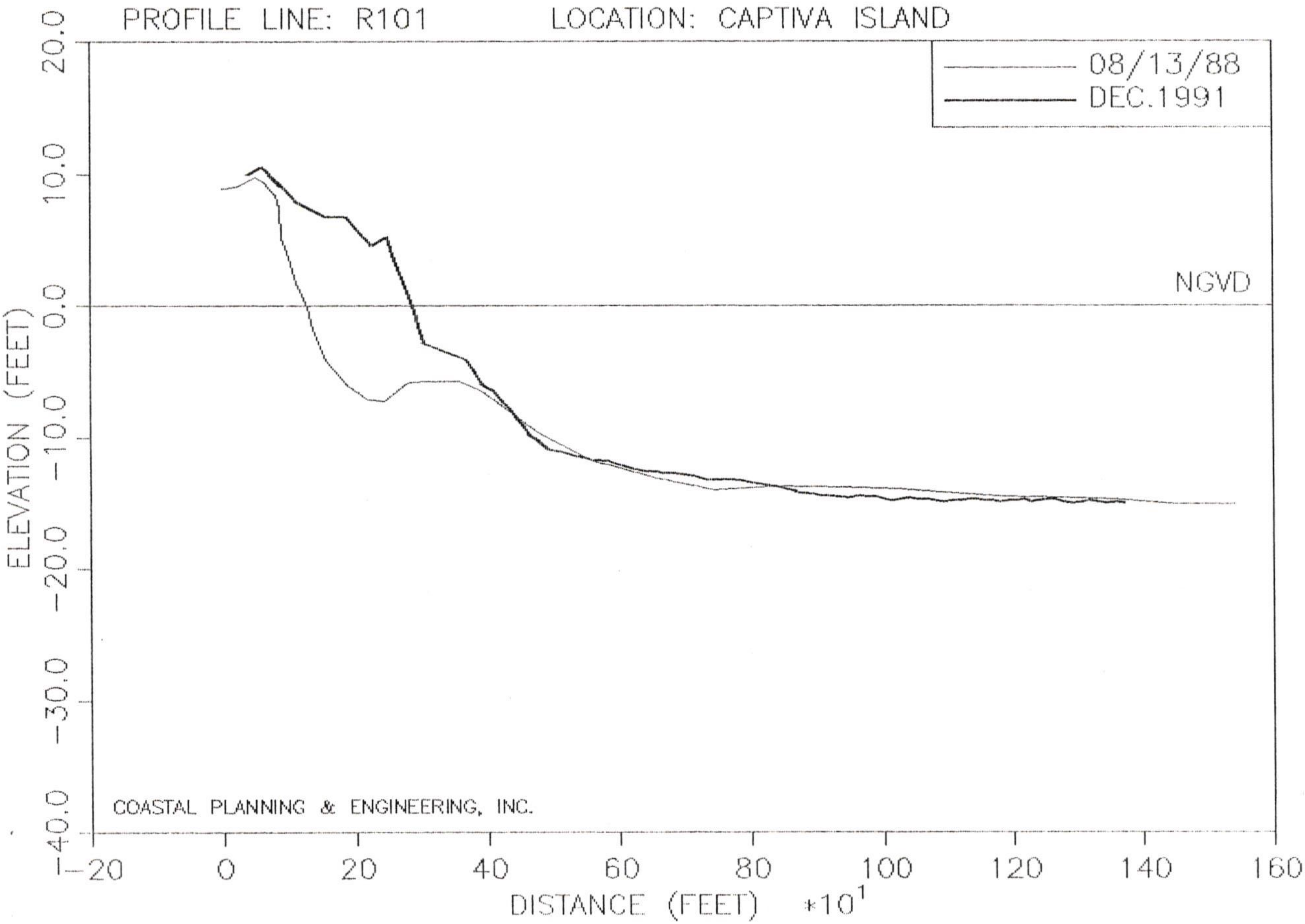


PROFILE LINE: R98
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

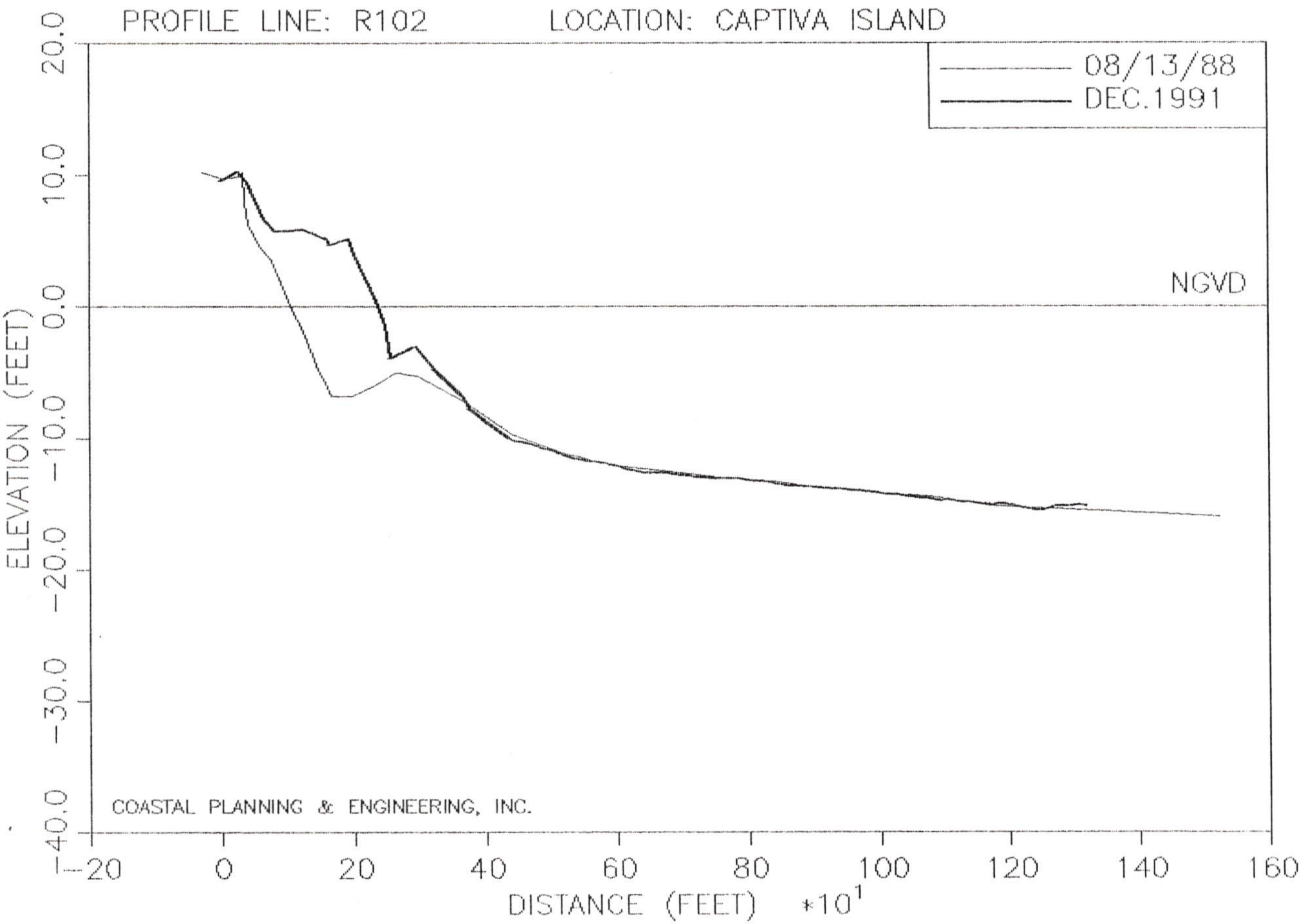

PROFILE LINE: R99
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1



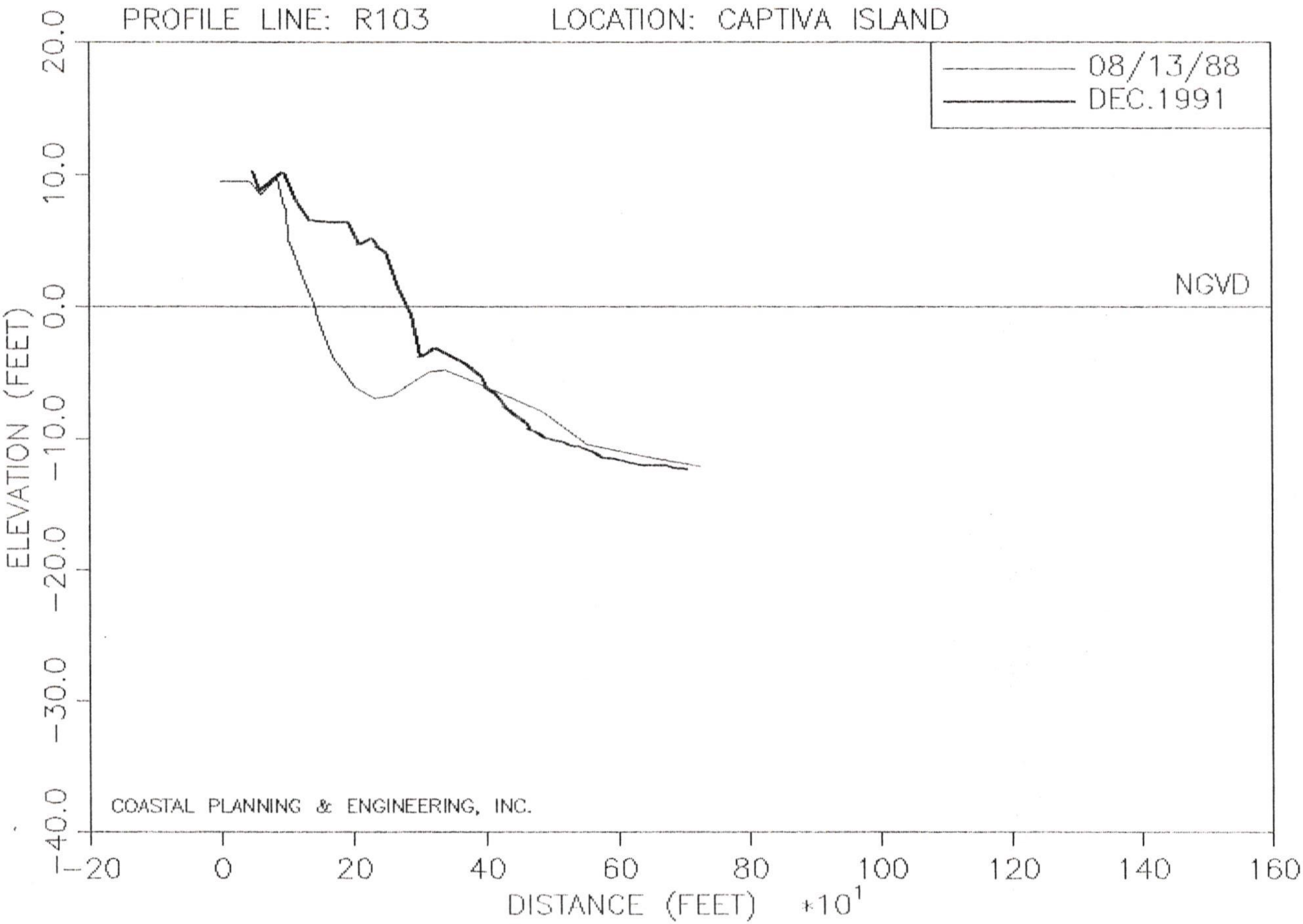
PROFILE LINE: R100
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

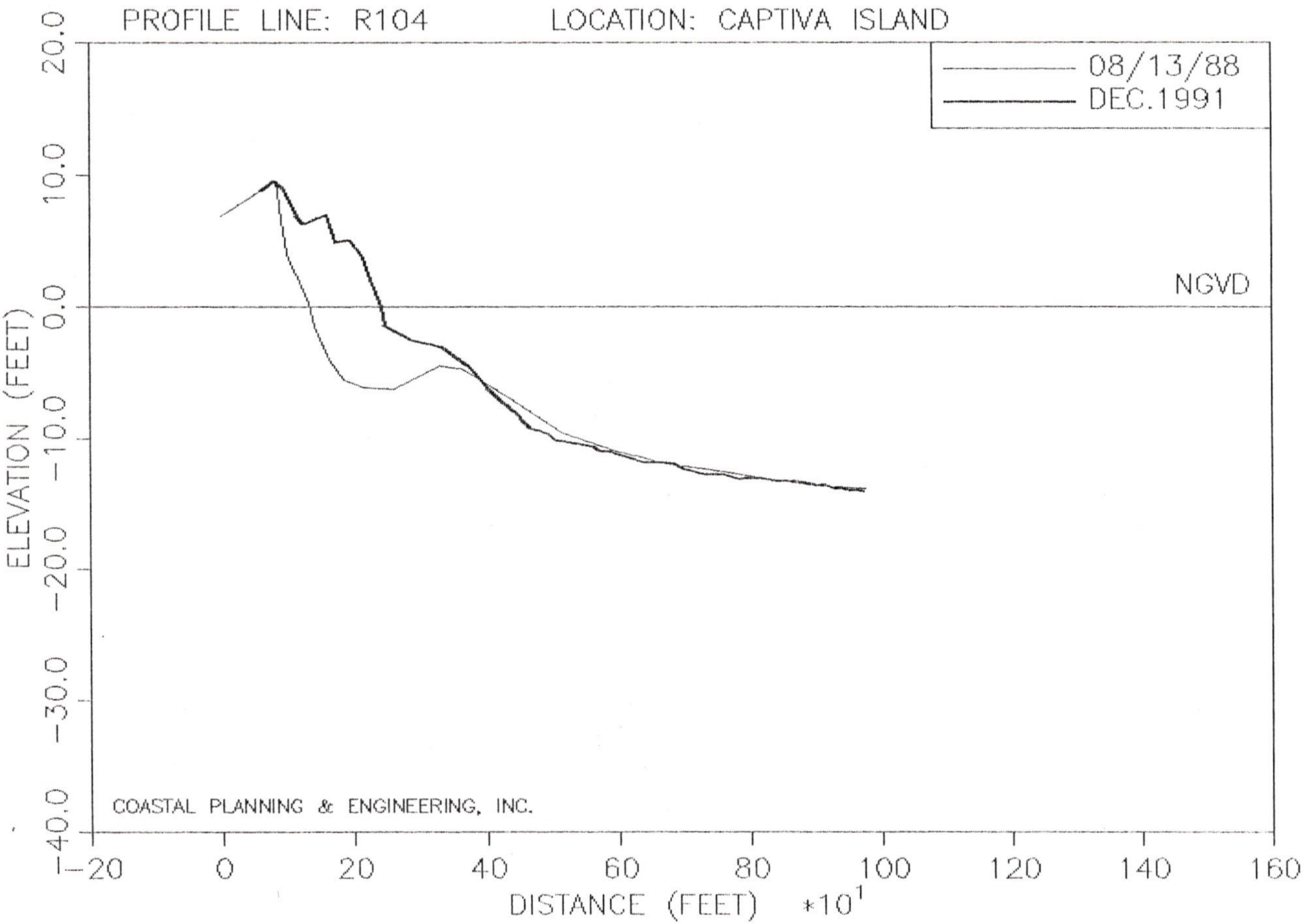


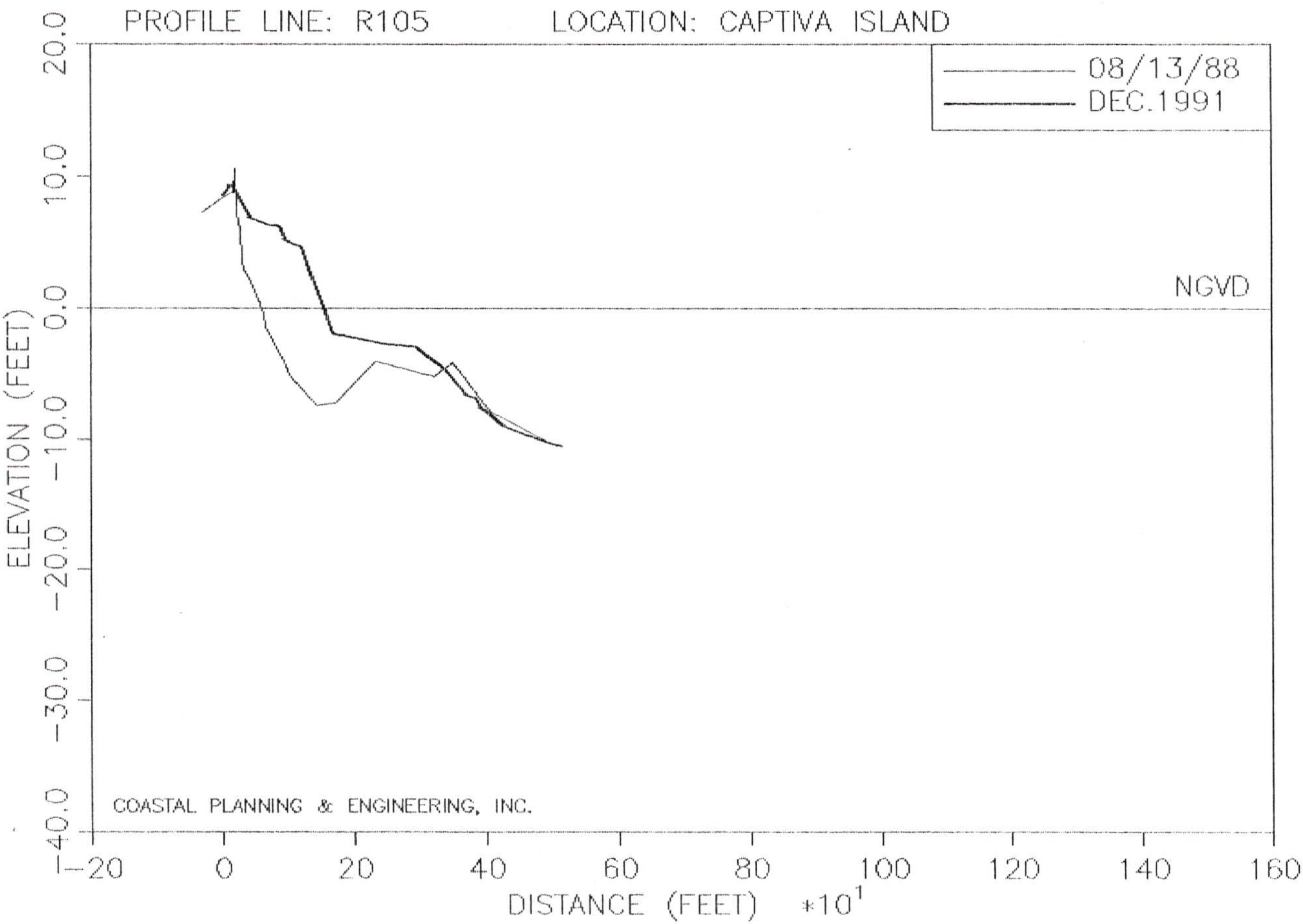
PROFILE LINE: R101
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

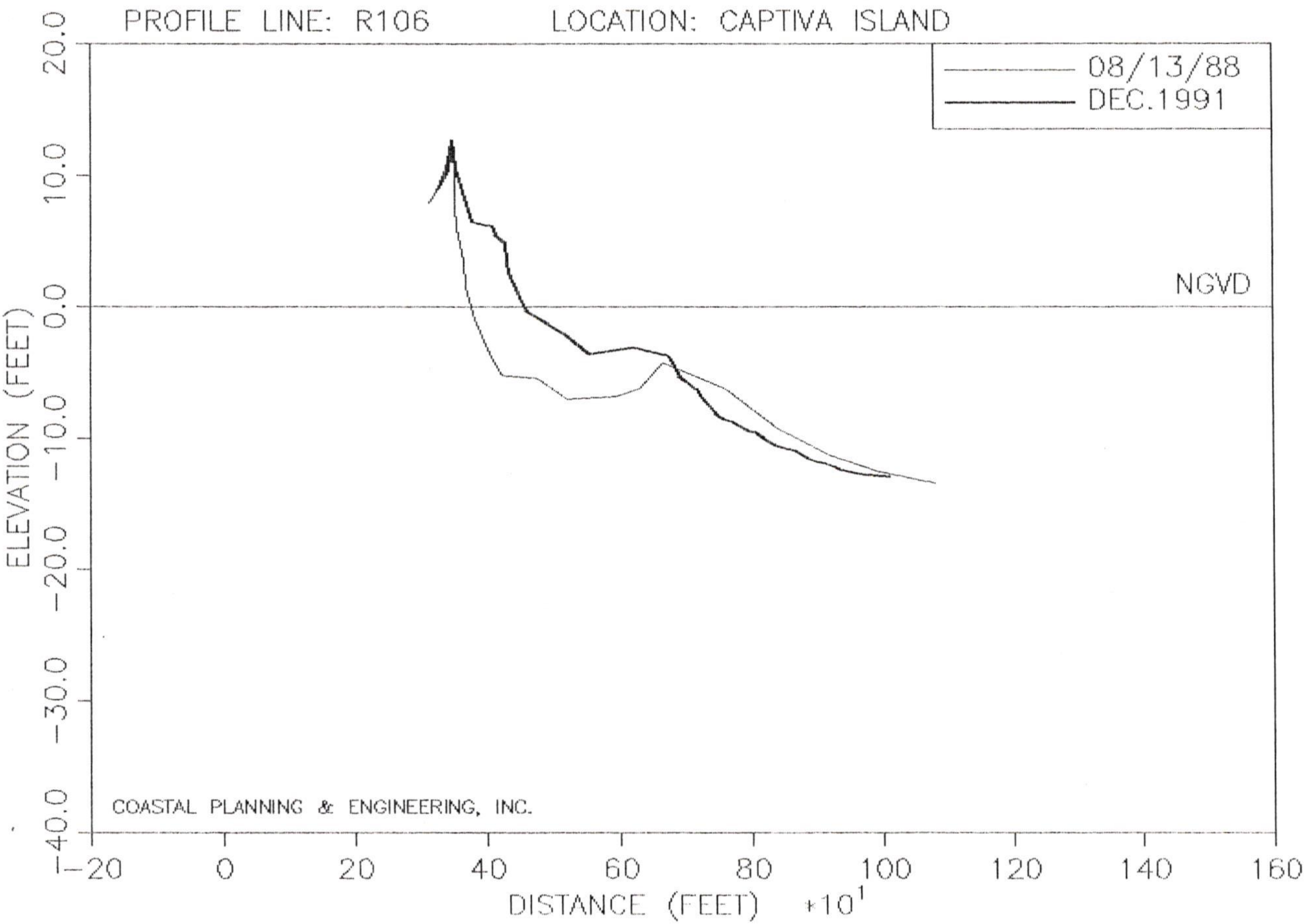


PROFILE LINE: R102
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

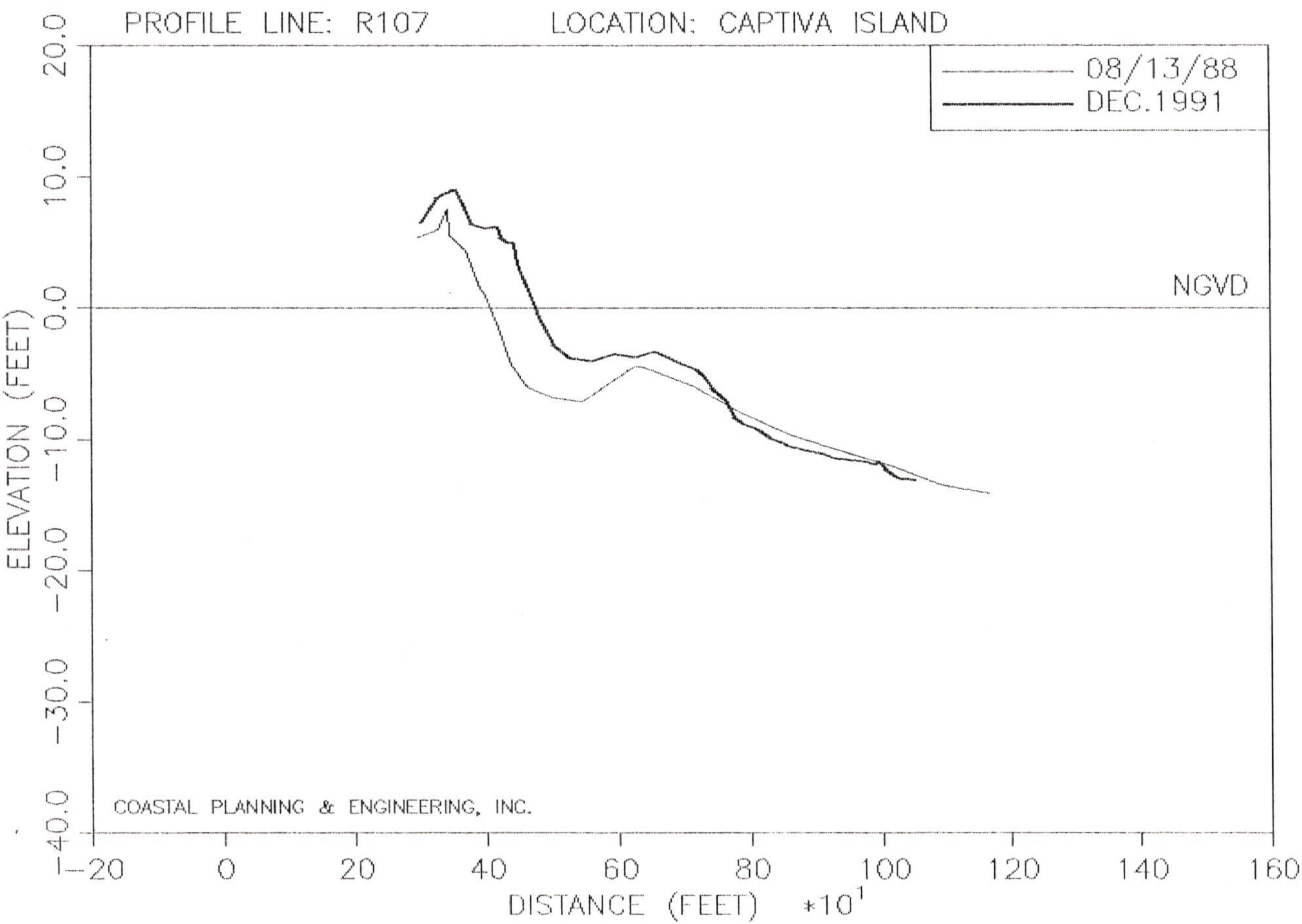

PROFILE LINE: R103
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

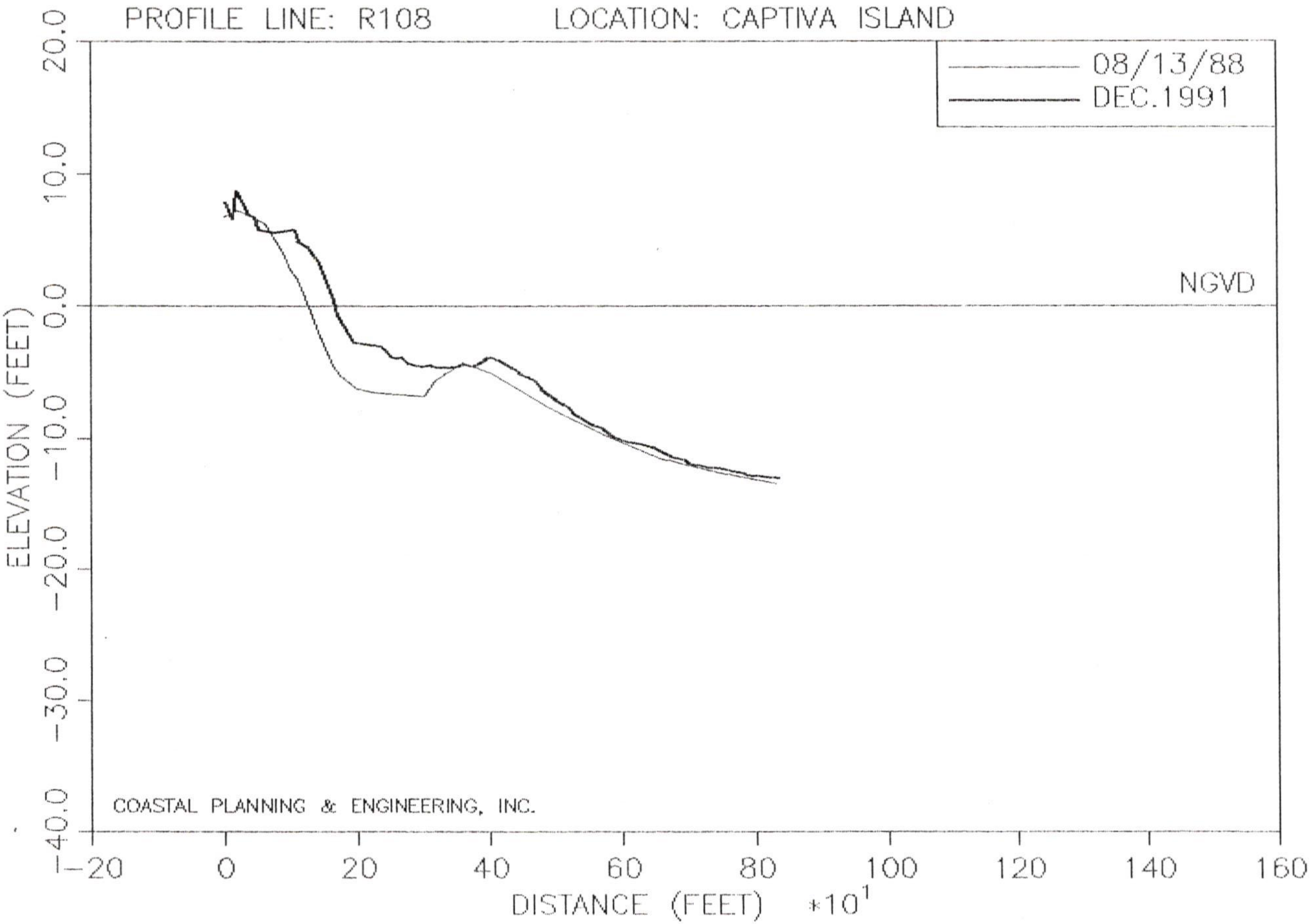

PROFILE LINE: R104
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

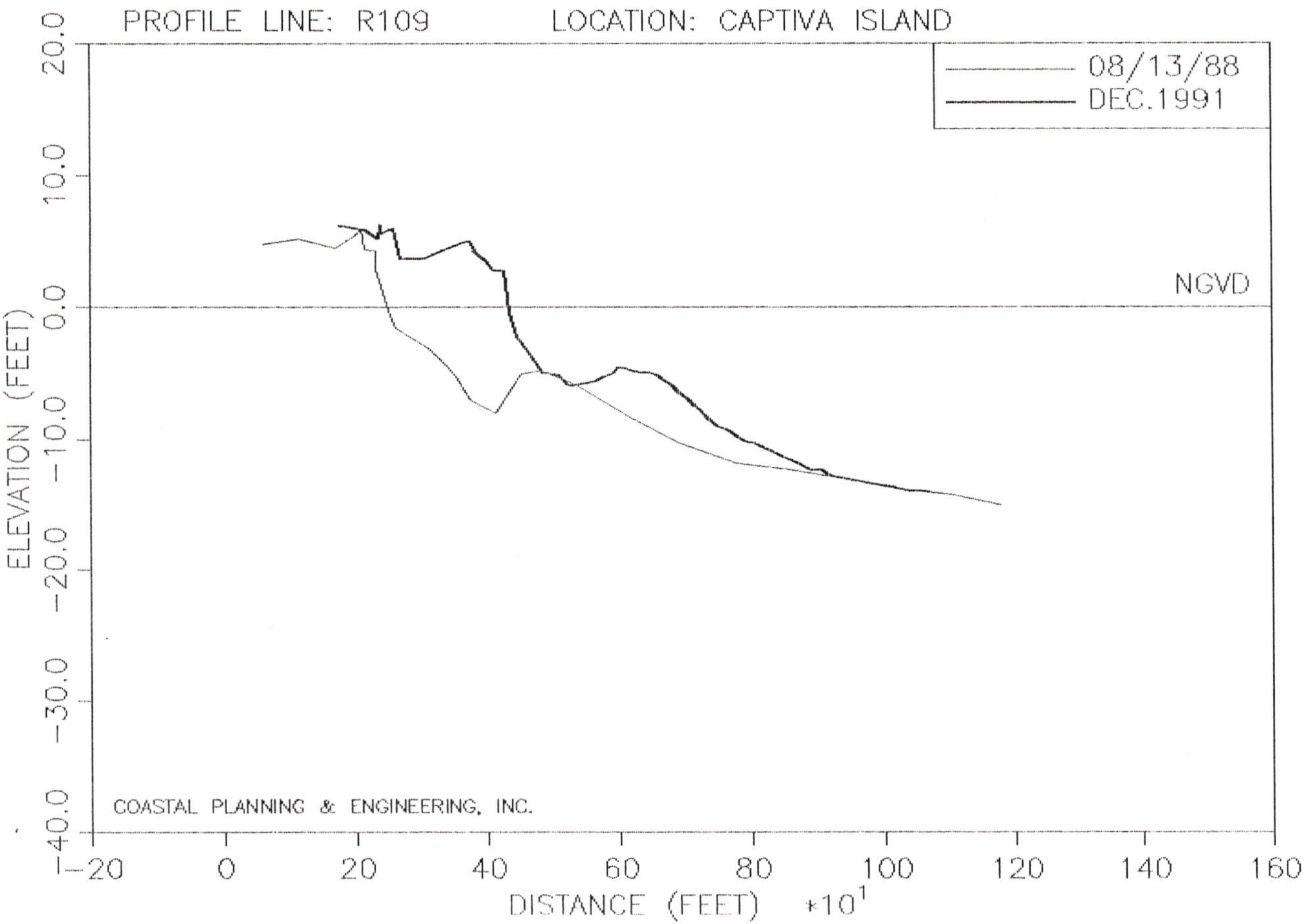

PROFILE LINE: R105
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

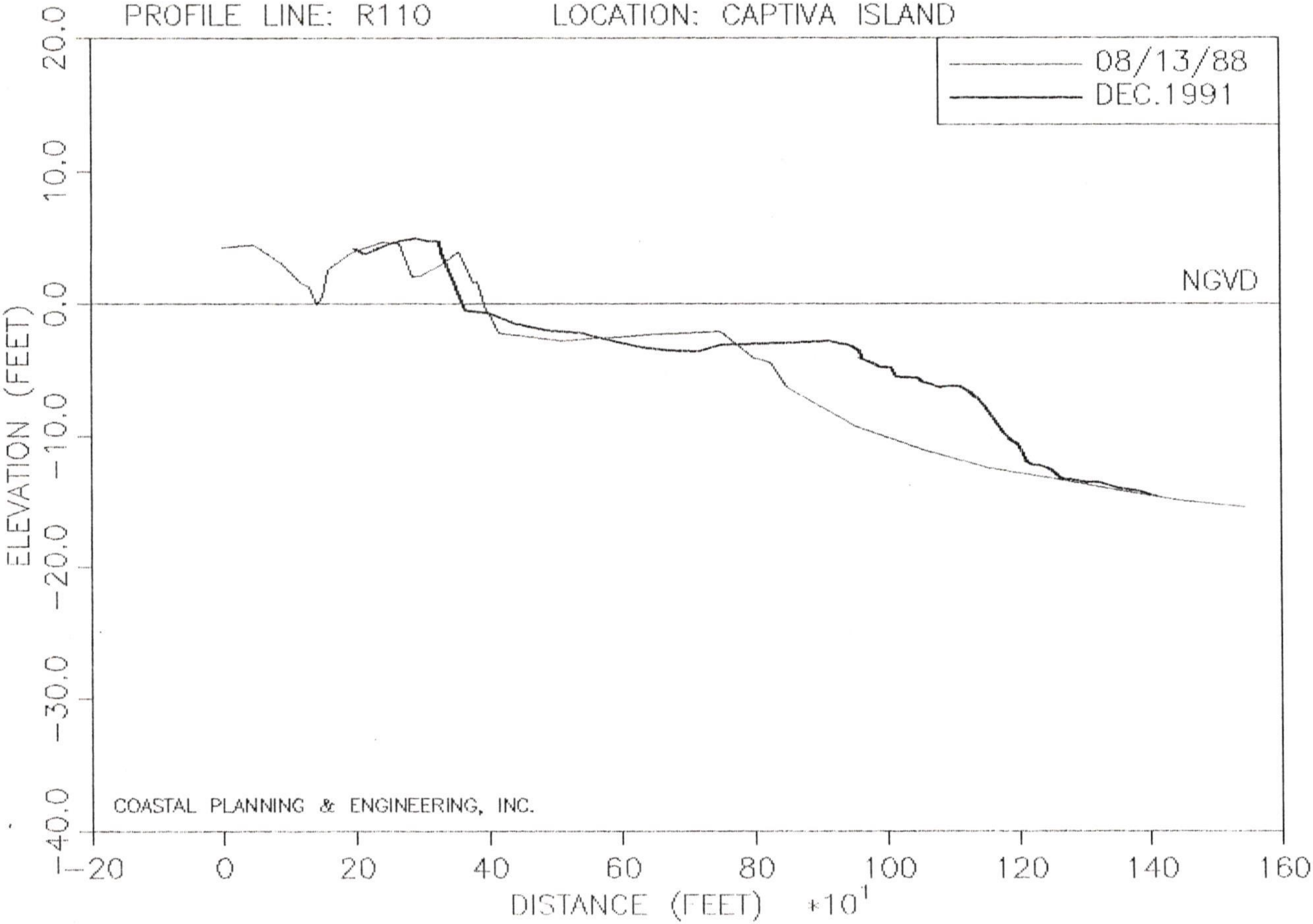


PROFILE LINE: R106
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

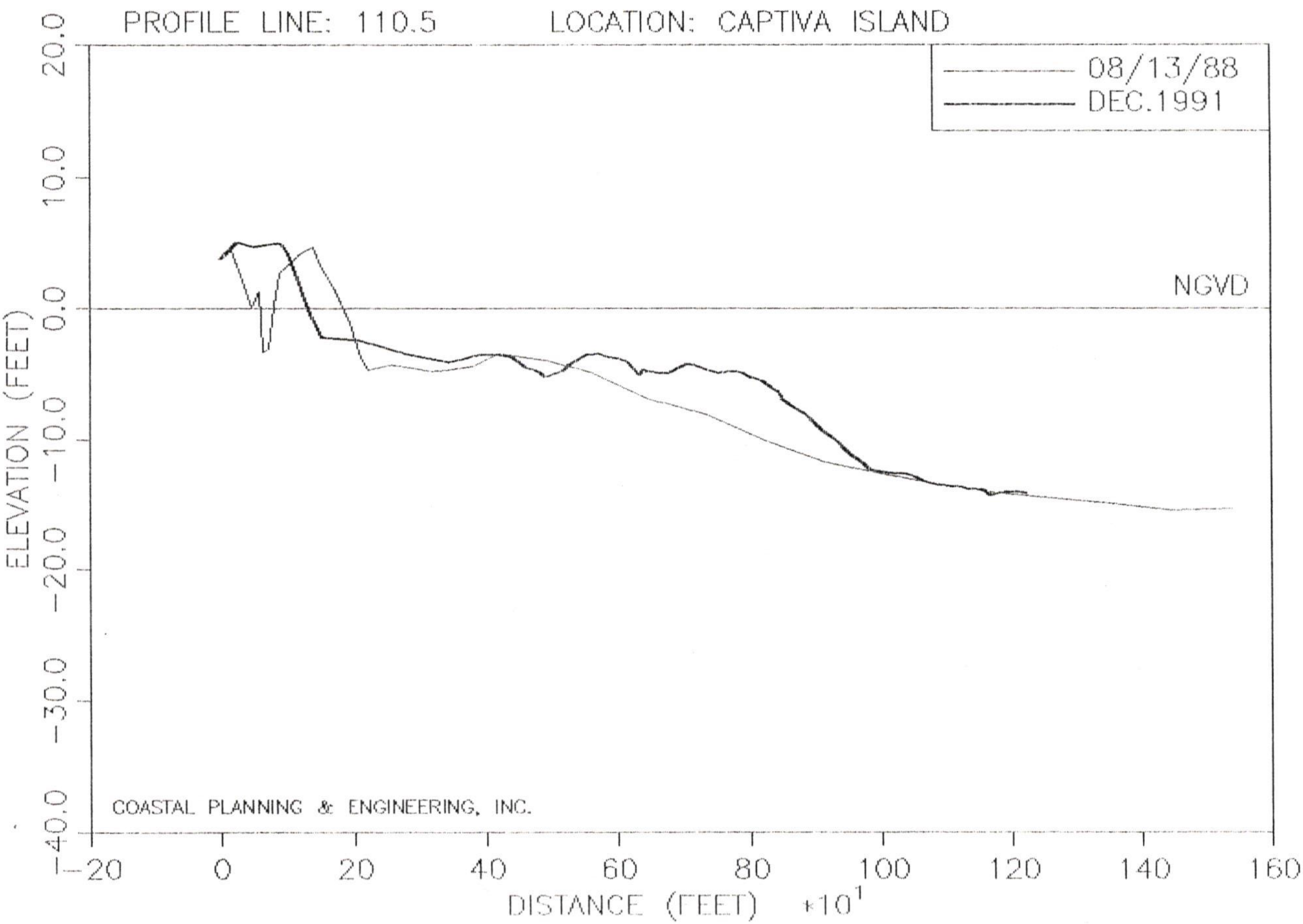

PROFILE LINE: R107
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.


PROFILE LINE: R108
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
COASTAL PLANNING & ENGINEERING, INC.
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

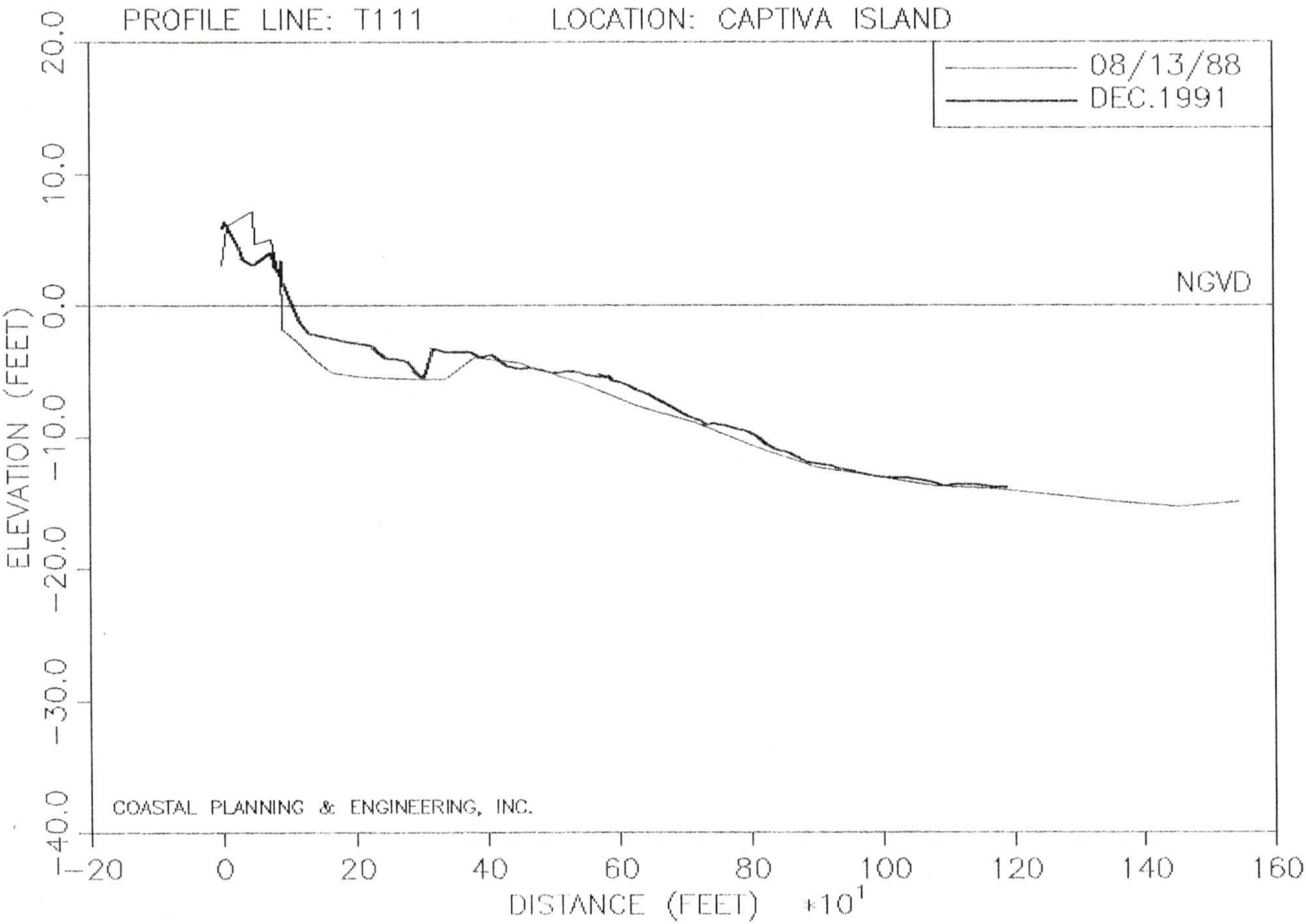

PROFILE LINE: R109
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.

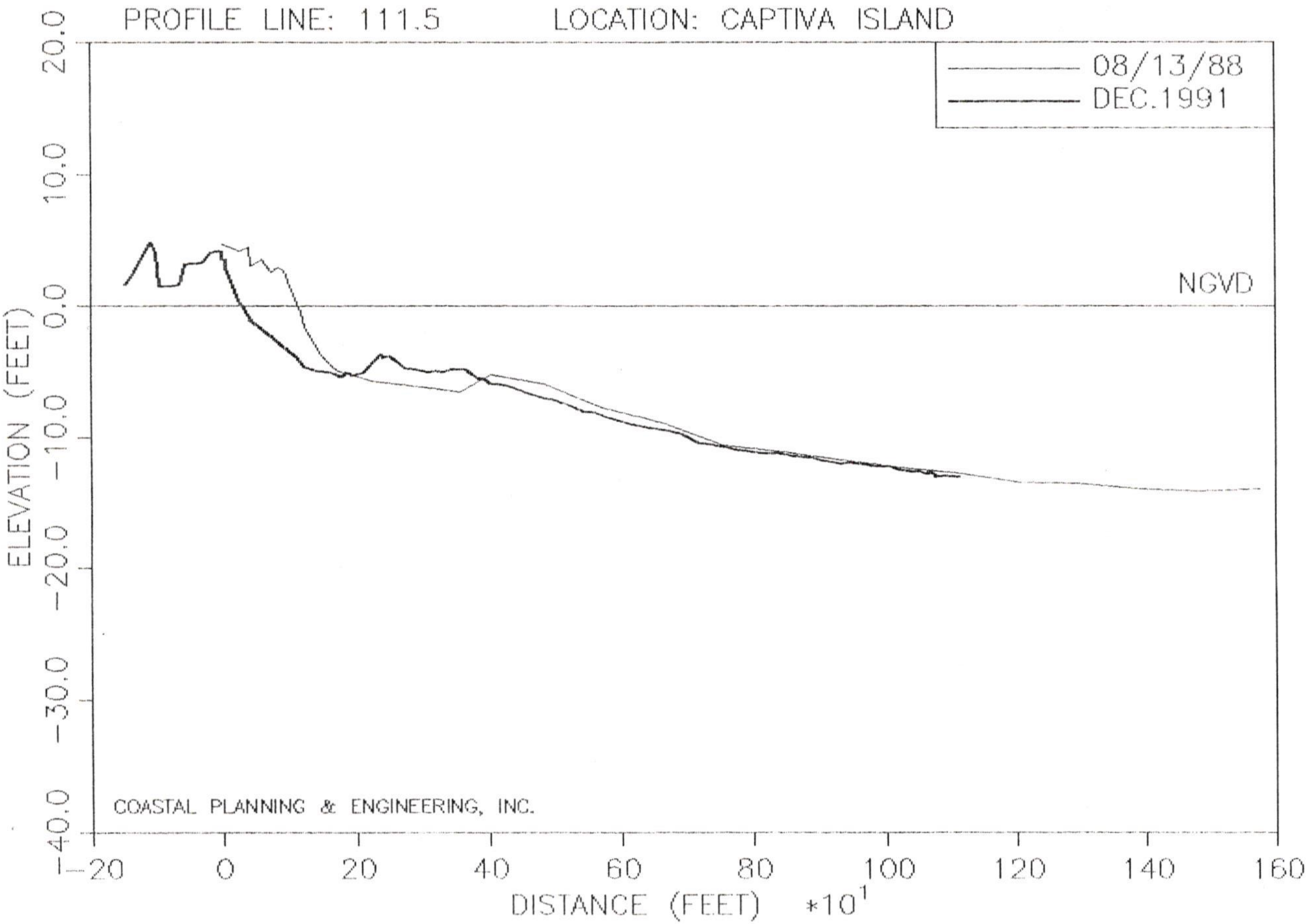


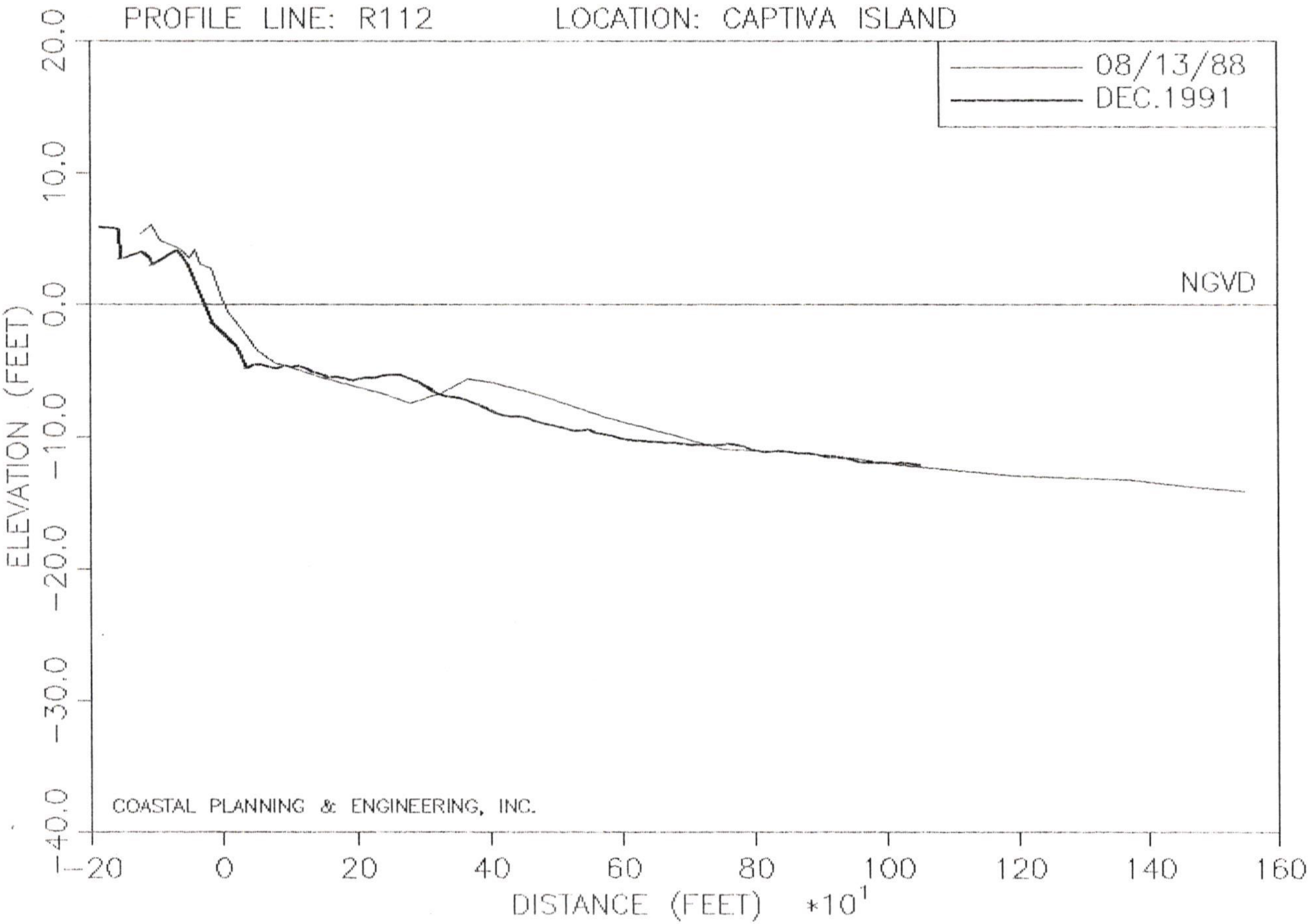
PROFILE LINE: R110
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1
COASTAL PLANNING & ENGINEERING, INC.



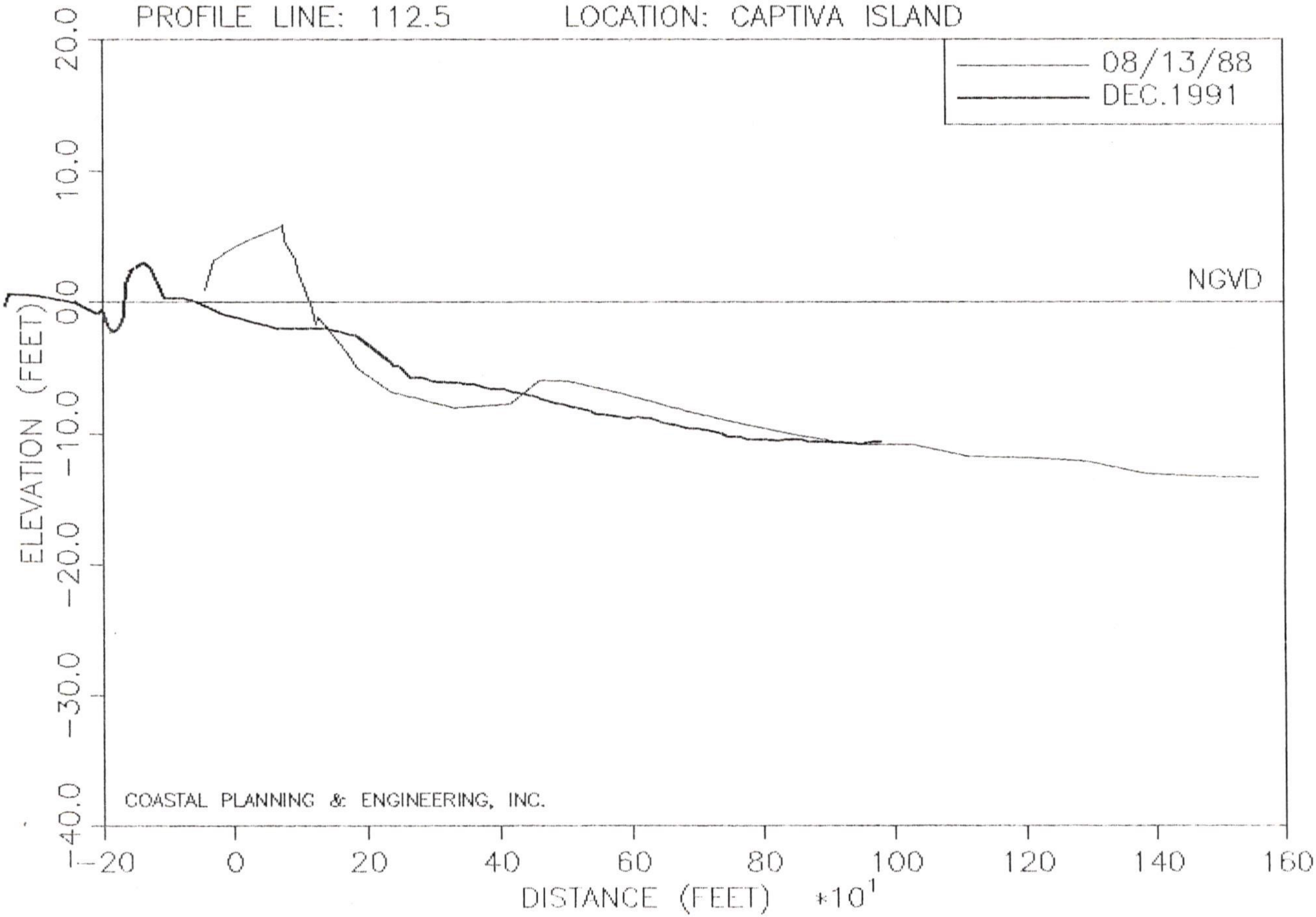
PROFILE LINE: 110.5
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1

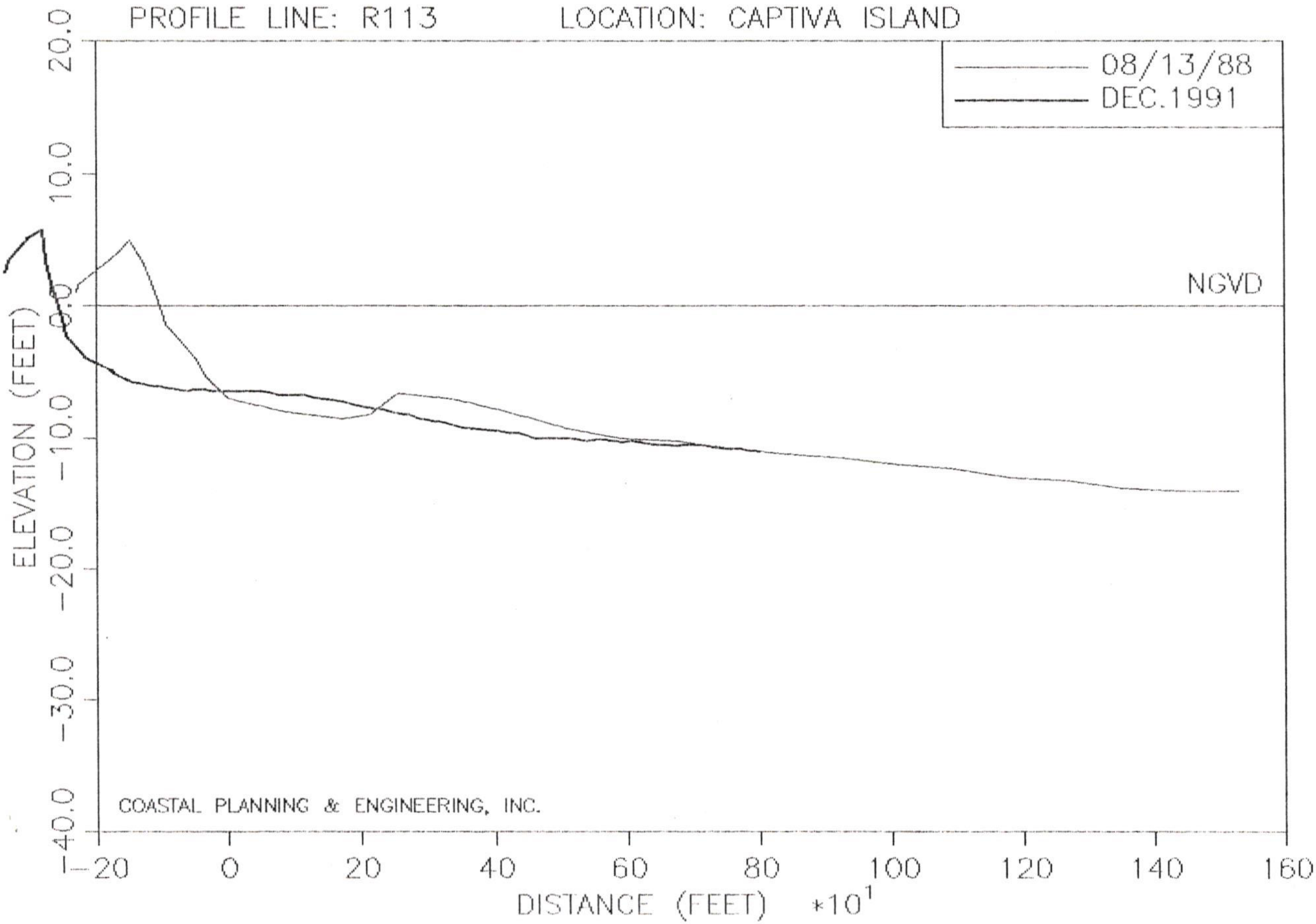

PROFILE LINE: T111
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1


PROFILE LINE: 111.5
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]
COASTAL PLANNING & ENGINEERING, INC.

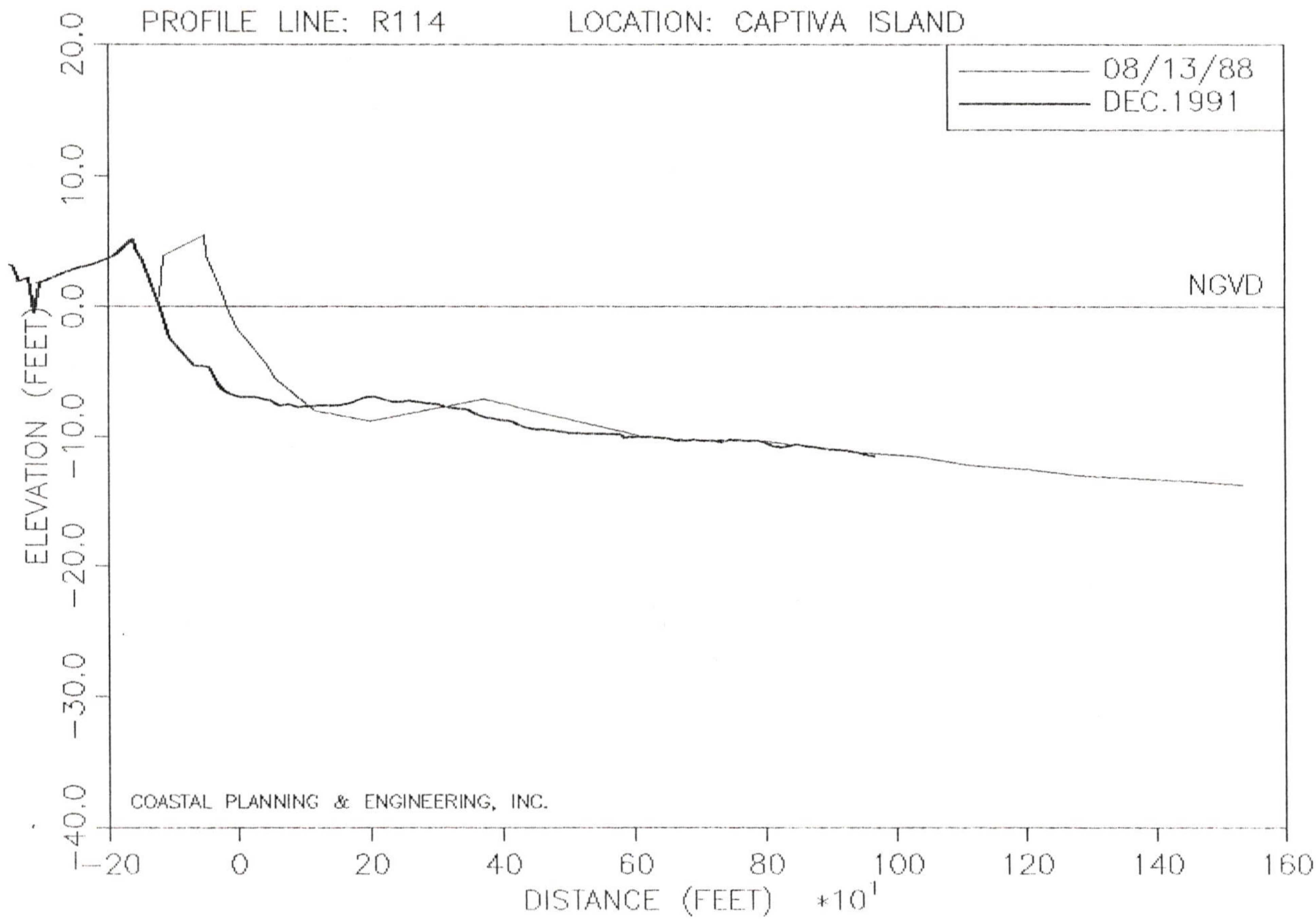


PROFILE LINE: R112
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

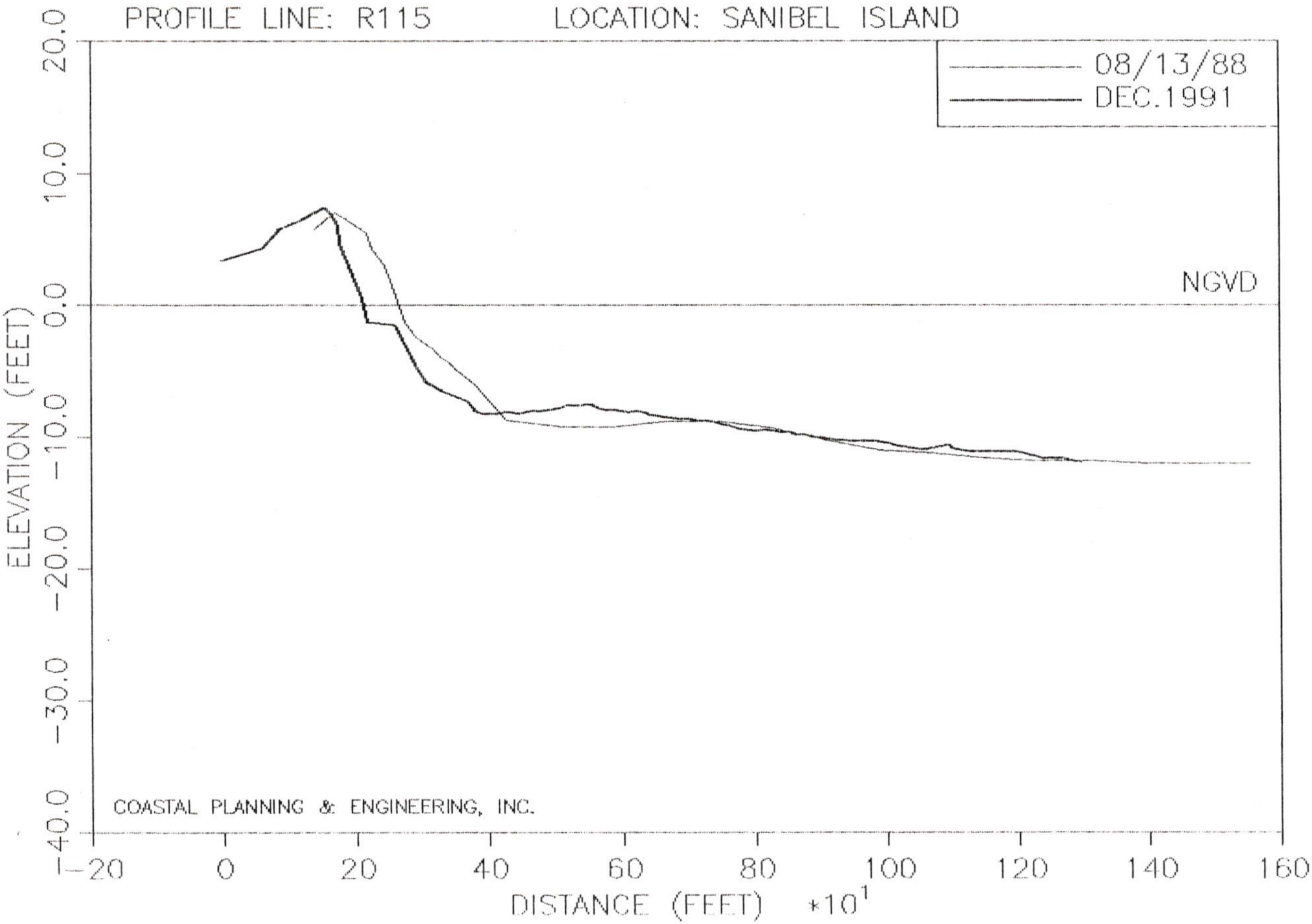

PROFILE LINE: 112.5
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

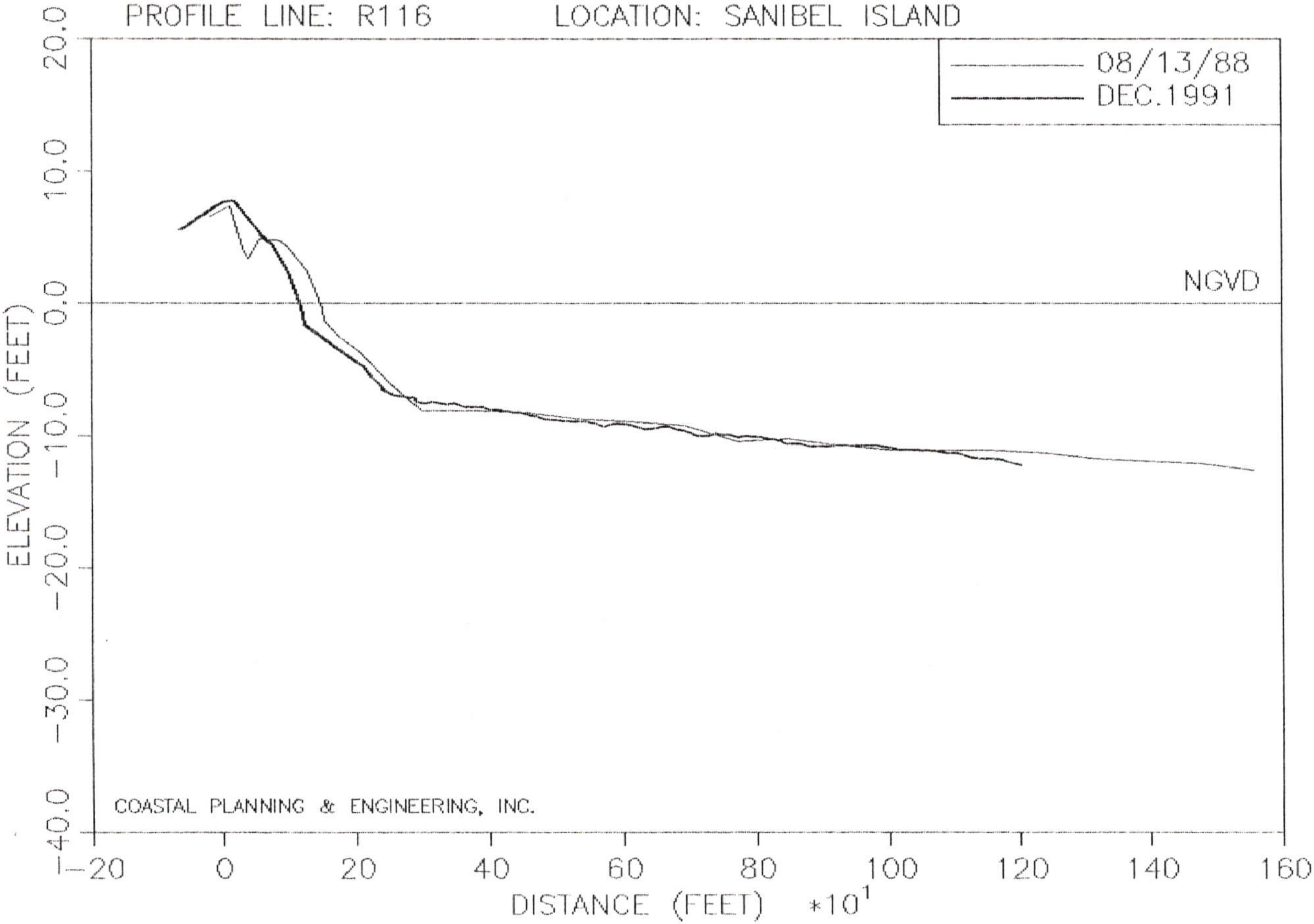


PROFILE LINE: R113
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]



PROFILE LINE: R114
LOCATION: CAPTIVA ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1


PROFILE LINE: R115
LOCATION: SANIBEL ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10^1



PROFILE LINE: R116
LOCATION: SANIBEL ISLAND
08/13/88
DEC.1991
NGVD
ELEVATION (FEET)
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
COASTAL PLANNING & ENGINEERING, INC.
-20
0
20
40
60
80
100
120
140
160
DISTANCE (FEET) *10[1]

APPENDIX B

SHORELINE POSITION AND VOLUME CHANGE TABLES

MHW STATIONS SOUTH OF REDFISH PASS (CAPTIVA ISLAND)

DNR PROFILE NUMBER	SURVEY STATION FOR THE YEAR OF: 1859	1941	1951	1955	1961	1972	1974	1978	1985	1988	1989	1990	DEC 1991
R-84	885.3	-253.0	133.0	181.6	182.6	477.5	178.3	156.6		348.4	339.5	352.0	377.9
R-85	1503.7	743.7	834.7	603.0	588.5	638.4	526.5	552.2	675.5	749.1	824.2	908.7	901.6
R-86	1447.7	850.0	705.8	425.4	415.4	472.6	390.2	347.3	459.2	455.7	534.7	532.3	530.0
R-87	1489.3	823.5	687.4	348.8	347.8	370.0	284.2	259.7	381.5	363.2	418.4	390.6	377.4
R-88	1283.4	695.4	614.1	264.3	247.4	258.4	155.1	146.1	236.4	218.8	271.4	265.0	253.0
R-89	1355.9	864.1	803.2	484.8	491.5	526.7	374.0	358.2	440.8	408.9	466.7	451.3	455.9
R-90	1026.2	619.7	558.9	322.9	311.7	270.5	147.4	122.5	192.4	164.6	227.3	212.1	213.5
R-91	825.6	559.6	472.8	256.6	259.1	283.7	114.2	110.0	151.2	114.4	194.2	181.0	171.8
R-92	658.5	549.3	447.8	266.5	277.0	229.2	157.7	127.8	185.9	155.0	249.2	231.1	221.8
R-93	527.7	495.6	474.5	276.4	277.1	266.7	186.6	178.3	195.6	179.8	266.1	255.0	242.6
R-94	226.5	324.8	343.4	219.9	206.1	166.4	94.1	94.9	106.2	92.7	219.5	177.8	178.6
R-95	98.3	232.8	252.4	136.6	126.2	183.3	62.8	46.3	48.8	44.6	128.1	122.4	116.8
R-96	55.5	208.3	247.7	116.3	95.6	146.6	79.3	88.6	83.4	70.5	158.9	135.8	131.0
R-97	15.6	190.8	247.1	110.7	94.2	142.7	71.3	37.1	64.3	69.1	201.3	163.9	160.9
R-98	-7.4	174.2	217.6	108.4	97.0	193.5	72.8	49.4	57.4	58.5	208.3	188.9	188.0
R-99	23.0	181.4	254.4	154.1	124.2	207.4	122.9	98.6	100.3	85.2	259.9	250.2	248.8
R-100	-10.1	134.3	232.2	136.2	118.6	135.2	114.3	66.6	84.6	39.7	230.9	232.6	230.3
R-101	-27.2	163.1	238.5	186.4	143.3	176.3	153.1	115.5	139.2	116.9	277.8	286.1	281.1
R-102	1.4	138.2	239.4	129.5	123.8	195.2	111.6	81.7	94.0	96.6	205.8	219.8	223.6
R-103	121.9	224.6	287.1	194.8	182.9	263.1	164.1	135.0	143.0	135.5	237.3	241.7	261.5
R-104	240.3	288.8	294.6	195.4	181.5	175.6	169.7	132.2	114.4	125.6	228.9	211.6	224.4
R-105	256.8	222.1	192.1	128.8	104.6	95.8	87.0	50.4	36.7	52.5	190.2	152.0	153.7
R-106	673.8	494.7	503.2	438.9	422.2	411.5	400.8	380.8	367.4	371.1	460.9	488.5	469.1
R-107	915.4	536.6	564.2	491.7	475.5	534.0	447.4	409.2	374.2	397.7	468.1	497.1	479.0
R-108	898.3	224.8	321.3	259.9	220.6	193.1	102.0	120.7	116.0	117.4	193.8	213.8	207.5
R-109	1701.5	559.3	770.2	537.6	436.2	441.7	118.6	247.0	274.4	241.2	421.5	427.2	322.4

SURVEY DATA SOURCES:		
	1859, 1939-43, 1953-58, 1960	U.S.C.& G.S.
	1951, 1972	U.S.G.S.
	1974, 1989	D.N.R.,B.& S.
	1978-79	N.O.S.
	1985, 1988, 1989, 1990, 1991	C.P.& E.

MHW STATIONS SOUTH OF BLIND PASS (SANIBEL ISLAND)

DNR PROFILE NUMBER	SURVEY STATION FOR THE YEAR OF:												
	1859	1941	1951	1955	1961	1972	1974	1978	1985	1988	1989	1990	1991
R-110	1582.5	762.0	910.7	746.8	680.2	674.8	164.3	436.3	439.2	401.4	397.2	342.7	420.6
R-111	1440.7	705.0	794.7	560.5	527.3	462.2	146.1	224.8	108.3	90.3	88.7	89.1	89.8
R-112	1458.6	840.6	784.7	588.2	578.1	472.7	212.7	200.0	-21.6	12.4	-94.5	-129.9	-153.4
R-113	1159.9	617.7	584.8	439.8	439.6	398.5	207.1	163.9	4.0	-155.4	-130.9	-188.6	-234.6
R-114	833.6	-249.0	455.2	344.6	370.6	318.8	224.0	57.8	60.4	-53.0	-41.0	-33.9	-123.0
R-115	-303.6	-533.4	284.6	388.0	347.1	488.7	426.8	263.3	285.4	240.3	190.8	219.5	230.0
R-116	-2339.6	-506.1	-270.7	42.9	49.4	184.6	171.9	90.0	131.3	99.6	97.3	87.9	96.3
R-117	-2470.7	-404.0	-456.7	42.5	158.3	150.5	212.9	195.6			213.1	221.0	235.0
R-118	-2322.4	-189.1	-238.3	83.7	249.4	225.7	293.1	379.1			331.6	348.0	311.0
R-119	-2041.2	-59.7	-390.2	61.7	260.6	255.8	273.8	395.1			374.8	372.0	355.0
R-120	-1978.1	-96.9	-446.3	-192.5	-526.9	117.2	163.4	234.6			232.0	203.0	223.0
R-121	-1664.4	30.9	-147.4	-383.7	-258.7	128.7	257.9	294.4			351.2	351.0	372.0
R-122	-1236.8	57.6	-13.9	-486.5	-468.3	116.5	245.2	351.7			427.2	424.0	427.0
R-123	-741.7	216.0	266.7	-138.7	-261.9	234.2	358.0	501.1			626.3	638.0	642.0
R-124	-667.5	-50.5	79.5	-162.6	-292.0	-69.4	39.5	225.9			344.0	370.0	380.0
R-125	-224.5	7.0	269.3	133.4	16.7	94.7	143.7	286.6			459.5	487.0	501.0
R-126	-88.8	-121.0	222.3	160.7	77.9	92.0	129.8	164.8			372.3	386.0	
R-127	85.9	-89.1	286.8	181.5	100.1	161.3	165.6	174.0			281.8	217.0	
R-128	191.5	-31.3	191.3	154.5	83.7	167.4	115.4	144.1			136.4	126.0	
R-129	321.2	29.0	143.7	173.6	52.7	206.6	137.6	161.7			103.5	94.0	
R-130	339.9	116.0	277.6	214.4	149.1	274.6	200.1	220.0			128.6	131.0	

SURVEY DATA SOURCES:		
	1859, 1939-43, 1953-58, 1960	U.S.C.& G.S.
	1951, 1972	U.S.G.S.
	1974, 1989	D.N.R.,B.& S.
	1978-79	N.O.S.
	1985, 1988, 1989	C.P.& E.
	* 1990	SANIBEL ENGINEERING DEPT.
	* 1991	S.S.,INC.

PROJECT AREA:
VOLUMETRIC CHANGE CALCULATION
1974 VS. 9/88

FROM PROFILE	TO PROFILE	.0	-3.0	-6.0	DEPTH CONTOUR (FT.) -12.0	-18.0	-24.0	-30.0	EOL	DISTANCE (FT.)
R 84	R 87	116041.1	160763.9	245453.5	262914.9	356869.8	356869.6	356869.4	356870.3	3169.9
R 87	R 90	40135.6	52586.2	55778.1	49897.0	112629.9	112629.7	112629.6	112630.4	2854.5
R 90	R 93	34661.4	48993.7	59393.0	53228.1	16243.1	16243.0	16243.0	16244.1	2992.5
R 93	R 96	17636.8	32742.1	39965.3	-3468.7	-157309.1	-157309.4	-157309.3	-157309.3	3472.3
R 96	R 99	-20589.5	-27678.9	-45698.9	-147774.3	-335557.5	-335558.0	-335557.6	-335558.2	2894.5
R 99	R 102	-27415.0	-37971.0	-52269.7	-162696.9	-308158.6	-308158.9	-308158.9	-308159.1	3254.1
R 102	R 105	-21999.8	-31189.7	-31438.7	-105073.5	-264254.5	-264296.4	-264296.4	-264297.1	2972.8
R 105	R 108	10920.1	13042.0	34480.4	-25269.7	-224817.3	-235423.1	-235422.6	-235421.6	3308.5
TOTAL		149390.7	211288.3	305662.9	-78243.1	-804354.2	-815003.4	-815002.7	-815000.5	24919.1

NOTES:
REFERENCE DATUM = D
EOL = END OF PROFILE LINE
VOLUME CHANGES ARE CUMULATIVE FROM LANDWARD END OF PROFILE LINE
VOLUME CHANGES ARE IN CUBIC YARDS

PROJECT AREA:
VOLUMETRIC CHANGE CALCULATION
1974 VS. 9/88

FROM PROFILE	TO PROFILE	DEPTH CONTOUR (FT.) .0	-3.0	-6.0	-12.0	-18.0	-24.0	-30.0	EOL	DISTANCE (FT.)
R 111	R 114	-48464.2	-93165.9	-145625.4	-287747.9	-417328.7	-417328.8	-417328.6	-417328.1	2934.4
TOTAL		-48464.2	-93165.9	-145625.4	-287747.9	-417328.7	-417328.8	-417328.6	-417328.1	2934.4

NOTES:
REFERENCE DATUM = NGVD
EOL = END OF PROFILE LINE
VOLUME CHANGES ARE CUMULATIVE FROM LANDWARD END OF PROFILE LINE
VOLUME CHANGES ARE IN CUBIC YARDS

PROJECT AREA: LEE
VOLUMETRIC CHANGE CALCULATION
1974 VS. 1989

FROM PROFILE	TO PROFILE	DEPTH CONTOUR (FT.) .0	-3.0	-6.0	-12.0	-18.0	-24.0	-30.0	EOL	DISTANCE (FT.)
C-84	R-87	183871.0	248565.8	360336.3	173864.7	184549.7	184550.3	184550.1	184549.6	3169.9
R-87	R-90	91584.1	123445.0	159255.6	225642.0	458365.9	458366.4	458366.2	458363.5	2854.5
R-90	R-93	116622.6	160943.1	197985.1	246315.4	329302.4	329303.3	329302.7	329303.3	2992.5
R-93	C-96	133866.4	190738.5	227729.5	252426.6	303245.4	303245.9	303245.5	303249.2	3472.3
C-96	R-99	86245.7	126765.4	148131.5	116270.9	174543.0	174542.9	174542.8	174542.9	2894.5
R-99	R-102	86061.2	131412.7	175314.5	140123.8	245959.8	245960.1	245959.6	245962.0	3254.1
R-102	R-105	60714.8	92304.3	155690.9	150327.6	203524.9	204003.6	204004.0	204005.1	2972.8
R-105	R-108	81618.7	120693.2	215729.0	229011.9	233054.8	264054.9	264055.7	264055.0	3308.5
TOTAL		840584.4	1194868.0	1640172.0	1533983.0	2132546.0	2164028.0	2164027.0	2164031.0	24919.1

NOTES:
REFERENCE DATUM = NGVD
EOL = END OF PROFILE LINE
VOLUME CHANGES ARE CUMULATIVE FROM LANDWARD END OF PROFILE LINE
VOLUME CHANGES ARE IN CUBIC YARDS

PROJECT AREA: LEE
VOLUMETRIC CHANGE CALCULATION
1974 VS. 1989

FROM PROFILE	TO PROFILE	DEPTH CONTOUR (FT.) .0	-3.0	-6.0	-12.0	-18.0	-24.0	-30.0	EOL	DISTANCE (FT.)
R-111	R-117	12234.6	-14469.3	-59640.8	-353580.2	-367241.1	-354510.5	-354510.1	-354506.5	6155.7
R-117	R-120	46655.0	57167.2	80432.7	83269.3	161719.0	161798.7	161799.3	161803.0	3178.7
R-120	R-123	110969.4	164323.6	235482.5	370103.2	384724.2	384724.3	384725.0	384726.6	3132.4
R-123	R-126	154756.6	241542.1	317481.2	455906.5	450743.1	450742.5	450742.0	450745.3	3342.6
R-126	R-129	61524.7	96045.0	134163.0	112536.5	90876.9	90876.6	90875.7	90880.2	3278.9
TOTAL		386140.3	544608.8	707918.6	668235.3	720822.1	733631.6	733631.9	733648.7	19088.2

NOTES:
REFERENCE DATUM = NGVD
EOL = END OF PROFILE LINE
VOLUME CHANGES ARE CUMULATIVE FROM LANDWARD END OF PROFILE LINE
VOLUME CHANGES ARE IN CUBIC YARDS

PROJECT AREA: CAPTIVA ISLAND
VOLUMETRIC CHANGE CALCULATION
9/1985 VS. 08/13/88

FROM PROFILE	TO PROFILE	DEPTH CONTOUR (FT.) .0	-3.0	-6.0	-12.0	-18.0	-24.0	-30.0	EOL	DISTANCE (FT.)
R 84	R 85	-2810.1	-4459.5	-15688.7	-27626.7	-27626.6	-27626.7	-27626.8	-27626.8	1343.9
R 85	R 86	1614.4	1185.6	-486.6	-749.9	1788.9	1788.9	1789.0	1788.8	826.4
R 86	R 87	-1834.2	-5719.4	-10384.9	-14927.2	-6716.4	-6716.3	-6716.3	-6716.4	1041.9
R 87	R 88	-1219.7	-5369.8	-10005.9	-19399.6	-10345.5	-10345.4	-10345.4	-10345.4	952.7
R 88	R 89	-1062.3	-5634.5	-10319.4	-17879.1	-8907.7	-8907.7	-8907.6	-8907.6	1022.1
R 89	R 90	-1312.5	-6045.4	-10414.5	-13089.0	-3265.6	-3265.5	-3265.5	-3265.5	928.7
R 90	R 91	-3291.9	-8851.1	-13358.3	-19465.7	-17546.8	-17546.7	-17546.7	-17546.4	965.8
R 91	R 92	-5117.7	-11453.4	-14931.4	-18758.0	-1720.6	-1720.6	-1720.7	-1720.4	1119.9
R 92	R 93	-2433.0	-6819.6	-7801.2	-7536.8	12607.7	12607.6	12607.6	12607.5	899.3
R 93	R 94	-658.5	-6503.0	-5479.0	-2187.0	4942.9	4942.9	4942.8	4942.8	1549.9
R 94	R 95	90.0	-1996.7	-1860.3	-1206.4	-6221.5	-6221.5	-6221.5	-6221.7	909.0
R 95	R 96	2754.0	1258.9	-334.0	-6403.8	-25593.3	-25593.2	-25593.3	-25593.3	1026.6
R 96	R 97	2749.9	1432.2	-544.3	-7921.7	-17369.2	-17369.1	-17369.2	-17368.8	892.7
R 97	R 98	60.5	-2761.4	-6410.4	-14057.9	-12337.3	-12337.2	-12337.2	-12336.8	1083.8
R 98	R 99	-1453.0	-4361.6	-10057.0	-16358.8	-20448.4	-20448.5	-20448.5	-20448.4	954.4
R 99	R 100	-5957.6	-9413.0	-16859.3	-24580.5	-41652.9	-41653.0	-41652.9	-41653.4	1037.5
R 100	R 101	-5947.9	-8975.8	-17521.2	-20092.1	-37531.2	-37531.2	-37531.1	-37531.1	985.5
R 101	R 102	-1280.0	-1608.0	-8531.0	-6395.6	-11367.6	-11367.6	-11367.4	-11367.4	837.4
R 102	R 103	-817.1	244.8	-16521.7	-9242.0	7350.8	7351.1	7351.2	7351.0	2775.7
R 103	R104	-144.8	-307.2	-4411.9	-465.5	14848.8	14848.9	14848.8	14848.9	1060.9
R104	R105	696.6	1007.0	1923.2	5024.5	8371.3	8371.2	8371.3	8371.1	1120.9
R105	R106	543.9	62.1	417.3	3253.9	-5717.5	-5717.5	-5717.4	-5717.6	1017.8
R106	R107	-2139.5	-3575.5	-6688.9	-7171.7	-8616.6	-8616.6	-8616.7	-8616.8	1123.7
R107	R108	3746.7	5045.2	2897.5	-7573.4	-16888.0	-16888.1	-16888.2	-16888.1	1241.0
R108	R 109	4503.5	6565.9	7649.8	-1373.0	-19619.4	-19619.4	-19619.4	-19619.5	884.8
TOTAL		-20720.2	-77053.2	-175721.8	-256182.8	-249581.6	-249581.3	-249581.0	-249581.3	27602.3

NOTES:
REFERENCE DATUM = NGVD
EOL = END OF PROFILE LINE
VOLUME CHANGES ARE CUMULATIVE FROM LANDWARD END OF PROFILE LINE
VOLUME CHANGES ARE IN CUBIC YARDS

PROJECT AREA: SANIBEL ISLAND
VOLUMETRIC CHANGE CALCULATION
9/85 VS. 08/13/88

FROM PROFILE	TO PROFILE	DEPTH CONTOUR (FT.) .0	-3.0	-6.0	-12.0	-18.0	-24.0	-30.0	EOL	DISTANCE (FT.)
R 110	R 111	4452.4	4797.0	11222.9	2111.7	-5566.0	-5566.1	-5566.2	-5565.8	1015.1
R 111	R 112	1195.6	-1185.7	-1887.4	-5352.0	-9290.9	-9290.8	-9290.8	-9290.8	794.3
R 112	R 113	-4873.2	-10050.2	-20150.1	-41007.5	-43056.9	-43056.9	-43056.9	-43057.3	1210.4
R 113	R 114	-8081.5	-14698.6	-22887.7	-43156.7	-42996.6	-42996.7	-42996.8	-42996.9	812.4
R 114	R 115	-10324.5	-16901.6	-22405.0	-53104.7	-53789.4	-53789.5	-53789.8	-53789.9	1222.9
R 115	R 116	-2842.4	-2833.6	-1531.6	-7543.8	-5632.8	-5632.7	-5633.1	-5632.5	1177.8
TOTAL		-20473.6	-40872.8	-57638.8	-148053.0	-160332.6	-160332.7	-160333.4	-160333.2	6232.8

NOTES:
REFERENCE DATUM = NGVD
EOL = END OF PROFILE LINE
COORDINATES OF FIRST BORDER: E = .0 N = .0
COORDINATES OF SECOND BORDER: E = .0 N = .0
VOLUME CHANGES ARE CUMULATIVE FROM LANDWARD END OF PROFILE LINE

PROJECT AREA: CAPTIVA ISLAND
VOLUMETRIC CHANGE CALCULATION
08/13/88 VS. DEC.1991

FROM PROFILE	TO PROFILE	.0	-3.0	-6.0	DEPTH CONTOUR (FT.) -12.0	-18.0	DISTANCE (FT.)
R84	R85	15396.1	20073.1	9783.6	11512.8	11512.9	1343.4
R85	R86	21497.8	29155.3	31647.2	42111.6	42111.6	826.4
R86	R87	13967.6	19954.6	25583.9	39301.3	41858.1	1055.5
R87	R88	7531.6	10162.3	12831.6	20251.4	26312.3	948.8
R88	R89	14302.5	19173.0	25172.3	39033.8	45963.8	1022.1
R89	R90	15002.9	20138.3	27192.3	40902.2	45670.9	928.7
R90	R91	17171.3	22749.7	31152.1	46127.2	49930.4	966.2
R91	R92	21955.1	29620.8	40440.2	58154.9	64924.1	1119.9
R92	R93	20175.0	28095.4	37020.9	50048.0	56348.6	899.8
R93	R94	38247.9	51852.1	64990.5	84011.2	88080.1	1549.6
R94	R95	23339.5	30168.7	37298.5	49042.4	55142.0	909.0
R95	R96	23396.4	30495.6	38880.6	53737.3	63465.1	1026.5
R96	R97	17841.8	25196.1	33587.4	45813.2	50496.3	893.6
R97	R98	26451.2	39623.1	52715.6	69555.5	69881.7	1083.4
R98	R99	31941.0	47721.2	62801.7	78537.0	79262.6	954.9
R99	R100	43184.2	63268.1	82222.7	97382.7	101930.2	1036.3
R100	R101	42240.3	60995.9	80660.8	87988.4	87295.3	986.4
R101	R102	42348.5	61456.9	84451.9	85390.5	82101.5	1201.1
R102	R103	24932.3	36527.6	50044.9	46994.8	46491.7	795.6
R103	R104	31335.6	46522.5	64637.2	57869.3	57077.9	1060.9
R104	R105	26874.5	41457.8	60650.5	58128.7	57408.7	1120.9
R105	R106	20158.5	32857.4	53249.7	49402.7	48695.8	1017.3
R106	R107	22171.5	33516.1	57794.7	52092.5	50749.9	1119.4
R107	R108	19132.6	27038.9	50713.6	53945.0	54166.7	1247.1
R108	R109	17932.7	28479.3	44071.9	60030.3	61228.7	884.0
TOTAL		598528.4	856299.8	1159596.0	1377365.0	1438107.0	25996.7

NOTES:
REFERENCE DATUM = NGVD
EOL = END OF PROFILE LINE
VOLUME CHANGES ARE CUMULATIVE FROM LANDWARD END OF PROFILE LINE
VOLUME CHANGES ARE IN CUBIC YARDS

VOLUMETRIC CHANGES HAVE BEEN CORRECTED FOR OFFSHORE CLOSURE BY DELETING THE SEAWARD ENDS OF PROFILES WHICH EXHIBITED SIGNIFICANT OFFSHORE CLOSURE ERROR.

PROJECT AREA: SANIBEL ISLAND
VOLUMETRIC CHANGE CALCULATION
08/13/88 VS. DEC.1991

FROM PROFILE	TO PROFILE	DEPTH CONTOUR (FT.) .0	-3.0	-6.0	-12.0	-18.0	-24.0	-30.0	EOL	DISTANCE (FT.)
R110	110.5	809.2	-65.2	9637.6	30016.9	31430.6	31430.7	31430.7	31430.6	541.5
110.5	T111	-329.6	78.1	8636.2	17751.1	18478.5	18478.5	18478.5	18478.5	481.9
T111	111.5	-3200.5	-3933.2	83.2	126.3	281.0	281.0	281.0	280.9	396.3
111.5	R112	-3887.4	-6171.1	-5459.1	-10163.6	-10336.3	-10336.2	-10336.2	-10336.7	400.9
R112	112.5	-9850.2	-13689.2	-11751.0	-19875.7	-19798.4	-19798.3	-19798.3	-19799.2	634.4
112.5	R113	-12283.3	-20164.1	-23497.6	-30081.6	-30081.6	-30081.6	-30081.5	-30081.9	646.8
R113	R114	-11790.1	-23280.1	-34727.9	-41870.4	-41870.3	-41870.3	-41870.3	-41870.4	812.4
R114	R115	-15731.7	-26015.1	-36869.7	-34306.9	-34307.0	-34306.9	-34306.9	-34306.7	1223.2
R115	R116	-7391.4	-11982.4	-16936.2	-12333.9	-12368.9	-12368.9	-12368.9	-12368.1	1177.5
TOTAL		-63654.9	-105222.3	-110884.3	-100737.8	-98572.2	-98572.1	-98572.0	-98573.1	6314.9

NOTES:
REFERENCE DATUM = NGVD
EOL = END OF PROFILE LINE
VOLUME CHANGES ARE CUMULATIVE FROM LANDWARD END OF PROFILE LINE
VOLUME CHANGES ARE IN CUBIC YARDS

APPENDIX C

SHORELINE CHANGE/VOLUME CHANGE COMPARISONS
SANIBEL ISLAND

APPENDIX C

SHORELINE CHANGE/VOLUME CHANGE COMPARISONS
SANIBEL ISLAND

Sanibel Post-1988 Volume Changes Compared with Shoreline Changes

Since 1988 the average shorelines in the northern mile of Sanibel Island have been retreating about 90 percent faster than the historic rate while the volumetric erosion rate has been 25% slower than the historic rate. Because this high retreat rate includes the effects of Tropical Storm Keith, this analysis is not intended to establish inlet impacts. An analysis was undertaken to determine why shoreline retreat was higher during a period when net erosion has been slower.

To analyze the shoreline changes, the northern mile of Sanibel was broken into 3 zones; Zone 1 (north), Zone 2 (central) and Zone 3 (south). Zones 1 and 3 (north and south) are backed by land while Zone 2 is predominantly backed by water (Clam Bayou and Old Blind Pass). It can be seen in Figure 1 that the 40-month retreat of Zone 1 is 10 percent slower than the historical rate while Zone 3 is 45 percent faster. Zone 2, however, has retreated 280 percent faster in the recent time period.

A volumetric comparison is shown on Figure 2. The August 1988 - December 1991 volumes are based on profile comparisons. DNR volume rates are based on historical retreat rates and 0.67 cubic yard conversion factors in Zones 1 and 3, and a 0.33 conversion factor in Zone 2. The total DNR annual erosion by this method totals 42,000 c.y./yr. which compares well with the 44,000 c.y./yr. developed from shorelines and profiles (see main text).

It can be seen that volumetric erosion rates have been between 35 percent to 45 percent of the historic rate in Zones 1 and 3, but have been 53 percent higher in Zone 2.

An analysis of conversion factors was performed by zone to establish the volume lost in cubic yards for each foot of shoreline retreat. The following was computed:

Table 1

Zone	Conversion Factor (cy./ft.)
1	0.29
2	0.18
3	0.22
Total	0.20

SANIBEL ISLAND MEAN HIGH WATER CHANGES

AUGUST 1988 TO DECEMBER 1991

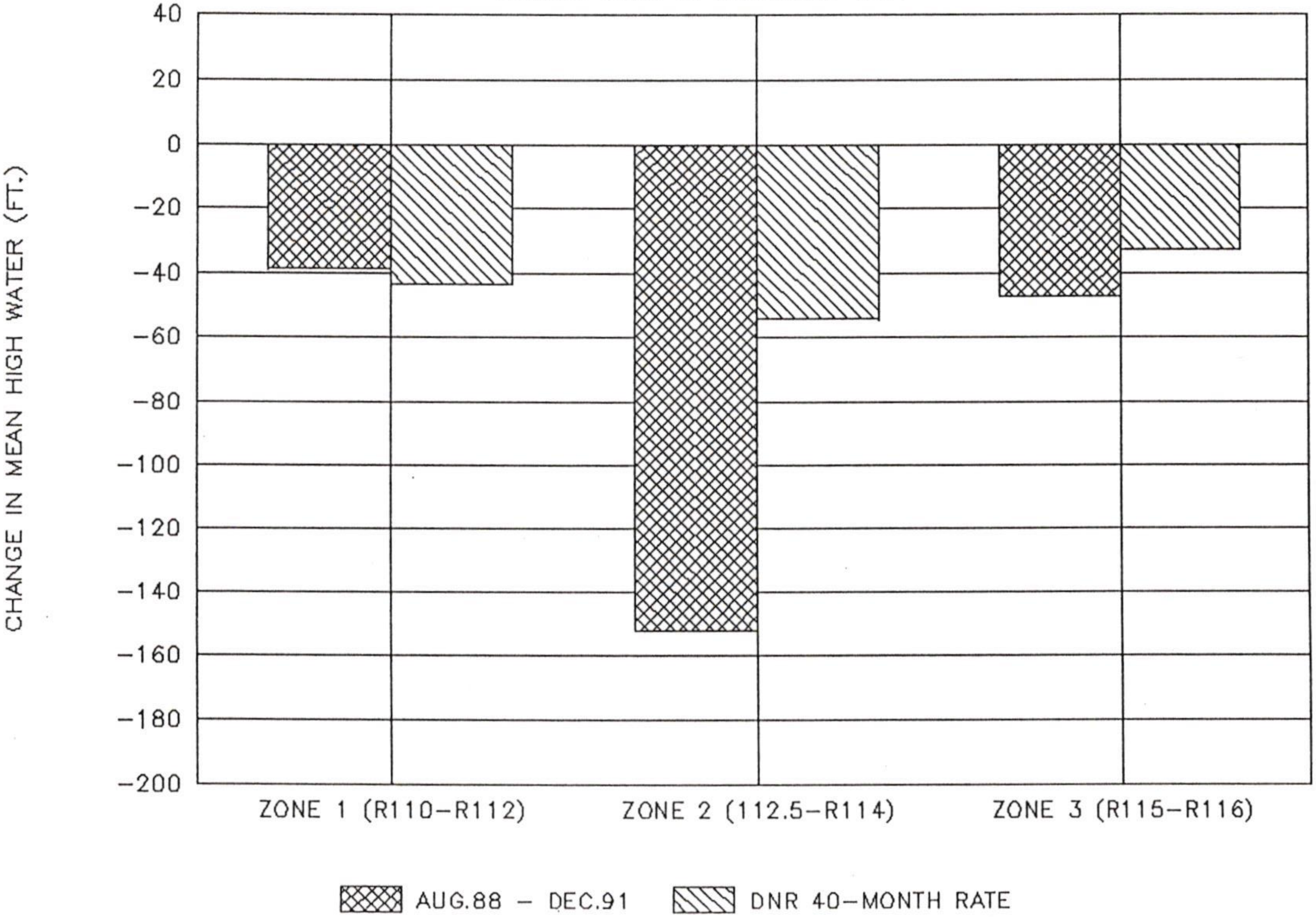


FIGURE 1

SANIBEL ISLAND VOLUMETRIC CHANGES

AUGUST 1988 TO DECEMBER 1991

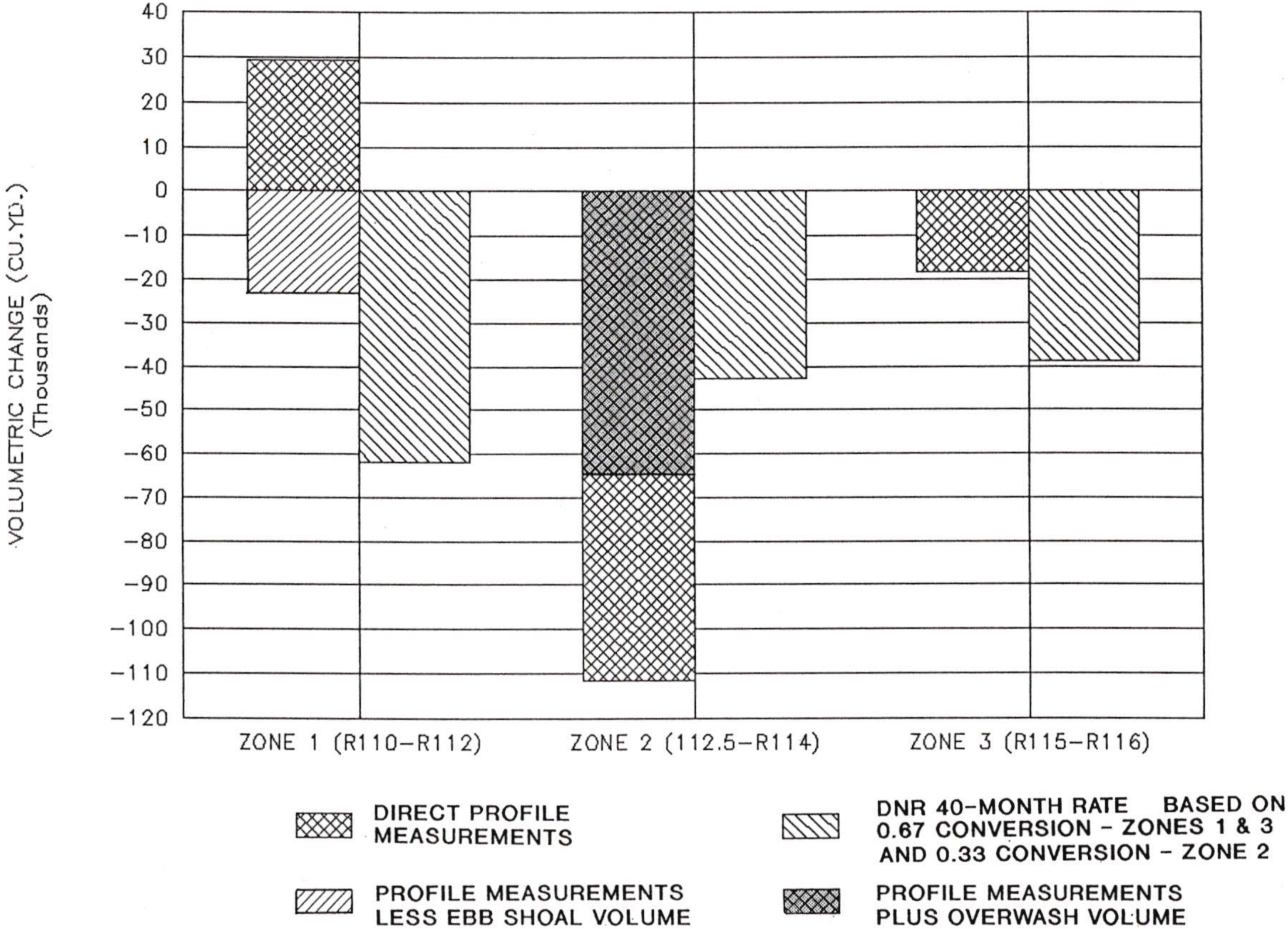


FIGURE 2

All conversion factors are very low indicating that most of the loss has occurred in the upper portion of the profile (dry beach). This would be consistent with an overwash/rollover process.

The above findings suggest that the rollover process in Zone 2 is the dominant coastal force in the post-1988 time period for northern Sanibel. Smaller storms causing the rollover in Zone 2 also caused longshore sand movement in shallow water in Zones 1 and 3. Sand from Zones 1 and 3 is moved into Zone 2 by wave action because Zone 2 is offset landward creating a sediment sink.

It is concluded that the profiles in northern Sanibel are out of equilibrium because of a high retreat rate in Zone 2. Sand is being overwashed into Clam Bayou and Old Blind Pass at a high rate causing the shoreline in Zone 2 to retreat more than 160 feet in 40 months. The shorelines in Zones 1 and 3 have retreated further than would be normally expected for the volumetric loss experienced because of movement of sand along the shore into Zone 2 from Zones 1 and 3.

Comparative Analysis Using DNR Profiles from 1974

In the main report volumetric changes in Captiva and Sanibel are estimated based on shoreline changes up through 1985, and subsequently with profile comparisons after 1985 when monitoring of the islands began. Profiles do exist, however, that were taken prior to 1985 which may be usable to identify volumetric changes. One such set of profiles was taken by the Florida Department of Natural Resources in 1974.

It can be seen in the following analysis that the 1974 data set for profile comparisons demonstrates too high of an offshore closure error to be directly usable for volumetric comparison. However, the profile comparisons which follow generally demonstrate the order of magnitude of volumetric changes that have been estimated using shoreline change.

Figure 3 shows estimates of volumetric change using the 1974 profiles when compared to two surveys. The first comparison is between the April 1974 DNR profiles and the August 1988 CPE profiles.

If we assume the volumetric change above the 12 foot contour is an indication of total volume and that the change between the 12 foot and 18 foot contour is indicative of offshore closure error, we find the following, presented on Figure 4.

From 1974 to 1988 the volumetric change was only 78,000 cubic yards of erosion while the offshore closure error amounted to -726,000 cubic yards. This would indicate a 928 percent error between the two surveys.

When comparing DNR 1974 and DNR 1989 the total change above the 12 foot contour was an accretion of 1.5 million cubic yards. The measurement of error beyond the 12 foot contour from the 12 to 18 foot depth contour was approximately +600,000 cubic yards or a potential closure error of 39 percent.

EROSION RATES FOR

CAPTIVA ISLAND AND SANIBEL ISLAND

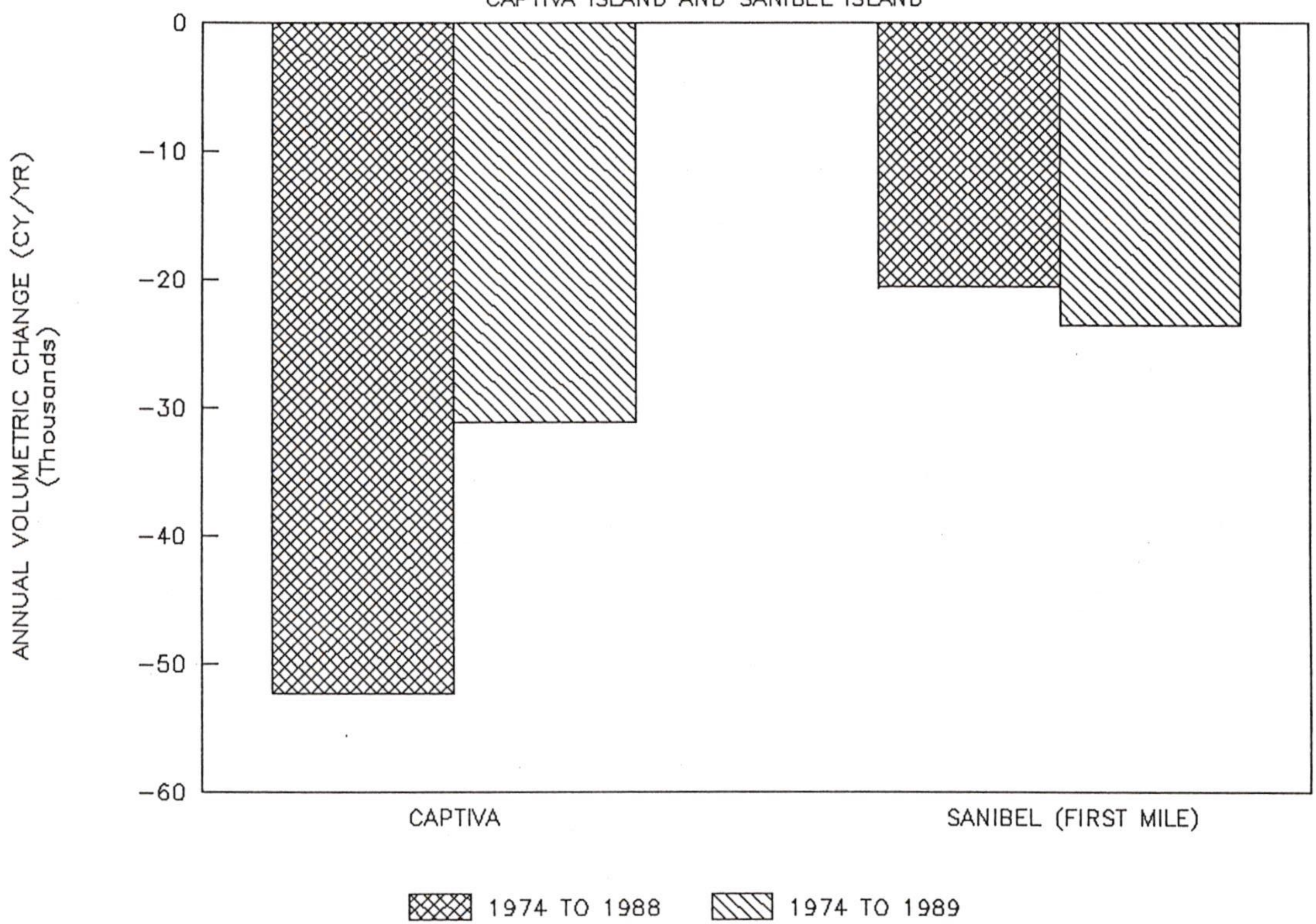


FIGURE 3

ANALYSIS OF OFFSHORE CLOSURE

CAPTIVA ISLAND

FIGURE 4

The above analysis would appear to indicate that the 1974-1988 and 1974-1989 comparisons are not reliable for representing Captiva volumetric change.

In Sanibel Island, the 1974-1988 comparison indicates a loss of 288,000 cubic yards, while the offshore error is 130,000 cubic yards or a 45 percent error (Figure 5). Similarly, the 1974-1989 comparisons in Sanibel show a 670,000 cubic yard gain in Sanibel (northern 4 miles) with an offshore error of 53,000 cubic yards. This represents approximately an 8 percent error. This last comparison appears to be the best comparison of the group, however, the amount of error in all of the other comparisons is so high that it precludes the use of this data set for further analysis.

It should also be noted that the profiles that extend offshore are generally over 3,000 feet apart, unlike shoreline measurements which have been taken every 1,000 feet. In Sanibel only one profile comparison is available in the first mile in the 1974-1988 comparison and only two profiles are available in the 1974-1989 comparison for the first mile. This further indicates that the 1974-1988 or 1974-1989 comparisons are not a reliable indicator of volume change.

It is informative to note, however, that the direct comparison of profiles from 1974-1988 and 1974-1989 yield similar calculations for erosion rates for Captiva Island. Specifically, the 1974 DNR - 1989 DNR survey indicates an erosion rate of 31,000 cubic yards per year. This is the survey comparison with the least amount of error in the Captiva area. The 1974-1988 comparison shows an erosion rate of 52,000 cubic yards per year. An average of these two numbers would yield an erosion rate of 41,500 cubic yards per year. This compares well with the composite analysis of erosion rates from 1974 through 1985 developed in the main text of 38,000 cubic yards per year erosion for Captiva Island.

It is generally felt that the Sanibel erosion rates as developed by the direct profile comparison from 1974 are unreliable because of the large offshore error and the limited number of full profiles available from the 1974 survey.

Additional Notes Used for the Previous Discussions

1) In general, DNR surveyed every third profile line out beyond the closure depth. The 1974, 1989 and 1988 surveys had nine profile lines in common for Captiva Island. The maximum distance between profile lines was 3,472.3 feet.

   In contrast, the 1974 and 1989 comparisons for 4 miles of Sanibel Island had six profile lines in common (R114 was not surveyed in 1989) with a maximum distance of 6155.7 feet between profile lines. The 1974 and 1988 surveys for Sanibel Island had only two profile lines in common. The distance between these lines was 2934.4 feet.

2) Following is a comparison of shoreline and direct profile results.

ANALYSIS OF OFFSHORE CLOSURE

SANIBEL ISLAND

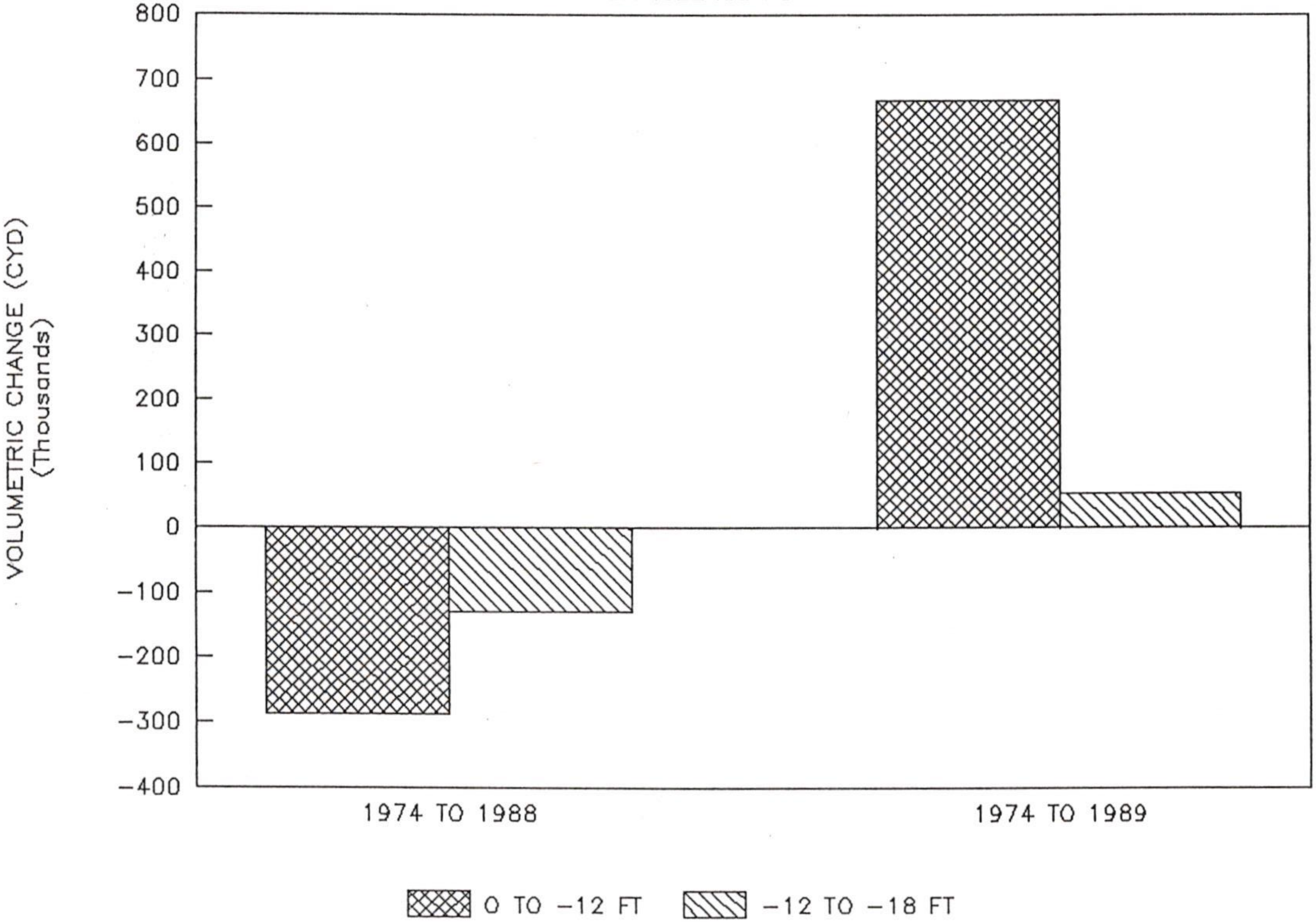


FIGURE 5

Table 2

Captiva Island
Volume Changes
(cy./yr.)

Volumes Based On:		Shorelines 1974-1988	No. of Profiles	Composite 1974-1988	No. of Profiles	1974-1988 Direct Profiles To -12 ft.	To -18 ft.	No. of Profiles
Mile	1	+3*	6	-1	6	-5*	+6*	2
	2	-20*	5	-19	5	-16*	-30*	2
	3	-4	5	-6	5	-11	-24	1
	4	-10	5	-11	5	-19	-41	2
	5	-3	5	-5	5	-2	-16	2
		-34		-42		-52	-104	

* beach nourishment volumes subtracted

Table 3

Sanibel
Volume Changes
(cy./yr)

Volumes Based On:		Shorelines 1974-1988	Composite 1974-1988	1974-1988 Direct Profiles To -12 ft.	To -18 ft.	No. of Profiles
Mile	1	-39	-37	-21	-30	2

APPENDIX D

ENGINEERING ALTERNATIVES
COST ESTIMATES

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE: A.1. REMOVE THE JETTY

		REMOVAL COSTS	
CONTINGENCY	15%	MOB COST	$50,000
E&D&S&A	10%	10,800 TONS @ $30	$324,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH
1992	$473,110	1.00000	$473,110
1993	$0	0.97087	$0
1994	$0	0.94260	$0
1995	$0	0.91514	$0
1996	$0	0.88849	$0
1997	$0	0.86261	$0
1998	$0	0.83748	$0
1999	$0	0.81309	$0
2000	$0	0.78941	$0
2001	$0	0.76642	$0
2002	$0	0.74409	$0
2003	$0	0.72242	$0
2004	$0	0.70138	$0
2005	$0	0.68095	$0
2006	$0	0.66112	$0
2007	$0	0.64186	$0
2008	$0	0.62317	$0
2009	$0	0.60502	$0
2010	$0	0.58739	$0
2011	$0	0.57029	$0
2012	$0	0.55368	$0
2013	$0	0.53755	$0
2014	$0	0.52189	$0
2015	$0	0.50669	$0
2016	$0	0.49193	$0
2017	$0	0.47761	$0
2018	$0	0.46369	$0
2019	$0	0.45019	$0
2020	$0	0.43708	$0
2021	$0	0.42435	$0
2022	$0	0.41199	$0
2023	$0	0.39999	$0
2024	$0	0.38834	$0
2025	$0	0.37703	$0
2026	$0	0.36604	$0
2027	$0	0.35538	$0
2028	$0	0.34503	$0
2029	$0	0.33498	$0
2030	$0	0.32523	$0
2031	$0	0.31575	$0
2032	$0	0.30656	$0
2033	$0	0.29763	$0
2034	$0	0.28896	$0
2035	$0	0.28054	$0
2036	$0	0.27237	$0
2037	$0	0.26444	$0
2038	$0	0.25674	$0
2039	$0	0.24926	$0
2040	$0	0.24200	$0
2041	$0	0.23495	$0
2042	$0	0.22811	$0

SUM OF PRESENT WORTHS	$473,110
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$18,388

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE: A.2. REMOVE THE JETTY AND FILL THE INLET

CONTINGENCY	15%	MOB COST	$50,000
E&D&S&A	10%	SAND COST	
		14,000 CY @$5	$70,000
		SHEET PILE WALL	$30,000
		ROCK WORK	
		10,900 TONS @ $50	$545,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH
1992	$879,175	1.00000	$879,175
1993	$0	0.97087	$0
1994	$0	0.94260	$0
1995	$0	0.91514	$0
1996	$0	0.88849	$0
1997	$0	0.86261	$0
1998	$0	0.83748	$0
1999	$0	0.81309	$0
2000	$0	0.78941	$0
2001	$0	0.76642	$0
2002	$0	0.74409	$0
2003	$0	0.72242	$0
2004	$0	0.70138	$0
2005	$0	0.68095	$0
2006	$0	0.66112	$0
2007	$0	0.64186	$0
2008	$0	0.62317	$0
2009	$0	0.60502	$0
2010	$0	0.58739	$0
2011	$0	0.57029	$0
2012	$0	0.55368	$0
2013	$0	0.53755	$0
2014	$0	0.52189	$0
2015	$0	0.50669	$0
2016	$0	0.49193	$0
2017	$0	0.47761	$0
2018	$0	0.46369	$0
2019	$0	0.45019	$0
2020	$0	0.43708	$0
2021	$0	0.42435	$0
2022	$0	0.41199	$0
2023	$0	0.39999	$0
2024	$0	0.38834	$0
2025	$0	0.37703	$0
2026	$0	0.36604	$0
2027	$0	0.35538	$0
2028	$0	0.34503	$0
2029	$0	0.33498	$0
2030	$0	0.32523	$0
2031	$0	0.31575	$0
2032	$0	0.30656	$0
2033	$0	0.29763	$0
2034	$0	0.28896	$0
2035	$0	0.28054	$0
2036	$0	0.27237	$0
2037	$0	0.26444	$0
2038	$0	0.25674	$0
2039	$0	0.24926	$0
2040	$0	0.24200	$0
2041	$0	0.23495	$0
2042	$0	0.22811	$0

SUM OF PRESENT WORTHS	$879,175
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$34,170

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:B.1.a. BEACH NOURISHMENT OF NORTHERN SANIBEL

CONTINGENCY	15%	MOBILIZATION	$500,000
E&D&S&A	10%	UNIT COST	$6.00
		FILL VOLUME	320,000
		ADVANCED NOUR	210,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	0
1993	$4,655,200	0.97087	$4,519,612	530000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$0	0.88849	$0	
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$2,226,400	0.81309	$1,810,267	210000
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$0	0.74409	$0	
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$2,226,400	0.68095	$1,516,070	210000
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$0	0.62317	$0	
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$2,226,400	0.57029	$1,269,685	210000
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$0	0.52189	$0	
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$2,226,400	0.47761	$1,063,341	210000
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$0	0.43708	$0	
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$2,226,400	0.39999	$890,531	210000
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$0	0.36604	$0	
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$2,226,400	0.33498	$745,806	210000
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$0	0.30656	$0	
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$2,226,400	0.28054	$624,601	210000
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$0	0.25674	$0	
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$2,226,400	0.23495	$523,093	210000
2042	$0	0.22811	$0	

SUM OF PRESENT WORTHS	$12,963,006
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$503,814

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:B.1.b. BEACH NOURISHMENT
MAINTENANCE ON CAPTIVA ISLAND SCHEDULE

CONTINGENCY	15%	MOBILIZATION	$500,000
E&D&S&A	10%	UNIT COST	$6.00
		FILL GAPS	320,000
		ADVANCED NOUR	210,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	0
1993	$3,858,250	0.97087	$3,745,874	425000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$1,593,900	0.88849	$1,416,160	210000
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$1,593,900	0.74409	$1,186,011	210000
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$1,593,900	0.62317	$993,266	210000
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$1,593,900	0.52189	$831,844	210000
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$1,593,900	0.43708	$696,657	210000
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$0	0.39999	$0	
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$1,593,900	0.36604	$583,439	210000
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$1,593,900	0.30656	$488,621	210000
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$1,593,900	0.25674	$409,212	210000
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	

SUM OF PRESENT WORTHS	$10,351,084
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$402,300

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:B.2. RESTORE NORTHERN SANBIEL AND STABILIZE WITH GROIN FIELD

CONTINGENCY	15%	UNIT COST	$6.00 /CY
E&D&S&A	10%	MOBILIZATION	$500,000
		GROIN COSTS	
		1,2,3	$1,810,000
		4	$497,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	
1993	$3,984,750	0.97087	$3,868,689	140000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$0	0.88849	$0	
1997	$628,705	0.86261	$542,326	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$0	0.74409	$0	
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$0	0.62317	$0	
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$0	0.52189	$0	
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$0	0.43708	$0	
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$0	0.39999	$0	
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$0	0.36604	$0	
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$0	0.30656	$0	
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$0	0.25674	$0	
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	

SUM OF PRESENT WORTHS	$4,411,016
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$171,436

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE: B.3. RESTORE NORTHERN SANIBEL, REMOVE JETTY EXTENSION AND PLACE EXTRA FILL ON CAPTIVA ISLAND, AND RENOURISH CAPTIVA AND SANIBEL TOGETHER

CONTINGENCY	15%	MOBILIZATION	$500,000
E&D&S&A	10%	UNIT COST	$6.00
		FILL VOLUME	160,000
EXT. REMOVAL	$375,000	ADVANCED NOUR	210,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	0
1993	$3,345,925	0.97087	$3,248,471	295000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$2,049,300	0.88849	$1,820,777	270000
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$1,821,600	0.74409	$1,355,441	240000
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$1,593,900	0.62317	$993,266	210000
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$1,593,900	0.52189	$831,844	210000
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$1,593,900	0.43708	$696,657	210000
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$0	0.39999	$0	
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$1,593,900	0.36604	$583,439	210000
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$1,593,900	0.30656	$488,621	210000
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$1,593,900	0.25674	$409,212	210000
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	

SUM OF PRESENT WORTHS	$10,427,728
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$405,279

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE: B.5. SOUTH JETTY AND BEACH NOURISHMENT ON NORTHERN SANIBEL

CONTINGENCY	15%	MOBILIZATION	$500,000
E&D&S&A	10%	UNIT COST	$6.00
		FILL VOLUME	320,000
SOUTH JETTY	$1,057,000	ADVANCED NOUR	210,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	0
1993	$5,195,355	0.97087	$5,044,034	425000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$1,593,900	0.88849	$1,416,160	210000
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$1,593,900	0.74409	$1,186,011	210000
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$1,593,900	0.62317	$993,266	210000
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$1,593,900	0.52189	$831,844	210000
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$1,593,900	0.43708	$696,657	210000
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$0	0.39999	$0	
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$1,593,900	0.36604	$583,439	210000
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$1,593,900	0.30656	$488,621	210000
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$1,593,900	0.25674	$409,212	210000
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	

SUM OF PRESENT WORTHS	$11,649,244
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$452,754

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:B.6. PURCHASE HOMES AND REROUTE ROAD TO THE EAST

CONTINGENCY	15%	HOMES BUYOUT	$2,350,000
E&D&S&A	10%	REROUTE ROAD	$625,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH
1992	$3,493,125	1.00000	$3,493,125
1993	$0	0.97087	$0
1994	$0	0.94260	$0
1995	$0	0.91514	$0
1996	$0	0.88849	$0
1997	$0	0.86261	$0
1998	$0	0.83748	$0
1999	$0	0.81309	$0
2000	$0	0.78941	$0
2001	$0	0.76642	$0
2002	$0	0.74409	$0
2003	$0	0.72242	$0
2004	$0	0.70138	$0
2005	$0	0.68095	$0
2006	$0	0.66112	$0
2007	$0	0.64186	$0
2008	$0	0.62317	$0
2009	$0	0.60502	$0
2010	$0	0.58739	$0
2011	$0	0.57029	$0
2012	$0	0.55368	$0
2013	$0	0.53755	$0
2014	$0	0.52189	$0
2015	$0	0.50669	$0
2016	$0	0.49193	$0
2017	$0	0.47761	$0
2018	$0	0.46369	$0
2019	$0	0.45019	$0
2020	$0	0.43708	$0
2021	$0	0.42435	$0
2022	$0	0.41199	$0
2023	$0	0.39999	$0
2024	$0	0.38834	$0
2025	$0	0.37703	$0
2026	$0	0.36604	$0
2027	$0	0.35538	$0
2028	$0	0.34503	$0
2029	$0	0.33498	$0
2030	$0	0.32523	$0
2031	$0	0.31575	$0
2032	$0	0.30656	$0
2033	$0	0.29763	$0
2034	$0	0.28896	$0
2035	$0	0.28054	$0
2036	$0	0.27237	$0
2037	$0	0.26444	$0
2038	$0	0.25674	$0
2039	$0	0.24926	$0
2040	$0	0.24200	$0
2041	$0	0.23495	$0
2042	$0	0.22811	$0

SUM OF PRESENT WORTHS	$3,493,125
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$135,762

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:B.7. PURCHASE HOMES AND REVET ROAD

CONTINGENCY	15%	HOMES BUYOUT	$2,350,000
E&D&S&A	10%	REVETMENT	$800,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH
1992	$3,714,500	1.00000	$3,714,500
1993	$0	0.97087	$0
1994	$0	0.94260	$0
1995	$0	0.91514	$0
1996	$0	0.88849	$0
1997	$126,500	0.86261	$109,120
1998	$0	0.83748	$0
1999	$0	0.81309	$0
2000	$0	0.78941	$0
2001	$0	0.76642	$0
2002	$126,500	0.74409	$94,128
2003	$0	0.72242	$0
2004	$0	0.70138	$0
2005	$0	0.68095	$0
2006	$0	0.66112	$0
2007	$0	0.64186	$0
2008	$0	0.62317	$0
2009	$0	0.60502	$0
2010	$0	0.58739	$0
2011	$0	0.57029	$0
2012	$0	0.55368	$0
2013	$0	0.53755	$0
2014	$0	0.52189	$0
2015	$0	0.50669	$0
2016	$0	0.49193	$0
2017	$0	0.47761	$0
2018	$0	0.46369	$0
2019	$0	0.45019	$0
2020	$0	0.43708	$0
2021	$0	0.42435	$0
2022	$0	0.41199	$0
2023	$0	0.39999	$0
2024	$0	0.38834	$0
2025	$0	0.37703	$0
2026	$0	0.36604	$0
2027	$0	0.35538	$0
2028	$0	0.34503	$0
2029	$0	0.33498	$0
2030	$0	0.32523	$0
2031	$0	0.31575	$0
2032	$0	0.30656	$0
2033	$0	0.29763	$0
2034	$0	0.28896	$0
2035	$0	0.28054	$0
2036	$0	0.27237	$0
2037	$0	0.26444	$0
2038	$0	0.25674	$0
2039	$0	0.24926	$0
2040	$0	0.24200	$0
2041	$0	0.23495	$0
2042	$0	0.22811	$0

SUM OF PRESENT WORTHS	$3,917,748
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$152,265

BLIND PASS(LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:B.8. DREDGE FLOOD SHOAL

CONTINGENCY	15%	MOBILIZATION	$150,000
E&D&S&A	10%	UNIT COST	$2.50

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	0
1993	$379,500	0.97087	$368,447	60000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$0	0.88849	$0	
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$0	0.74409	$0	
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$0	0.62317	$0	
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$0	0.52189	$0	
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$0	0.43708	$0	
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$379,500	0.39999	$151,795	60000
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$0	0.36604	$0	
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$0	0.30656	$0	
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$0	0.25674	$0	
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	

SUM OF PRESENT WORTHS	$520,242
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$20,219

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:B.10. COUNTY BUILDS 800' REVETMENT, MAINTAIN BEACH ON NORTH SANIBEL, RENOURISH WITH CAPTIVA PROJECT

CONTINGENCY	15%	MOBILIZATION	$500,000
E&D&S&A	10%	UNIT COST	$6.00

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$1,012,000	1.00000	$1,012,000	
1993	$1,657,150	0.97087	$1,608,883	135000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$2,049,300	0.88849	$1,820,777	270000
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$1,821,600	0.74409	$1,355,441	240000
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$1,593,900	0.62317	$993,266	210000
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$1,593,900	0.52189	$831,844	210000
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$1,593,900	0.43708	$696,657	210000
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$0	0.39999	$0	
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$1,593,900	0.36604	$583,439	210000
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$1,593,900	0.30656	$488,621	210000
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$1,593,900	0.25674	$409,212	210000
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	

SUM OF PRESENT WORTHS	$9,800,141
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$380,887

BLIND PASS(LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:B.11. BEACH NOURISHMENT AND SEGMENTED OFFSHORE BREAKWATER

CONTINGENCY	15%	SAND UNIT	$6.00 /CY
E&D&S&A	10%	MOBILIZATION	$500,000
		BREAKWATER COSTS	
		1000 FT. @ $3,100/FT.	$3,100,000

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$0	1.00000	$0	
1993	$5,768,400	0.97087	$5,600,388	160000
1994	$0	0.94260	$0	
1995	$0	0.91514	$0	
1996	$0	0.88849	$0	
1997	$0	0.86261	$0	
1998	$0	0.83748	$0	
1999	$0	0.81309	$0	
2000	$0	0.78941	$0	
2001	$0	0.76642	$0	
2002	$0	0.74409	$0	
2003	$0	0.72242	$0	
2004	$0	0.70138	$0	
2005	$0	0.68095	$0	
2006	$0	0.66112	$0	
2007	$0	0.64186	$0	
2008	$0	0.62317	$0	
2009	$0	0.60502	$0	
2010	$0	0.58739	$0	
2011	$0	0.57029	$0	
2012	$0	0.55368	$0	
2013	$0	0.53755	$0	
2014	$0	0.52189	$0	
2015	$0	0.50669	$0	
2016	$0	0.49193	$0	
2017	$0	0.47761	$0	
2018	$0	0.46369	$0	
2019	$0	0.45019	$0	
2020	$0	0.43708	$0	
2021	$0	0.42435	$0	
2022	$0	0.41199	$0	
2023	$0	0.39999	$0	
2024	$0	0.38834	$0	
2025	$0	0.37703	$0	
2026	$0	0.36604	$0	
2027	$0	0.35538	$0	
2028	$0	0.34503	$0	
2029	$0	0.33498	$0	
2030	$0	0.32523	$0	
2031	$0	0.31575	$0	
2032	$0	0.30656	$0	
2033	$0	0.29763	$0	
2034	$0	0.28896	$0	
2035	$0	0.28054	$0	
2036	$0	0.27237	$0	
2037	$0	0.26444	$0	
2038	$0	0.25674	$0	
2039	$0	0.24926	$0	
2040	$0	0.24200	$0	
2041	$0	0.23495	$0	
2042	$0	0.22811	$0	

SUM OF PRESENT WORTHS	$5,600,388
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$217,662

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:C.1. MOBILE JET PUMP SAND TRANSFER SYSTEM

CONTINGENCY	15%	MOBILIZATION	$500,000
E&D&S&A	10%	UNIT COST	$6.00

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	SAND VOLUMES (CY)
1992	$934,000	1.00000	$934,000	
1993	$3,101,550	0.97087	$3,011,214	295000
1994	$230,000	0.94260	$216,797	
1995	$230,000	0.91514	$210,483	
1996	$2,279,300	0.88849	$2,025,129	270000
1997	$230,000	0.86261	$198,400	
1998	$230,000	0.83748	$192,621	
1999	$230,000	0.81309	$187,011	
2000	$230,000	0.78941	$181,564	
2001	$230,000	0.76642	$176,276	
2002	$2,051,600	0.74409	$1,526,583	240000
2003	$230,000	0.72242	$166,157	
2004	$230,000	0.70138	$161,317	
2005	$230,000	0.68095	$156,619	
2006	$230,000	0.66112	$152,057	
2007	$230,000	0.64186	$147,628	
2008	$1,823,900	0.62317	$1,136,594	210000
2009	$230,000	0.60502	$139,154	
2010	$230,000	0.58739	$135,101	
2011	$230,000	0.57029	$131,166	
2012	$230,000	0.55368	$127,345	
2013	$230,000	0.53755	$123,636	
2014	$1,823,900	0.52189	$951,880	210000
2015	$230,000	0.50669	$116,539	
2016	$230,000	0.49193	$113,145	
2017	$230,000	0.47761	$109,849	
2018	$230,000	0.46369	$106,650	
2019	$230,000	0.45019	$103,543	
2020	$1,823,900	0.43708	$797,184	210000
2021	$230,000	0.42435	$97,600	
2022	$230,000	0.41199	$94,757	
2023	$230,000	0.39999	$91,997	
2024	$230,000	0.38834	$89,318	
2025	$230,000	0.37703	$86,716	
2026	$1,823,900	0.36604	$667,629	210000
2027	$230,000	0.35538	$81,738	
2028	$230,000	0.34503	$79,357	
2029	$230,000	0.33498	$77,046	
2030	$230,000	0.32523	$74,802	
2031	$230,000	0.31575	$72,623	
2032	$1,823,900	0.30656	$559,129	210000
2033	$230,000	0.29763	$68,454	
2034	$230,000	0.28896	$66,461	
2035	$230,000	0.28054	$64,525	
2036	$230,000	0.27237	$62,646	
2037	$230,000	0.26444	$60,821	
2038	$1,823,900	0.25674	$468,262	210000
2039	$230,000	0.24926	$57,330	
2040	$230,000	0.24200	$55,660	
2041	$230,000	0.23495	$54,039	
2042	$230,000	0.22811	$52,465	

SUM OF PRESENT WORTHS	$16,819,015
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$653,679

BLIND PASS MOBILE JETPUMP SAND TRANSFER SYSTEM

ITEM	QUANTITY	UNIT	UNIT PRICE	COST IN $1000
MOB.DEMOB	1	JOB	$80,000	$80
CRANE	1	EA	$75,000	$75
JET PUMP	2	EA	$10,000	$20
CLEAR WATER PUMP				
JET PUMP(270 hp)	1	EA	$47,500	$48
SLURRY PUMP(270 hp)	1	EA	$58,400	$58
POWERLINE	1	JOB	$40,000	$40
VALVING & CONTROLS	1	JOB	$50,000	$50
OPERATION BUILDING 1000 SF	1	JOB	$100,000	$100
PIPE				
STEEL 3/4" WALLS				
12" INTAKE & MISC.	500	L.F.	$60	$30
FLEXIBLE(12 inch)	1,000	L.F.	$90	$90
HD PE(14" 110 psi)	2,200	L.F.	$27	$59
SUBTOTAL				$650
CONTINGENCIES (25%)				$162
TOTAL CONSTRUCTION				$812
E&D, S&A (15%)				$122
TOTAL COST				$934

BLIND PASS (LEE CO.) MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:C.2. JET PUMP WITH FLUIDIZER

CONTINGENCY	15%	EQUIPMENT	$1,067,000	
E&D&S&A	10%	OPER. & MAINT	$200,000	($/YR)
		UNIT COST	$6.00	
		MOBILIZATION	$500,000	

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	FILL VOLUME(CY)
1992	$1,267,000	1.00000	$1,267,000	
1993	$1,811,250	0.97087	$1,758,495	125000
1994	$230,000	0.94260	$216,797	
1995	$230,000	0.91514	$210,483	
1996	$2,279,300	0.88849	$2,025,129	270000
1997	$230,000	0.86261	$198,400	
1998	$230,000	0.83748	$192,621	
1999	$230,000	0.81309	$187,011	
2000	$230,000	0.78941	$181,564	
2001	$230,000	0.76642	$176,276	
2002	$2,051,600	0.74409	$1,526,583	240000
2003	$230,000	0.72242	$166,157	
2004	$230,000	0.70138	$161,317	
2005	$230,000	0.68095	$156,619	
2006	$230,000	0.66112	$152,057	
2007	$230,000	0.64186	$147,628	
2008	$1,823,900	0.62317	$1,136,594	210000
2009	$230,000	0.60502	$139,154	
2010	$230,000	0.58739	$135,101	
2011	$230,000	0.57029	$131,166	
2012	$230,000	0.55368	$127,345	
2013	$230,000	0.53755	$123,636	
2014	$1,823,900	0.52189	$951,880	210000
2015	$230,000	0.50669	$116,539	
2016	$230,000	0.49193	$113,145	
2017	$230,000	0.47761	$109,849	
2018	$230,000	0.46369	$106,650	
2019	$230,000	0.45019	$103,543	
2020	$1,823,900	0.43708	$797,184	210000
2021	$230,000	0.42435	$97,600	
2022	$230,000	0.41199	$94,757	
2023	$230,000	0.39999	$91,997	
2024	$230,000	0.38834	$89,318	
2025	$230,000	0.37703	$86,716	
2026	$1,823,900	0.36604	$667,629	210000
2027	$230,000	0.35538	$81,738	
2028	$230,000	0.34503	$79,357	
2029	$230,000	0.33498	$77,046	
2030	$230,000	0.32523	$74,802	
2031	$230,000	0.31575	$72,623	
2032	$1,823,900	0.30656	$559,129	210000
2033	$230,000	0.29763	$68,454	
2034	$230,000	0.28896	$66,461	
2035	$230,000	0.28054	$64,525	
2036	$230,000	0.27237	$62,646	
2037	$230,000	0.26444	$60,821	
2038	$1,823,900	0.25674	$468,262	210000
2039	$230,000	0.24926	$57,330	
2040	$230,000	0.24200	$55,660	
2041	$230,000	0.23495	$54,039	
2042	$230,000	0.22811	$52,465	

SUM OF PRESENT WORTHS	$15,899,297
CAPITAL RECOVERY FACTOR	0.0389
AVERAGE ANNUAL VALUE	$617,934

BLIND PASS (LEE CO.) INLET MANAGEMENT PLAN
ENGINEERING ALTERNATIVES COST ESTIMATE

ALTERNATIVE:C.3. RESTORE NORTHERN SANIBEL,
MAINTAIN WITH DEWATERING SYSTEM

CONTINGENCY	15%	UNIT COST	$6.00 /CY
E&D&S&A	10%	MOBILIZATION	$500,000
		DEWATERING SYSTEM	
		$400 PER FOOT	$720,000
		MAINT & POWER/YR.	$22,500

YEAR	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH	INITIAL VOLUME
1992	$2,786,163	1.00000	$2,786,163	160000
1993	$25,875	0.97087	$25,121	
1994	$25,875	0.94260	$24,390	
1995	$25,875	0.91514	$23,679	
1996	$25,875	0.88849	$22,990	
1997	$25,875	0.86261	$22,320	
1998	$25,875	0.83748	$21,670	
1999	$25,875	0.81309	$21,039	
2000	$25,875	0.78941	$20,426	
2001	$25,875	0.76642	$19,831	
2002	$25,875	0.74409	$19,253	
2003	$25,875	0.72242	$18,693	
2004	$25,875	0.70138	$18,148	
2005	$25,875	0.68095	$17,620	
2006	$25,875	0.66112	$17,106	
2007	$25,875	0.64186	$16,608	
2008	$25,875	0.62317	$16,124	
2009	$25,875	0.60502	$15,655	
2010	$25,875	0.58739	$15,199	
2011	$25,875	0.57029	$14,756	
2012	$25,875	0.55368	$14,326	
2013	$25,875	0.53755	$13,909	
2014	$25,875	0.52189	$13,504	
2015	$25,875	0.50669	$13,111	
2016	$25,875	0.49193	$12,729	
2017	$25,875	0.47761	$12,358	
2018	$25,875	0.46369	$11,998	
2019	$25,875	0.45019	$11,649	
2020	$25,875	0.43708	$11,309	
2021	$25,875	0.42435	$10,980	
2022	$25,875	0.41199	$10,660	
2023	$25,875	0.39999	$10,350	
2024	$25,875	0.38834	$10,048	
2025	$25,875	0.37703	$9,756	
2026	$25,875	0.36604	$9,471	
2027	$25,875	0.35538	$9,196	
2028	$25,875	0.34503	$8,928	
2029	$25,875	0.33498	$8,668	
2030	$25,875	0.32523	$8,415	
2031	$25,875	0.31575	$8,170	
2032	$25,875	0.30656	$7,932	
2033	$25,875	0.29763	$7,701	
2034	$25,875	0.28896	$7,477	
2035	$25,875	0.28054	$7,259	
2036	$25,875	0.27237	$7,048	
2037	$25,875	0.26444	$6,842	
2038	$25,875	0.25674	$6,643	
2039	$25,875	0.24926	$6,450	
2040	$25,875	0.24200	$6,262	
2041	$25,875	0.23495	$6,079	
2042	$25,875	0.22811	$5,902	

SUM OF PRESENT WORTHS	$3,451,920
CAPITAL RECOVERY FACTOR	0.03887
AVERAGE ANNUAL VALUE	$134,161

APPENDIX E

INLET STABILITY STUDY AT BLIND PASS
LEE COUNTY, FLORIDA

INLET STABILITY STUDY AT BLIND PASS, LEE COUNTY, FLORIDA

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November, 1991

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INLET STABILITY STUDY AT BLIND PASS, LEE COUNTY, FLORIDA

SUMMARY

This investigation was motivated by the need to examine the stability of Blind Pass inlet in conjuction with a study to develop options for the management of the inlet and the nearby beaches. The study efforts entailed using analytical models based on Keulegan-type inlets to attempt to characterize the long-term stability of Blind Pass, and a numerical model based on one-dimensional integrated momentum and flow and sediment continuity equations to model its short-term stability. Interpretation of photographic records coupled with a review of published reports was vital in assessing the morphological development of Blind Pass.

Based on these efforts, it may be concluded that the rate of sediment supply to the inlet has reduced measurably, principally a result of jetty construction and its subsequent extension. From long-term stability criteria, Blind Pass is found to be marginally stable based on present configuration. At this stage of its continuing development, this inlet is apparently still adjusting to an equilibrium state. Other than external factors such as variation in wave-induced sediment transport and the relative well-being of adjacent inlets especially Redfish Pass, the apparent reluctance to gravitate toward equilibrium may be the result of the lateral restraint imposed by bridge abutments. The altered morphological response manifests in a greater than expected depth at the inlet cross-section. However, further excursion of the depth due to scour is likely to be met with increased soil strength and reduced scouring power of the flow, thereby preventing the adjustment of the inlet section to the predicted equilibrium state. In terms of short-term stability, it is suggested that the critical rate of deposition in the inlet for which the inlet is just in a self-flushing condition is about 250 cu.m/day, which is in qualitative agreement with the volumetric computation based on the growth of the flood tidal shoal.

To the extent that two geographically close inlets can interact mutually, theoretical considerations indicate that one of the inlets will exhibit tendency toward shoaling and eventual closure. Based on past documented developments of Blind Pass and Redfish Pass, it is apparent that Redfish Pass is the dominant inlet in the analogous twin-inlet system considered. While Blind Pass has undergone alternate closure and reopening, underscoring its susceptibility to instability, the chronic shoreline erosion prevalent along Captiva Island appears to have helped reduce the sediment loading that would otherwise have gained ingress into the inlet. Furthermore, the interruption of longshore sediment transport by the jetty and the efficient bar-bypassing mechanism across the inlet further mitigate against any tendency toward permanent closure.

The analytical and numerical efforts yield a "potential" representation of the inlet in a simplified setting. Combining the idealized scenario considered with field experience derived from published reports, it is suggested that the efforts at shore protection, especially jetty construction, may have given a new lease of life to Blind Pass. However, some engineering improvements such as channel dredging in the interior may be required to ensure the continuous presence of the inlet.

Chapter 1

INTRODUCTION

1.1 Background

Blind Pass is one of many inlets that punctuate the southwest coast of Florida facing the Gulf of Mexico. Located in Lee County, it separates the Captiva Island to the north and Sanibel Island to the south and connects a part of Pine Island Sound to the Gulf. The inlet was first opened naturally around three hundred years ago and for quite a while behaved as a tide-dominated inlet with a prograding ebb-tidal shoal. Since the opening of Redfish Pass to the north in 1926, the inlet has gravitated toward a wave-dominated one, and is less stable. The capture by Redfish Pass of a substantial portion of the tidal prism that had kept Blind Pass active since its inception by the Redfish Pass is evidenced by the alternate closure and opening that has typified its existence up to at least the middle 1980s. Its emphemeral existence is also evidenced by the disintegration of the once stable ebb tidal shoal to relative insignificance. Concern, for instance, regarding the water quality in the part of Pine Island Sound that abuts the inlet has prompted studies on the morphological development of the inlet and its longevity. The present study is motivated by the need to examine the stability of the inlet in conjunction with a study to develop options for the management of the inlet and the nearby beaches.

1.2 Scope of Study

The scope of study as embodied in this report is confined to the physical inlet response using both analytical and numerical approaches to inlet hydraulics. The report outlines the approaches and calibration process and presents the computation results in an effort to characterize the inlet stability. The report consists of the following main elements:

a) collation and review of all the available study reports on Blind Pass in order to reconstruct the morphological development of the inlet with the aim of obtaining input parameters for subsequent analysis;

b) analysis of primary and secondary data;

c) detailing the use of analytical and numerical approaches to characterize the inlet stability behavior with a view to predicting its response under different scenarios; and

d) preliminary conclusions and recommendation for refinement.

The numerical model used is a one-dimensional code that describes the response of a Keulegan-type inlet-bay system to sinusoidal tidal forcing. The model includes the effect of precipitation and has been applied to Phillips Inlet south of Panama City [Lin, 1988].

Chapter 2

MORPHOLOGICAL STUDY

2.1 Morphological Changes

In addition to the relevant study reports, the authors have relied on the collection of old aerial photographs in the Coastal Engineering Archives and monitoring reports associated with the Captiva Island Beach Nourishment Project [Coastal Planning & Engineering, Inc., 1990 & 1991] and the associated photographic records supplied by Coastal Planning and Engineering, Inc. This store of documented and photographic information was converted into a chronology of events and description of temporal morphological changes to facilitate better understanding of the morphological development of the inlet as summarized in Tables 2.1 and 2.2, respectively.

It is apparent from Table 2.1 that Blind Pass has undergone a series of closures and reopenings as a consequence of the predominant southerly drift. The alternate inlet closure and opening represent an efficient pathway whereby sediments are fed to the south, i.e., Sanibel Island. Prior to 1926, the inlet section at Blind Pass measured 200 m across by 5 m deep due to the appreciable water surface area it commanded in the Pine Island Sound. Following the opening of Redfish Pass in 1926, the tidal prism that had maintained Blind Pass shrunk considerably due to flow diversion through Redfish Pass, which grew to a size about twenty times that of Blind Pass with significant development of the ebb-tidal shoal. Subsequently, there has been at least three episodes of downdrift migration, closure, and reopening. While the first two phases of the cycle may occur over time, the reopening is usually an episodic phenomenon that occurs during storm events. Since severe storm events are always accompanied by storm surges, some as much as 2 m above the mean water level, it is likely that the sand bar was breached by the overtopping water from the sea and the subsequent enlargement of the initial breach was aided by scouring of the pilot channel by outflowing water from the bay side. Consequently, the time of occurrence of inlet closure is easier to trace, normally being narrowed down to the particular hurricane that occurred in the year concerned. Examples are 1960 (Hurricane Donna), 1972 (Hurricane Agnes) and

Table 2.1: A Chronology of Events, Blind Pass

Year	*Event*	*Remarks*
995 BP -655 BP	Original pass opened.	ref. CPE. Inc.
300 BP	Pass broke through barrier island.	ref. Winton et al.
1883	Inlet broke through near the current podition.	ref. CPE. Inc.
1888	Inlet @ throat = 200 m x 5 m. Downstream offset of 250 m.	ref. US Army COE.
1926	Opening of Redfish Pass.	A substantial portion of tidal prism captured.
1941	New inlet opened near current position. Possibly the result of hurricane.	ref. CPE. Inc.
1953	Inlet width at throat = 60 m.	ref. 5.
1958	Inlet width at throat = 20 m.	ref. 5.
8/29-9/13/ 1960	Hurricane Donna reopened pass.	ref. CPE. Inc.
1961	Direct inlet closed. Flow exit further south.	ref. CPE. Inc.
1962	Gulf entrance reportedly closed by storm action.	ref. US Army COE.
1964	Inlet closed by spit.	ref. CPE. Inc.
1966	Historical flow area = 95 m^2.	ref. Winton et al.
1970	Historical flow area = 160 m^2.	ref. Winton et al.
1972	Hurricane Agnes reopened pass.	ref. Hine.
1972	Short rip-rap jetty constructed on the north side.	ref. CPE. Inc.
1974	Historical flow area = 140 m^2.	ref. Winton et al.
1975	Historical flow area = 42 m^2.	ref. Winton et al.
11/76	Gradual inlet narrowing in the past several months closed inlet to boat traffic.	ref. Island Rept.
May 1977	Inlet closed by tidal accretion.	ref. Larson.
1979	Inlet closed.	ref. Davis & Gibeaut.
6/1982	Subtropical 'No-Name' storm reopened pass. Minimum Cross-sectional area = 56 m^2.	ref. Hine.
12/1987	Inlet closed	ref. Dean & O'Brien.
1988	Inlet remained open.	ref. Davis & Gibeaut.
11/88	Terminal groin lengthened by 31 m.	ref. CPE. Inc.
8/1991	Throat Cross-section below NGVD = 64 m^2.	Computed based on field data.

1982 (Subtropical Storm 'No Name'). On the other hand, the estimation of the time of closure is very rough indeed and is usually given in interval of years in published reports. The preparation of Table 2.2 is in part aimed at arriving at a better estimate of an actual closure event so that its replication by the numerical model will yield the values of the relevant calibrating parameters for predictive purposes.

As apparent from Table 2.2, there are gaps in the sequence of aerial photographs and at other times there is a cluster of closely spaced shots in time. While this irregular temporal coverage does help elucidate some of the processes, the static and gapped coverage does not reveal substantially more information as regards the timing of the closure events. However, the lateral migration of the inlet channel and the timing of the construction and completion of the north jetty are apparent from the photographic records. The jetty is believed to have been constructed within a several-month period from July to November, 1972. The episodic nature of the inlet opening is also borne out, this paricular one occuring within the three-week period from June 23 to July 15, 1972. Prior to the inlet opening, the southward extending inlet channel was observed to be clogged with wave overwash deposits. The clogged waterway may have helped to concentrate bay water in the wave-created pilot channel, and hence to scour out a more or less equilibrium inlet channel as evident from the progressive widening of the inlet from time-lapsed photographs.

2.2 Longshore Sediment Transport

An estimation of the longshore sediment transport is a necessary input to the numerical model. A concomitant input is the estimated percentage of the amount of longshore drift that enters the inlet during the ebb, the amount that deposits on the flood tidal shoal, the amount that leaves the inlet in the ensuing flood, the amount of the ejected material that deposits on the ebb-tidal shoal or rejoins the longshore transport system, and the amount that returns in the next ebb-flood cycle. A sediment budget balance will then enable an estimate of the amount of littoral materials that actually settle out during each ebb-flood cycle and deposit in the inlet section to be made.

A relatively simple way of computing littoral drift along the coastline of Florida based on visually observed waves from ships has been presented by Walton [1973]. The method uses the SSMO (Summary of Synoptic Meteorological Observations) wave data, which are a compilation of meteorological and sea state observations made from ships plying through "Data Squares" defined by their longitudes and latitudes, as input in computing longshore energy flux and consequent littoral drift based on linear wave theory. The basic equation used is:

$$Q_l = C\frac{\gamma}{8}H_o^2 C_{go}\cos\alpha_o \sin\alpha_b K_f^2 \frac{24.(3600)}{10^6} \tag{2.1}$$

where

Table 2.2: Temporal Morphological Changes at Blind Pass

Date	*Observation*	*Record Type*
1859	Wide inlet channel flanked by south-growing sand spit and exit far to the south of interior channel.	Fig. 1.3 in ref. Winton et al.
1883	Inlet broke through the spit.	Air photo.
1944	Direct inlet closed. Inlet flow exit about 2.0 *km* south of interior channel.	Airphoto. (ref. 13)
Early 1950s	Direct Inlet closed. Inlet flow exit south of interior channel and was flanked on the left by southward growing sand spit with vegetation on its northern half.	Airphoto.
1958	Inlet has migrated about 2.8 *km* to the south.	Fig. 1.3 in ref. Winton et al.
1960	Hurricane Donna opened a new gap at the spit.	Air photo.
1961	Gap closed and inlet exit far to the south.	Air-photo.
2/66	Direct inlet closed. Inlet flow exit further south outside record confines. Closure bar not vegetated.	Slide.
2/14/70	Inlet completely closed. Closure bar not vegatated.	Airphoto.
4/72	Direct inlet closed. No jetty yet. Inlet flow exit further south outside record confines. However, closure bar has thinned.	Slide.
6/23/72	Direct inlet essentially closed. Wave overwash deposits clogged up exit channel. Rock outcrops/partial jetty (?) visible.	Airphoto.
7/15/72	Direct inlet partially open. (size = $\frac{1}{3}$ of bridge span.)	Airphoto.
11/30/72	Inlet size = $\frac{1}{2}$ of bridge span. Jetty in place. Updrift fillet began to form. Rivermouth bar deflected close to left bank.	Airphoto.
7/73	Inlet open. Jetty in place. Updrift accretion fillet just visible.	Oblique photo.
1975	Inlet open.	Fig. in ref. CPE. Inc.
May(?)/78	Inlet partially open. ($\frac{1}{3}$ of bridge span.)	Airphoto.
1978	Inlet completely closed.	Fig. 1.3 in ref. Winton et al.

Table 2.2: Temporal Morphological Changes at Blind Pass (continued)

Date	*Observation*	*Record Type*
10/25/78	Inlet completely closed. Updrift fillet full.	Airphoto.
11/1/78	Inlet completely closed. Updrift fillet full. Downdrift beach straight.	Airphoto.
11/2/78	Inlet completely closed. Updrift fillet full.	Airphoto.
11/12/78	Inlet completely closed. Updrift fillet full.	Airphoto.
12/80	Inlet completely closed. Updrift fillet full.	Slide.
5/14/85	Inlet open. Updrift fillet full.	Airphoto.
10/8/85	Inlet open. Updrift fillet receded slightly behind jetty head.	Airphoto.
2/25/86	Inlet open. Updrift fillet full.	Airphoto.
5/9/86	Inlet open. However, sediment bypassed jettyand recurved into inlet mouth. Inlet channel deflected southeastward.	Airphoto.
10/3/86	Inlet open. Updrift fillet receded behind jetty head. Downdrift deposition disappeared and bulge appeared on right bank of mouth.	Airphoto
1/87	Inlet open. Updrift fillet full. Flow confined by linear ebb-shoal bar.	Slide.
4/1/87	Inlet open.	Blown up airphoto.
2/90	Inlet open. Updrift fillet full. (Jetty extended by 31 m by end of 1988.)	Slide.
5/1/90	Inlet open. Updrift fillet receded slightly behind jetty head.	airphoto.
12/13/90	Inlet open. Updrift fillet about 15 m behind jetty head.	Blown up airphoto.
12/30/90	Inlet open. Updrift accretion full and sediment bypassed jetty and deposited immediately downdrift.	Airphoto
4/9/91	Inlet open. Updrift fillet receded behind jetty head. Downstream deposition disappeared. Right bank of inlet mouth deflected southward forming funnel shape followed by a planform bulge.	Airphoto.

Q_l = littoral drift rate ($\frac{yd^3}{day}$);

C = a constant correlation coefficient equalling 125;

γ = specfic weight of sea water (= 64 $\frac{lbs}{ft^3}$);

H_o = deepwater wave height (ft);

C_{go} = deepwater wave group velocity (ft/s);

α_o = deepwater wave approach angle;

α_b = breaking wave angle; and

K_f = friction-percolation coefficient (= 0.01).

While the method contains numerous assumptions, which is a necessary outcome of the simplicity of approach adopted, the magnitudes of net drift computed are in reasonable agreement with other estimates. Hence, the annual drift values for Blind Pass, which lies within the physiographic reach from San Carlos to Boca Grande, are taken from the littoral drift roses in the above report [Walton, 1973] based on the local azimuth of the shore normal. The azimuth angles are an average of the shoreline trends at several different times, care being taken to disregard local variations in order to reflect the more regional shore orientation. A follow-up work by Walton [1976] has included the monthly drift roses and the same were extracted to yield monthly drift values for Blind Pass as summarized in Table 2.3.

Blind Pass is situated at the break in shoreline orientation, which signifies the abrupt end of the north-western terminus of Sanibel Island. The major change in shore configuration at this point is controlled by a subsurface structure formed in the geologic past [Hine, 1987]. From Table 2.3 it is noticed that there are two distinct drift patterns, predominant northerly from March to September and the reverse for the balance of the year. The high northerly transport tends to coincide with the hurricane seasons, which usually occur during the third quadrant of the year and the hurricane route generally veers to follow a direction in the north-east sector after tracking through the lower half of the Florida peninsula.

On the other hand, the southerly transport is a consequence of winter wave action. Combined with the photographic interpretation in previous sections, it is suggested that the northerly drift is the agent that tends to close Blind Pass while the hurricanes are responsible for the reopening episodes, primarily associated with storm surges generated in the process. Other relevant volumetric rates have been computed for the flood tidal shoal; these being being 14,000 $yd^3/year$ for the period 1956 - 1960 and 2200 $yd^3/year$ for 1960 - 1989 respectively [Coastal Planning & Engineering, Inc., 1990]. While the reduction in the growth of the flood tidal shoal may be linked to the repeated closure of the inlet,

Table 2.3: Longshore Transport Rate at Blind Pass

Month	*Transport South* $\Theta_n = 255° N$ (m^3/day)	*Transport North* $\Theta_n = 220° N$ (m^3/day)	*Gross* (m^3/day)	*Net* (m^3/day)
Annual	350	230	580	120 S
January	840	90	920	750 S
February	750	150	900	600 S
March	410	250	660	160 S
April	50	400	450	350 N
May	80	240	320	160 N
June	20	300	320	280 N
July	100	120	220	20 N
August	50	170	220	120 N
September	90	250	340	160 N
October	220	160	380	60 S
November	320	100	420	220 S
December	240	210	450	30 S

longshore transport system is relatively easily and rapidly carried southward across the inlet and passed on to the downdrift [Hine, 1987], an efficient bar-bypassing process.

For comparison purposes, Davis & Gibeaut [1990] have reported a net southerly drift of 84,000 m^3/yr compared to about 44,000 m^3/yr based on Table 2.3. On the other hand, Coastal Planning & Engineering, Inc. [1991] gives the net longshore transport at Blind Pass as about 31,000 m^3/yr for the period 1974 - 1989 while the corresponding figures for the periods 1955 - 1974 and 1941 - 1955 are given as about 54,000 and 82,000 m^3/yr, respectively. Considering the usually large differences that attend sediment transport prediction, the above values can be deemed as close, the discrepancies at least in part arising from the subjective interpretation of the shoreline azimuth for the former two since they are both based on littoral drift roses of Walton [1973].

Chapter 3

FIELD DATA ANALYSIS

The following field data collected in July/August 1991 by Coastal Planning & Engineering, Inc. were analysed to obtain geometric and hydraulic data required for the subsequent portion of the study:

a) cross-sectional survey covering the inlet and a substantial part of the flood shoal;

b) one continuous point current measurement at about one-third depth located at the throat section;

c) two surface current measurements using drogues; and

d) spot tidal elevation measurements at selected locations and times.

3.1 Tides

While simultaneous measurement of both ocean and bay tides is desirable, the scant tide data collected in the field necessitates recourse to predicted tides by National Ocean Service (NOS), which was found to be in general agreement with the few measured spot tidal elevations. Hence, the NOS Tide Tables are used to generate the Gulf tide required in the analysis.

These tides are generated numerically using the tidal constituents reported in Winton et al [1981], which are then plugged into the general equation:

$$\eta_n = a_0 + \sum_{i=1}^{N} a_i \cos\left(\frac{2\pi t}{T_i} - \delta_i\right) \qquad (3.1)$$

where η_n is the resultant tidal variation at time t, being composed of N constituents. The amplitude, phase, and period of the i^{th} constituents are a_i, δ_i, and T_i, respectively. a_0 denotes the displacement from the reference datum, in this case the 1965 Mean Low Water,

Table 3.1: Tidal Constituents used in Generating Gulf Tide (a_0=0.18 m)

Constituent	*Period*, T_i (*solarhr.*)	*Amplitude*, a_i (m)	*Phase*, δ_i (*degree*)
M_2	12.421	0.1869	77.8219
S_2	12.000	0.1001	99.6483
N_2	12.658	0.0299	194.7250
K_1	23.934	0.0528	185.8221
O_1	25.819	0.1079	115.1912
P_1	24.066	0.0601	132.1366
K_2	11.967	0.1351	342.0671
ν_2	12.626	0.0157	145.0242
M_1	24.833	0.0082	248.4851
J_1	23.099	0.0088	238.9296
Q_1	26.868	0.0298	221.5013
L_2	12.191	0.0461	140.3845
M_{tm}	219.191	0.0539	62.4574
M_f	327.869	0.0578	81.6405
M_{sf}	354.365	0.0690	225.0921
M_m	661.230	0.0161	193.1122

to the mean water level. Table 3.1 lists the 16 tidal constituents with their respective periods, amplitudes and phases, the latter two being obtained by harmonic analysis of a 35-day period continuous tidal data collected in Oct/Nov 1978 and conducted by Winton et al [1981].

Fig. 3.1 shows a plot of the generated tide, which exhibits a mixed state with two unequal highs and lows in a day. The mean tide range is about 0.50 m while the mean diurnal range is 0.80 m as reported in the NOS Tide Tables. Fig. 3.2 shows the variation of Gulf tidal range that will be used as input for the numerical model.

The generated tides are reduced to National Geodetic Vertical Datum (1929) by using the following tidal datums for the open coast gage at South Captiva Island (Station I.D.: 5383) [Balsillie et al, 1987]:

Mean Higher High Water = 0.46 m NGVD;

Mean High Water = 0.39 m NGVD;

Mean Tide Datum = 0.13 m NGVD;

Mean Lower Low Water = -0.13 m NGVD;

Mean Low Water = -0.29m NGVD; and

Mean Tide Range = 0.52 m.

Another source has placed the MHW on adjacent beaches at 0.52 m NGVD [Coastal Engineering & Planning, Inc., 1991]. Judging from the simplicity of approach and the many assumptions inherent in the study approach, the discrepancy was deemed tolerable and no effort was made to reconcile the difference. As an added simplification, the NGVD was used as the reference datum to compute the geometric properties of the inlet as elaborated in subsequent sections. The difference in the mean tide level between the Gulf and the bay is taken from Winton et al [1981], being 0.10 m, and is used in the model.

3.2 Currents

The measured current, which is mainly tide-driven and shown in Fig. 3.3, shows a similar pattern of change to the tidal variation. Current deflection from the inlet axis is apparent from Fig. 3.4, where the ebb and flood flow directions are each modified by the inlet exit and entrance geometry. The peak ebb current is stronger than the peak flood current, being about 1.3 m/s and 0.9 m/s respectively. The corresponding peak surface currents are about 1.6 m/s and 1.3 m/s based on surface drogue measurements. Assuming a theoretical logarithmic velocity distribution and accounting for variation in the transverse direction, the mean cross-sectionally averaged velocity is taken to be about 1.1 m/s for calibration purposes. This value is also consistent with those indicated in coastal charts, which indicate that velocities up to 1.1 m/s may be expected to occur in inlet throats.

3.3 Geometric Data

The survey data were analysed to yield the geometric data as summarized in Table 3.2 and graphically depicted in Fig. 3.5 and 3.6.

It is noted that while the throat flow depth, h_c, occurs at Section 4, the throat flow area, Ac, occurs at section 10. In the field, Section 10 is located at a constricted part of the flow channel due to the presence of an island that bifurcates the flow. This island most likely originated as a part of the flood tidal shoal the subaerial part of which became colonized by vegetation and eventually the entire complex became a stable feature. There are other mangrove-covered islands within the channel that connects Pine Island Sound to the Gulf. Immediately downstream of Section 10 is a branch channel that serves as an escape conduit for the incoming flood flow that would otherwise pile up against the constricted Section 10. Hence, for the present purpose, the inlet channel is considered to be stretching from Sections 1 to 7, and the water area thereafter is considered part of the

Table 3.2: Geometric Data for Blind Pass

Cross-section No.	Distance (m)	Cross-section Area (m^2)	Mean Depth (m)
1	0	125	0.8
2	29	91	1.0
3	60	64	1.5
4	76	64	2.1
5	116	94	1.8
6	134	74	1.2
7	163	78	0.9
10	259	52	1.4
11	312	57	1.2
12	648	76	0.8
13	984	189	0.7
14	1296	313	0.9
15	1548	234	0.7
16	1747	275	0.5

bay area. Confining the analysis to the first seven sections, h_c and A_c are found to be 2.1 m and 64 m^2, respectively.

The equivalent length of the inlet, L_c, is next computed using the following expression [Bruun, 1978]:

$$L_c = A_c^2 h_c^{\frac{4}{3}} \sum_{i=1}^{7} \frac{\Delta x_i}{h_i^{\frac{4}{3}} A_i^2} \tag{3.2}$$

where A_i and h_i are the individual cross-sectional areas and mean flow depths below Mean Water Level as summarized in Table 3.2 and Δx_i is the channel length of the *ith* segment. In this way, the equivalent length is found to be 194 m, i.e., longer than the measured length due to the irregular geometric shape of the inlet that increases flow resistance.

Chapter 4

ANALYTICAL STUDY

4.1 Inlet Hydraulics

The first part of the analytical study entails using the one dimensional model equation developed for the Keulegan-type bay to obtain parameters that characterize the hydraulic behavior of the inlet. The principal assumptions inherent in the analysis are:

a) the forcing tidal variation is sinusoidal in time;

b) effects of tides dominate over wave-induced effects;

c) negligible spatial variation in water surface elevation and velocity within the inlet channel; and

d) the bay is a small and deep body of water in which the kinetic energy of the flow issuing from the channel is dissipated, and the instantaneous water surface is horizontal throughout.

Combining the resulting momentum and continuity equations leads to the following second-order ordinary differential equation as the governing equation of motion [Bruun, 1978]:

$$\frac{d^2\eta_B}{dt^2} + \frac{F}{2L_c}\frac{d\eta_B}{dt}\left|\frac{d\eta_B}{dt}\right| + \frac{gA_c}{L_cA_B}\eta_B = \frac{gA_c}{L_cA_B}\eta_o \tag{4.1}$$

where

η_o = ocean elevation;

η_B = bay elevation;

A_B = bay surface area;

A_c = cross-sectional area at throat;

L_c = equivalent channel length;

g = acceleration due to gravity; and

F = impedance given by:

$$F = k_{en} + k_{ex} + \frac{fL_c}{4h_c} \tag{4.2}$$

where

k_{en} = entrance loss;

k_{ex} = exit loss; and

f = Darcy-Weisbach friction factor.

A relatively simple solution to the non-dimensional form of the governing equation of motion based on the describing function technique can be found in Bruun [1978]. The resulting solutions as used in the present study are reproduced below:

$$\tilde{\eta}_o = \sin \alpha\tilde{t} \tag{4.3}$$

$$\tilde{\eta}_B = \tilde{a}_B \sin(\alpha\tilde{t} - \epsilon) \tag{4.4}$$

$$\tilde{u} = \tilde{u}_{max} \cos(\alpha\tilde{t} - \epsilon) \tag{4.5}$$

$$\tilde{a}_B = \left\{ \frac{[(1-\alpha^2)^4 + \mu^2]^{\frac{1}{2}} - (1-\alpha^2)^2}{\frac{1}{2}\mu^2} \right\}^{\frac{1}{2}} \tag{4.6}$$

$$\epsilon = \tan^{-1}\left[\frac{\mu\tilde{a}_B}{2(1-\alpha^2)}\right] \tag{4.7}$$

$$\tilde{u}_{max} = \tilde{a}_B \tag{4.8}$$

where

$\tilde{\eta}_o = \frac{\eta_o}{a_o}$; $\tilde{\eta}_B = \frac{\eta_B}{a_o}$; $\tilde{t} = \left[\frac{gA_c}{L_cA_B}\right]^{\frac{1}{2}} t$; $\tilde{u} = \frac{\bar{u}A_c}{a_o\sigma A_B}$;

α = dimensionless tidal frequency = $\left[\frac{L_cA_B}{gA_c}\right]^{\frac{1}{2}} \sigma$;

$\tilde{a}_B = \frac{a_B}{a_o}$;

a_B = bay tidal amplitude;

a_o = ocean tidal amplitude;

$\bar{u}$ = depth-averaged flow velocity;

$\mu = \frac{16\beta\alpha^2}{3\pi}$;

β = dimensionless damping coefficient $= \frac{FA_B}{2L_cA_c}a_o$; and

σ = tidal frequency

In addition, an additional correction to L_c in the dimensional tidal frequency, α, is included via the following equations:

$$L_c' = \frac{W_c}{\pi} \ln\left[\frac{2\alpha\sqrt{gh_c}}{\sigma W_c}\right] \tag{4.9}$$

$$L_{c1} = L_c + L_c' \tag{4.10}$$

where

L_c' = correction;

W_c = width of idealized inlet; and

L_{c1} = value to be used in evaluating α.

Since α also appears in Equation 4.9 above, the correction is obtained iteratively.

4.2 Long-term Stability

The second part of the analytical study involves computation of the relation between the repletion coefficient, K, and the maximum flow velocity at the throat, u_{max}, which enables a qualitative assessment of the hydraulic stability of the inlet to be made. This is followed by the use of the O'Brien relationship linking the tidal prism, Ω, and the minimum flow area, A_c, from which the sedimentary regime of the inlet can be derived. The superposition of the hydraulic and sedimentary stability criteria then yields the inlet stability diagram for Blind Pass.

The various analytical expressions required for the above analysis are well-documented in the literature [Bruun, 1978; Escoffier & Walton, 1979; Mehta & Bruun, 1983] and are reproduced below:

Hydraulic Stability:

$$K = \frac{A_c F_n \sqrt{2g} T}{2\pi A_B \sqrt{a_o}} \tag{4.11}$$

$$F_n = (\frac{2gLn^2}{R^{\frac{4}{3}}} + m)^{-\frac{1}{2}} \tag{4.12}$$

where F_n is a dimensionless head loss parameter. The value of K is then obtained iteratively using the following equation:

$$K = \sqrt{e}\tilde{a}_B \left\{ 1 - \left[1 - \alpha_i^2 (\frac{K_i}{K})^p \right]^2 \tilde{a}_B^2 \right\}^{-\frac{1}{4}} \tag{4.13}$$

where

$$e = \frac{4}{\pi}[\frac{1}{3}\cos\theta_n(2+\sin^2\theta_n) + \theta_n \sin\theta_n] \tag{4.14}$$

$$\theta_n = \sin^{-1}(\frac{Tq}{2\pi a_o A_B \tilde{a}_B}] \tag{4.15}$$

$$\alpha^2 = \alpha_i^2(\frac{K}{K_i})^{-p} \tag{4.16}$$

$$A_c = A_{ci}(\frac{K}{K_i})^p \tag{4.17}$$

$$U_{max} = \frac{2\pi a_o A_B \tilde{a}_B}{TA_c}(1+\sin\theta_n) \tag{4.18}$$

where q is the tributary inflow and other parameters are as defined earlier.

The above set of equations, which is described in Escoffier & Walton [1979], incorporates the effects of inertia through the dimensionless tidal frequency term, α, and of tributary inflow through q found in the equation containing e. Equations 4.16 and 4.17 are assumed variations of α and A_c relative to K where the subscript i denotes initial values before accretion or erosion. The value of the parameter p lies between 0.6 for the condition when the wetted perimeter is assumed to vary but not R, the hydraulic radius, and 1.0 for the opposite condition in response to sedimentary processes. It is used here as a calibrating parameter to reproduce the measured flow velocity.

Sedimentary Stability

$$\Omega = \frac{U_{max}A_c T}{\pi C_k} \tag{4.19}$$

$$\Omega = a^{-\frac{1}{m}} A_c^{\frac{1}{m}} \tag{4.20}$$

Combining the above two equations leads to the following equation describing the relationship between U_{max} and A_c:

$$U_{max} = \frac{\pi C_k}{T} a^{-\frac{1}{m}} A_c^{\frac{1-m}{m}} \tag{4.21}$$

where C_k varies between 0.811 and 0.999 and is taken as 0.86 here. Values of a and m have been published for the Gulf of Mexico for "*Zero, One & Two*" and "*Zero & One*" jetty conditions [Bruun, 1978]. It was found that the two set of values yield $U_{max} \propto A_c$ relationships that are not far from each other in the present case. Hence, the values for the "*Zero & One*" jetty condition, i.e, a=3.51$\times$10^{-4} and m=0.86, are used in this study.

Chapter 5

NUMERICAL MODELING

5.1 Model Description

The model is a one-dimensional dynamic model that is based on integrated momentum equation for flow and DuBoys formula for sediment transport. The model first computes the flow discharge and water depth in each numerical cell along the axis of the inlet using an iterative approach based on a given Gulf tide, bay area, bed resistance represented by the Manning's n, and exit and entrance losses. The integrated momentum equation that governs the tidal flow along the inlet is:

$$\eta_o - \eta_B = \frac{u_{m_i}^2}{2g}(k_{ex} + k_{en}) + \sum_{i=1}^{N} \Delta H_i \tag{5.1}$$

where

u_m = flow velocity in cell i;

ΔH_i = heat loss due to friction in cell i; and

N = total number of cells.

The values of η_o are specified from the generated Gulf tide mentioned earlier while the values of η_B are computed from the values of $\tilde{a}_B$ and ϵ computed from the analytical study. So is A_B, which is the result of the flow calibration exercise in the analytical study. The friction head loss in each cell is computed based on the Manning's Equation:

$$u_m = \frac{1}{n}(\Delta h)^{\frac{1}{2}} h^{\frac{2}{3}} \tag{5.2}$$

where both the uniform flow condition ($\Delta h = S$, the slope of the energy grade line) and the wide channel assumptions ($R \approx h$) have been invoked.

Once the flow conditions have been computed, the sediment fluxes entering and leaving each cell are computed by the DuBoys formula for given hydraulic conditions and sediment properties. The Duboys formula expresses the volumetric sediment transport rate per unit width, q_s, in terms of the excess shear stress as follows:

$$q_s = C_s \tau_o (\tau_o - \tau_{cr.h}) \tag{5.3}$$

where

τ_o = average bed shear stress = γRS;

$\tau_{cr.h}$ = critical shear stress for incipient motion on a horizontal bed;

Duboys'$C_s = \frac{0.173}{d^{\frac{3}{4}}}$

d = sediment size in mm; and

γ = unit weight of water.

$\tau_{cr.h}$ is computed from the Shields Diagram assuming that the flow is in the turbulent rough range (Roughness Reynolds Number, R_e ($= \frac{u_* d}{\nu}$) > 70) where the dimensionless Shear Stress, Θ_t, is a constant at 0.06. A metric conversion factor of 4.05×10^{-5} need to be incorporated into the expression for C_s, which is taken from Graf [1984].

The sediment conservation equation for each compartment is then:

$$\int_{t_1}^{t_2} q_{s_{in}} W \, dt - \int_{t_1}^{t_2} q_{s_{out}} W \, dt - m[(Wh)_{t_1} - (Wh)_{t_2}] = 0 \tag{5.4}$$

where the subscripts *in* and *out* denote fluxes into and out of the compartment, and m and W are the porosity of the sediment and the cross-sectional width, respectively. In order for the computation to proceed, initial conditions are ascribed for q_s, W and h, and boundary conditions assigned to q_s in terms of M, the fraction of littoral drift that enters the inlet, and ξ, the composite factor that represents the fraction of M that deposits during flood and the subsequent ebb in each time increment of the tidal cycle. An implict assumption is that bed erosion and deposition occur uniformly throughtout the entire inlet.

The flow area then adjusts to the sediment scour or deposition by changing the width to suit the new flow depth. Based on an examination of a large number of inlets, an empirical relation that expresses the gemetric relationship between W and h for the minimum flow area of the following form has been in use [Bruun, 1978]:

$$h = aW^b \tag{5.5}$$

Values of a and b used in the model are 0.087 and 0.88, respectively, for W and h in meters, based on the trend line for jettied inlet [Bruun, 1978].

Table 5.1: Calibrated Parameters from Analytical Method

T (hr)	a_o (m)	f	A_B (m^2)	$\tilde{a}_B$	ϵ
12.42	0.20	0.025	2.80×10^6	0.86	33.3
12.42	0.25	0.025	2.10×10^6	0.92	26.0
12.42	0.30	0.025	1.70×10^6	0.94	21.5
12.42	0.35	0.025	1.43×10^6	0.96	18.1
12.42	0.40	0.025	1.25×10^6	0.97	15.9

5.2 Preliminary Runs

A series of run was first conducted using the same input data as for Phillips Inlet, except the geometric data which were based on conditions at Blind Pass. The runs always terminated early due to the exponential growth of the inlet cross-section, even under the condition of appreciable sediment input. After a few more runs, it was found necessary to reduce the C_s coefficient in Eq. 5.3 by 100-fold. The next series of runs were for different values of the bay area, A_B, calibrated againest different values of a_o to achieve an average flow velocity of about 1.1 m/s as shown in Table 5.1

The range of a_o selected encompasses the mean tide range on one end and the mean diurnal range on the other end. As observed, higher values of a_o lead to lower A_B and ϵ but higher $\tilde{a}_B$ values. Fig. 5.1 shows the results of comparative runs for the case of the fraction of littoral drift that enters the inlet, M, equalling 1,000 m^3/day, which indicates that lower values of η_o, and hence, higher A_B values, result in inlet widening. Since the chosen emphasis here is on inlet closure, the largest value of η_o, i.e., 0.40 m, was adopted for all subsequent runs.

The next preliminary test runs involved inputting various arbitrary values of M to assess the response of inlet under different scenarios. As indicated in Fig. 5.2, the inlet demonstrated no tendency to close even at M = 2,900 m^3/day, a very large figure indeed that is unlikely to be realized at the site. This is interpreted as the overwhelming effect of the erosion algorithm in the model. Fig. 5.3 indicates two comparative runs with the q_s reduction coefficient of 0.01 and 0.001, which is equivalent to reducing the C_s coefficient in Eq. 5.3 by another 10 times, for the case of M = 1,000 m^3/day. The latter case seemed to perform as expected, i.e,. exhibiting tendency to close. Hence, the value of 0.001 was adopted for subsequent runs.

With these input data, the model was run to simulate conditions after a week as indicated in Fig. 5.4 (a) and (b). While the output for the flow area is reasonable other than some initial high-frequency oscillations, which is not unusual for model start-up, the

Table 5.2: Final Input Values for Numerical Model Runs

L	194 m	h	64 m	n	0.05	n_p	0.4
d	0.26 mm	K_{en}	1.00	K_{ex}	0.05	a_o	0.40 m
T	12.00 $hr.$	$\tilde{a}_B$	0.64	ϵ	51	A_B	1.9 $\times 10^6 m^2$
ξ	0.3	RF_{q_s}	0.001	RF_{η_o}	0.75	$\tau_{cr.h}$	0.88 $\frac{N}{m^2}$

output for velocity is too excessive. It was then decided to increase the roughness to reduce the flow velocity to a more realistic level, being achieved by increasing the value of Manning's n from 0.03 to 0.05.

The relevant input parameters were recomputed from the analytical method using the revised n value. The value of friction factor, f, which is an input in the analytical method, was computed using the following relationship:

$$n = h^{\frac{1}{6}} \left[\frac{f}{8g} \right]^{\frac{1}{2}} \tag{5.6}$$

Table 5.2 lists all the inputs to the numerical model for the final runs where n_p, the only unexplained parameter thusfar, is the sediment porosity. The only varying input is M, which ranges from 200 to 2000 m^3/day.

In Table 5.2, RF_{q_s} and $RF_{\eta o}$ denote the reduction factors for the flow-induced bottom erosion rate computed using DuBoys formulation, and the forcing tide amplitude in the Gulf, respectively. The critical shear stress for incipient motion, $\tau_{cr.h}$, is computed from the graph for metric units (Fig. 7.2) in Graf [1984]. The average sediment size, d, is taken from the US Army Corps of Engineers Report [1969], which lists the representative beach sediment for beaches adjacent to Blind Pass.

Chapter 6

RESULTS AND DISCUSSION

In the literature on inlet stability, a distinction between long-term and short-term stability is frequently made. The former refers to the gradual deterioration of the inlet due to shoaling and may occur over several months or even decades. On the other hand, short-term stability is associated with storm events, which can result in inlet closure. Hence, while the former considers average conditions, the latter is necessarily linked to the intensity and duration of storm events.

6.1 Long-term stability

One of the frequently used criteria for long-term stability is the sedimentary and hydraulic stability diagram discussed in Chapter 4 : Analytical Study. Since there is substantial temporal variation in the tide conditions, two stability diagrams were prepared: one based on the mean tide condition (average of the two daily tides) and the other one based on the same parameter inputs for the numerical model, which represents a more extreme condition associated with the average of the higher daily tides only. This was done in the hope that the two conditions would envelope the expected behavioral range of the inlet.

The inlet performance for the mean tide condition is shown in Fig. 6.1, which indicates that the K value for the present inlet configuration (1.19) is more than K_c (0.74 in this case), indicating that the inlet is stable under the scenario considered. On the other hand, K-curve for the more extreme condition indicates that the K value for the present inlet (0.73 in this case) is very close to the corresponding K_c, which ranges from 0.42 to 0.74 depending on the p value used, as shown in Fig. 6.2. The figure also shows a lower peak velocity, which is expected due to the higher resistance coefficent used ($n = 0.05$). Hence, while Blind Pass may be deemed as stable under mean tide condition, it is only marginally stable under the more extreme tidal forcing scenario. Escoffier & Walton [1979] have recommended that the value of K for an inlet should always be considerably larger than K_c for stability. In a more quantitative sense, Oliveira [1976] has stated that a tidal inlet characterized by $K < 0.6$ is in a condition of non-steady alluvial equilibrium, which means that shoaling may be in progress there.

Perhaps a more complete picture may be gleaned from Fig. 6.3 and 6.4, which includes sedimentary regime as well. In both figures, curves for three different p values, which is the exponent characterizing the variation of the critical flow area, A_c, with K as discussed previously, have been drawn. The curve for $p = 0.7$ corresponds to that shown in Fig. 6.1. As indicated, higher p values lead to a shift to smaller A_c. However, the recession part of the curves remains relatively constant. Hence, the stable flow area, which is the point of interception of the two stability curves, is about 125 m^2 and 150 m^2 based on averaged and more extreme conditions respectively. These values are close to the historical flow area of Blind Pass in 1966, 1970, and 1974 (Table 2.1).

Based on both Fig. 6.3 and 6.4, the critical flow area ranges from 25 to 80 m^2, depending on the value of p used. The fact that the present cross-sectional area at the inlet throat (64 m^2) under mean conditions is between the critical and stable flow areas quoted above seems to indicate that the inlet is within the stable side of the stability diagram. However, the proximity of the present A_c value to the critical flow area, even disregarding the more extreme conditions where the present A_c value lies to the left of the critical flow area, does reflect the uncertainty on which the above interpretation is based, given possible errors in the field data collection and the simplicity of the approach adopted. Without distinguishing between the tidal conditions as was done here, Foster [1991] has characterized Blind Pass as a marginally stable inlet.

It should be noted that long-term criteria, as established from the above methodolody, presuppose adequate sand supply to satisfy the sedimentary regime. Hence, its application to improved inlets where sediment pathways are interrupted by human intervention as is the case in Blind Pass, requires judicious interpretation. Conceivably, the north jetty cuts off some of the natural flow of the littoral drift, thereby alleviating the shoaling tendency at Blind Pass. As pointed out by Hine [1987], the inlet jetty, although constructed to function as a terminal groin to retain beach nourishment to the north, has provided a measure of stability for this comparatively unstable inlet.

6.2 Short-term Stability

The results of the numerical runs are shown in Fig. 6.5 to Fig. 6.16 for M values ranging from 200 to 2000 m^3/day, a ten-fold increase. The length of run duration was chosen such that it would encompass an entire spring-neap tidal cycle, a period of approximately a month. Since the model was run each time with a constant M value, the duration of about a month more or less fits in with the strong monthly variation in littoral transport exhibited in Table 2.4.

In general, the model outputs in the form of temporal variations of flow area and flow velocity follow the same trend as that of the Gulf tide, which would be expected since the tide is the primary forcing agent. The variation reflects the influence of the two unequal tides in a day typical of a strongly mixed tide. Where the two daily tides approach each other in magnitude (day 7 to day 11), the variation is a smooth oscillation. At other times, the lower of the two tides is almost non-existent and the water level is sustained at almost the same elevation for hours. The horizontal trend of the variation (day 16 to day 18) is indicative of the tideless condition, which also appears in the velocity plots.

The flow area reaches a maximum of about 150 m^2, which is within the historical flow area reported. On the other hand, the simulation of flow velocity is perhaps less satisfactory, occasionally reaching a maximum of about 3 m/s during ebb flow, except for the $M = 200\ m^3/day$ run. However, most of the flows are within the 2 m/s cap. Flows of such magnitudes are not entirely unrealistic, if they occur only during part of the tidal cycle when spring, or even perigean spring, conditions prevail.

It is seen that up to about $M = 600\ m^3/day$, the inlet exhibits either stable or slight accreting conditions. From $M = 700\ m^3/day$ to $800\ m^3/day$, the shoaling trend is clearly noticeable, but the inlet still remains open at the one-month cut-off point. The inlet closes in about a month for $M = 900\ m^3/day$ and thereafter the time of closure is more rapid as the M value increases to $2000\ m^3/day$ where the inlet closes in twelve days. These outputs, therefore, are in qualitative agreement with the expected behavior of Blind Pass under increasing sediment loading.

As supported by photographic interpretation and qualitative observations made in published reports on the survivability of Blind Pass, the closure takes place over a period of months. Bearing this observation in mind, it is suggested that the critical M value for which the inlet is just in a self-flushing condition is probably around 700 - 900 m^3/day. Multiplying M by the ξ factor ($= 0.3$) used in the model, which is a reasonable estimate of the actual fraction of sediment that ultimately desposits on the bed of the inlet over a flood-ebb cycle from the total amount of sediments that enter the inlet, results in an actual rate of deposition of about 250 m^3.

There are no field data available on the rate of littoral drift that enters the inlet, other than the figures obtained from volumetric difference of the temporal growth of the flood tidal shoal. Since it has been acknowledged that the value computed for the period 1960 - 1965 is conservative, implying low, a reasonable estimate of the rate of deposition is probably three times the computed figure ($\approx 30\ m^3/day$), i.e., about 100 m^3/day. Considering the prevailing thinking that sediment transport predictions can differ by $\pm$ 200%, the M value based on numerical model is perhaps not too far-fetched.

The corresponding figure for post-1965 period is about one-sixth of the earlier value. Hence, by the same token, there is quite a reduction in the amount of littoral material that entered the inlet after the 1960s. The change is attributed mainly to the presence of the north jetty as explained earlier. Hence, it is possible that any southerly transport that manages to bypass the jetty is jettisoned to deeper water and subsequently brought back to shore at a point further downdrift beyond the inlet by the process of bar bypassing. In trying to explain the role of northerly transport, which can be appreciable in the middle of the year (about half of the maximum monthly southerly transport) based on computation, it can be argued that the littoral drift roses actually represent potential transport, i.e., solely based on the sediment transporting power of the waves. Hence, the realization of the actual transport is contingent upon the availability of mobile material. Looking at the regional scale of the shoreline orientation south of Blind Pass, it is apparent that the reach of shoreline immediately south of Blind Pass, the azimuth of which was used in computing littoral transport, is a relatively short transition that joins with the major shoreline of the Sanibel Island that trends roughly 280° N. Hence, it is conceivable that the nearshore bathymetry around this area may cause the waves to arrive at a more normal incidence, and hence result in a less sediment transport capacity.

Another aspect of inlet closure of Blind Pass is the southerly growth of the inlet channel south of its interior channel. This type pf lengthening of the inlet channel almost always precedes inlet closure. It increases flow resistance and hence, reduces the tidal prism. As the channel lengthens, it becomes hydraulically less efficient up to a point where the wave-induced transport just out-balances the tidal flow and closes the inlet at its southerly exit position. The closed channel then shoals from within until a storm event breaches across the enclosed sand bar, usually at the end of the interior channel. The encircling sand bar can also act to obstruct northerly drift from gaining entry into the inlet proper, in a way supporting the premise that the northerly drift may not feature strongly in the inlet closure process. The strong directional preference of ebb flow at Blind Pass also mitigates against any significant sediment movement to the north as suggested by Foster [1991].

It is intersting to note that in the sediment budget prepared by Coastal Engineering & Planning, Inc. [1991], the stretch of shoreline immediately south of Blind Pass ($\approx$ 1,800 m long) has lost about 17,000 m^3/yr for the period 1859 - 1941, 38,000 m^3/yr for 1955 - 1974, 30,000 m^3/yr for 1974 - 1978, and again 38,000 m^3/yr for 1978 - 1988. While these losses may be linked to the inlet sink, it is more likely the result of interruption in southerly drift by first the evolution of the ebb-tidal shoal at Redfish Pass and later the jetty and other protection works along the Captiva Island. The report also indicates the successive reduction in net southerly transport to the south of Redfish Pass for the three periods, 1941 - 1955, 1955 - 1974 and 1974 - 1989. In every case, no losses to the Blind Pass was indicated in the littoral budget established. Again, this may be construed as insignificant sediment supply to the inlet.

While Blind Pass has undergone alternate closure and reopening, the chronic shoreline erosion prevalent along Captiva Island appears to have helped reduce the sediment loading that would otherwise have gained ingress into the inlet. Analysis by Walton [1977] has shown that from 1859 to 1967, the shoreline of the sand bulge seaward of the interior channel of Blind Pass has progressively receded close to about 550 m. While this loss may reflect an efficient mode of sand transfer to the south, it does help mitigate against any tendency toward closure by removing sand from the region immediately offshore of the inlet via alongshore littoral transport.

6.3 Limitations of Approach Methodology

A drawback of the present approach is that it does not account for the presence of multiple inlets that share a common bay of water. Theoretical considerations by van de Kreeke [1985] for a twin- inlet system, albeit with certain simplifying assumptions, has shown that the condition for the existence of stable equilibrium flow area for both inlets is that the enhanced parts of the equilibrium flow curves computed based on the stability analysis of Escoffier [1940] intersect. In the event that no such intersection occurs, then a combination of individual flow area for which both inlets are in equilibrium with the flow conditions does not exist. In other words, one of the two inlets will survive; the other will close eventually.

The significance of the inter-relationship among the inlets is already attested to by the effect of the opening of Redfish Pass on the behavior of Blind Pass. Winton et al [1981], using a numerical approach, has attempted to investigate one facet of the problem, that being the effect of different inlet sizes of Blind Pass on the overall tidal response of Pine Island Sound. They concluded that these changes (up to an inlet cross-sectional area of 1400 m^2), did not significantly change the overall tidal response. However, they did acknowledge that there will be water interchange.

The effect of closing Redfish Pass was also simulated and they found no significant changes in flows through the other inlets. Specifically, their results indicated that the closing of Redfish Pass caused a slight decrease in the flows and in the maximum velocities through Blind Pass and Captiva Pass. However, Foster [1991] has cited Blind Pass, in qualitative terms, as an example whereby changes in the amount of tidal prism, as shared among a group of geographically close inlets, is a strong factor controlling inlet throat cross-section and stability. Nevertheless, these surprising results of Winton et al [1981] may be explained on the premise that the system may have equilibrated to such an extent that it has become irreversible. In fact, this finding may be used to support the premise of the present approach, i.e, treating it as essentially a single inlet system. The other major discrepancy between theirs and the present study is in the maximum velocity through the inlet. For the present configuration, their model predicted a maximum spring velocity of about 0.6 m/s, compared to the measured velocity of about 1.1 m/s used in the present study. They also attributed the very weak dependence of flow velocities on inlet cross-section area and flow depth, which their results indicated, on the fact that the tidal prisms through Redfish Pass and through the southern model boundary (San Carlos Bay) provide a tidal head difference between the inner and outer ends of Blind Pass, and hence, is the dominant factor which controls the flows through Blind Pass.

The constant inlet length assumption employed in the model is also not reflective of the actual tendency of the inlet to increase its length with time. As explained, inlet lengthening increases flow resistance, and the resulting reduced flow velocity makes the inlet more prone to closure. Another complicating element appears in the form of flow constriction imposed by structures. The fact that a bridge spans across Blind Pass implies that the inlet cross-section will not be able to adjust according to the pre-determined $h \propto W$ relationship. In this case, the restriction imposed by the bridge abutments appears to have resulted in a deeper section than expected based on the morphological relation.

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Fig. 3.1 GENERATED GULF TIDES, BLIND PASS

16 TIDAL CONSTITUENTS

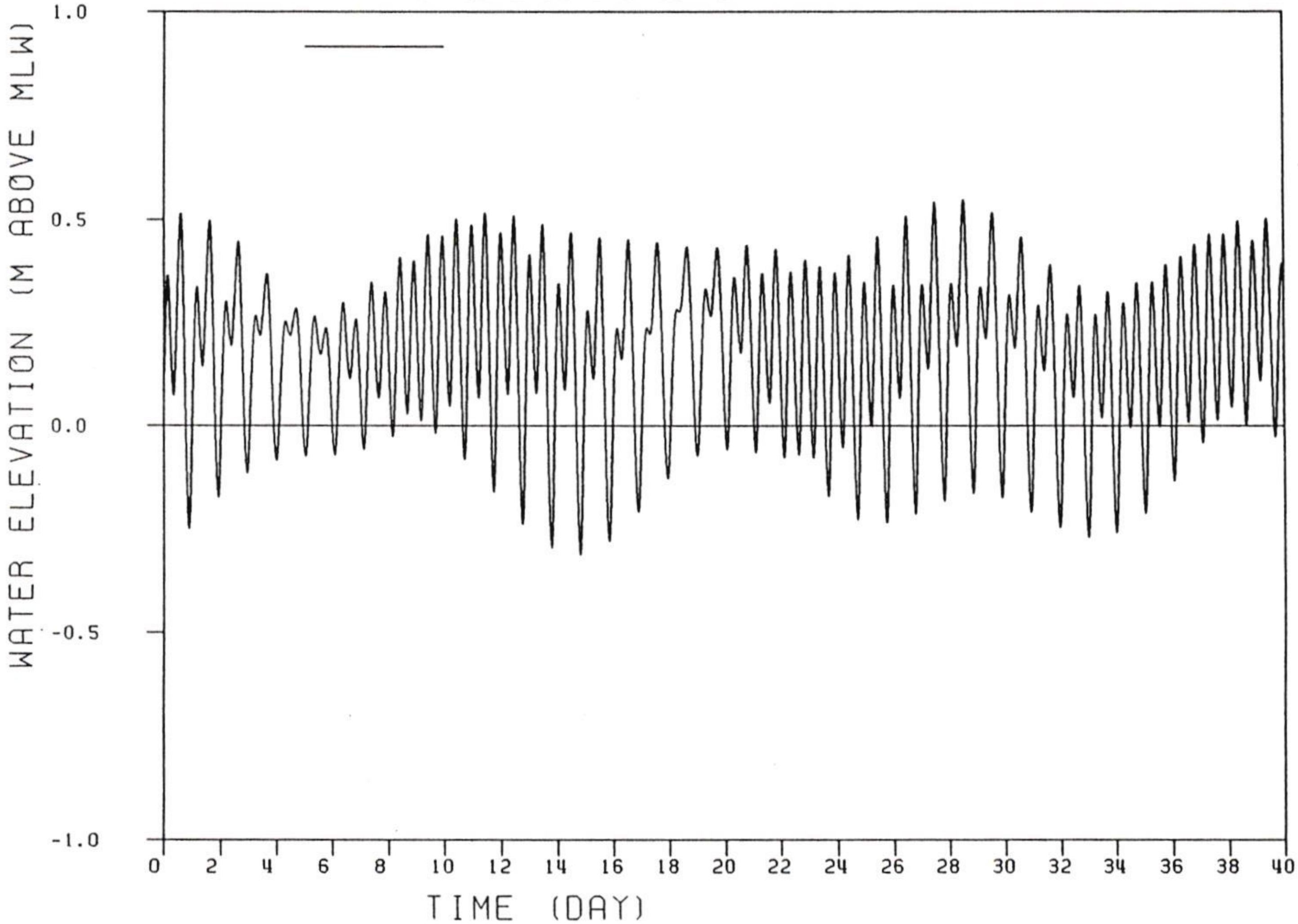


Fig.3.2 VARIATION ØF GULF TIDAL RANGE

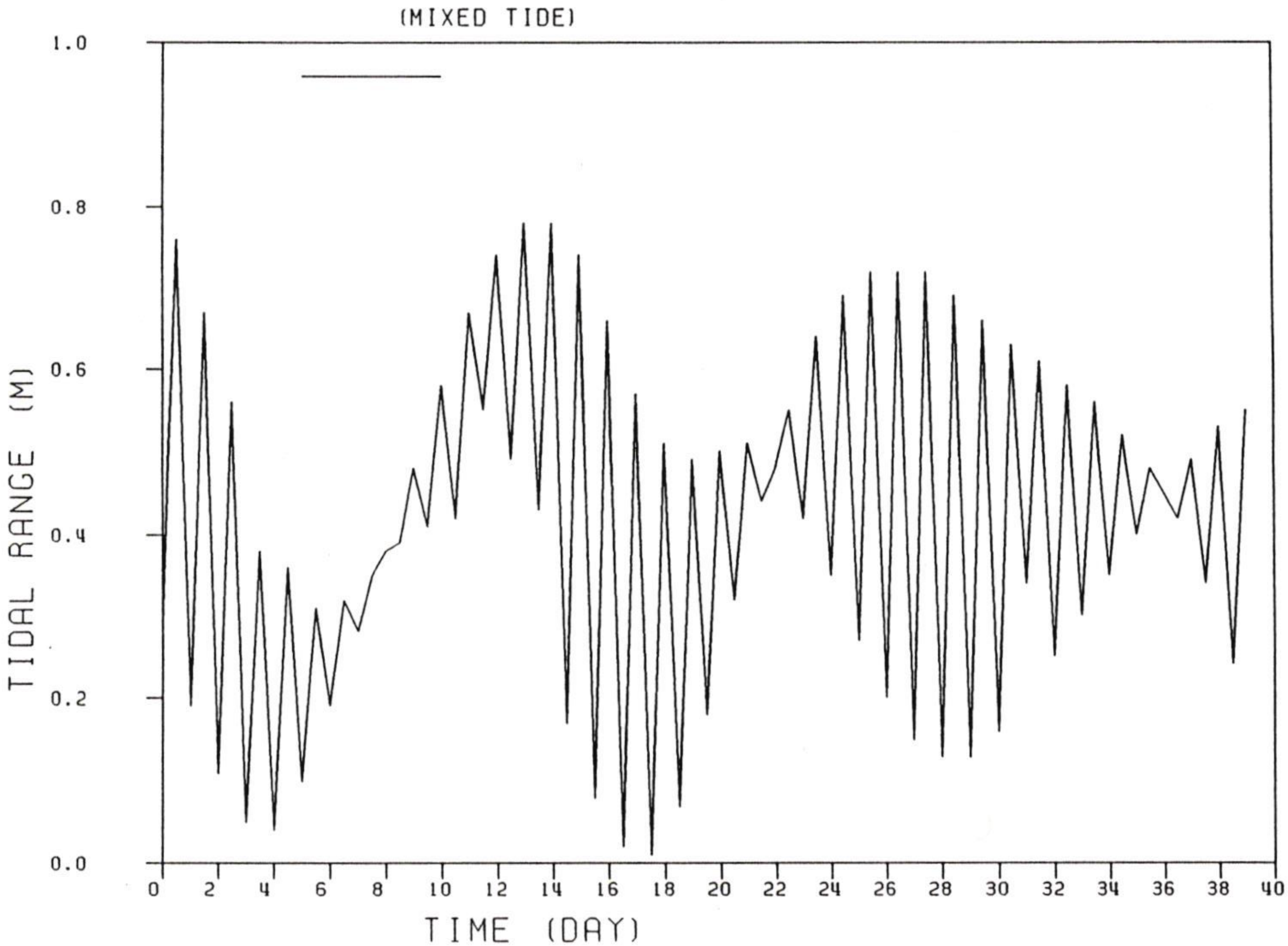


Fig. 3.3 MEASURED POINT VELOCITY AT BLIND PASS
(STARTING TIME: 3.21 PM, 31/7/91)

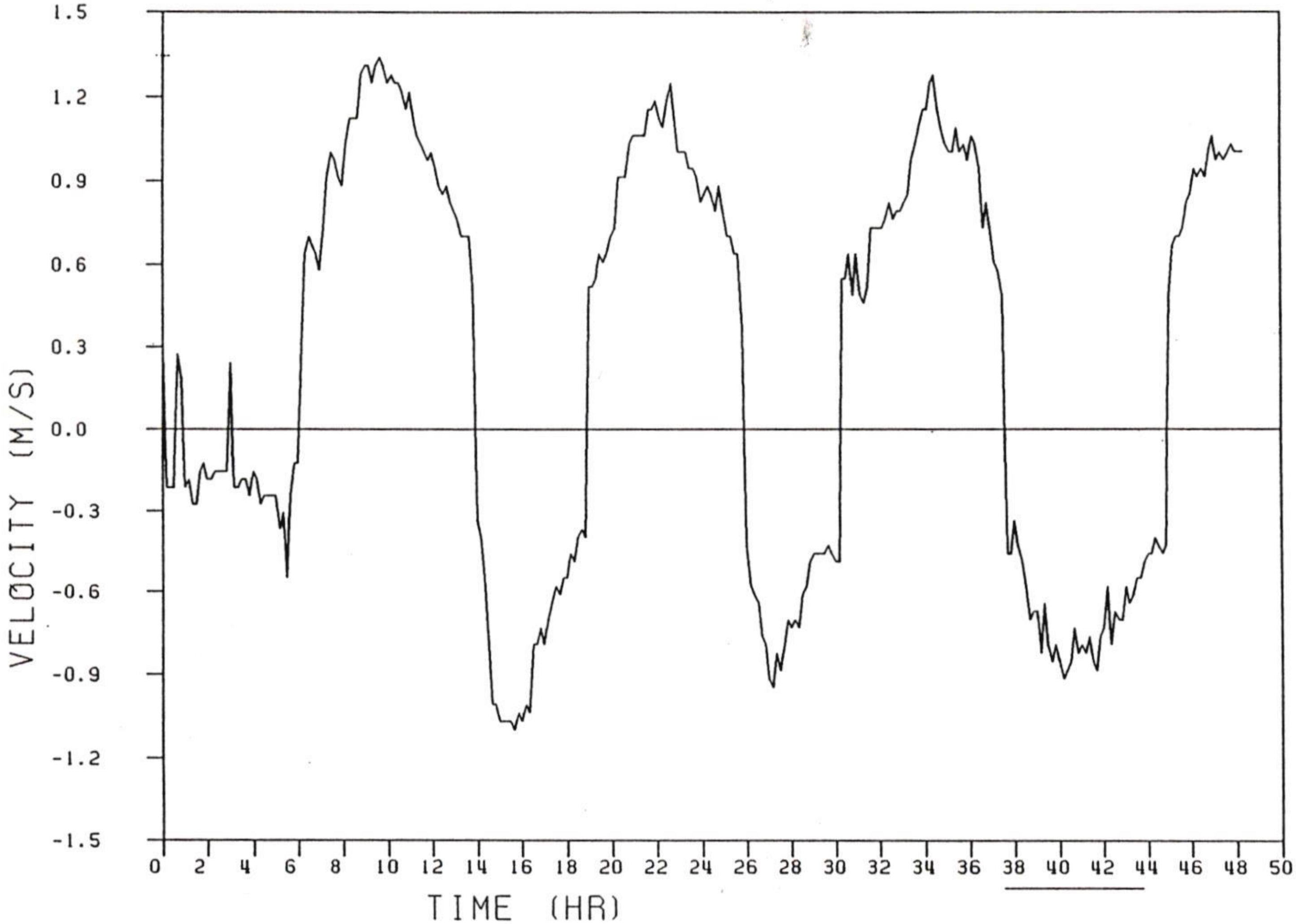


Fig.3.4 MEASURED POINT VELOCITY AT BLIND PASS

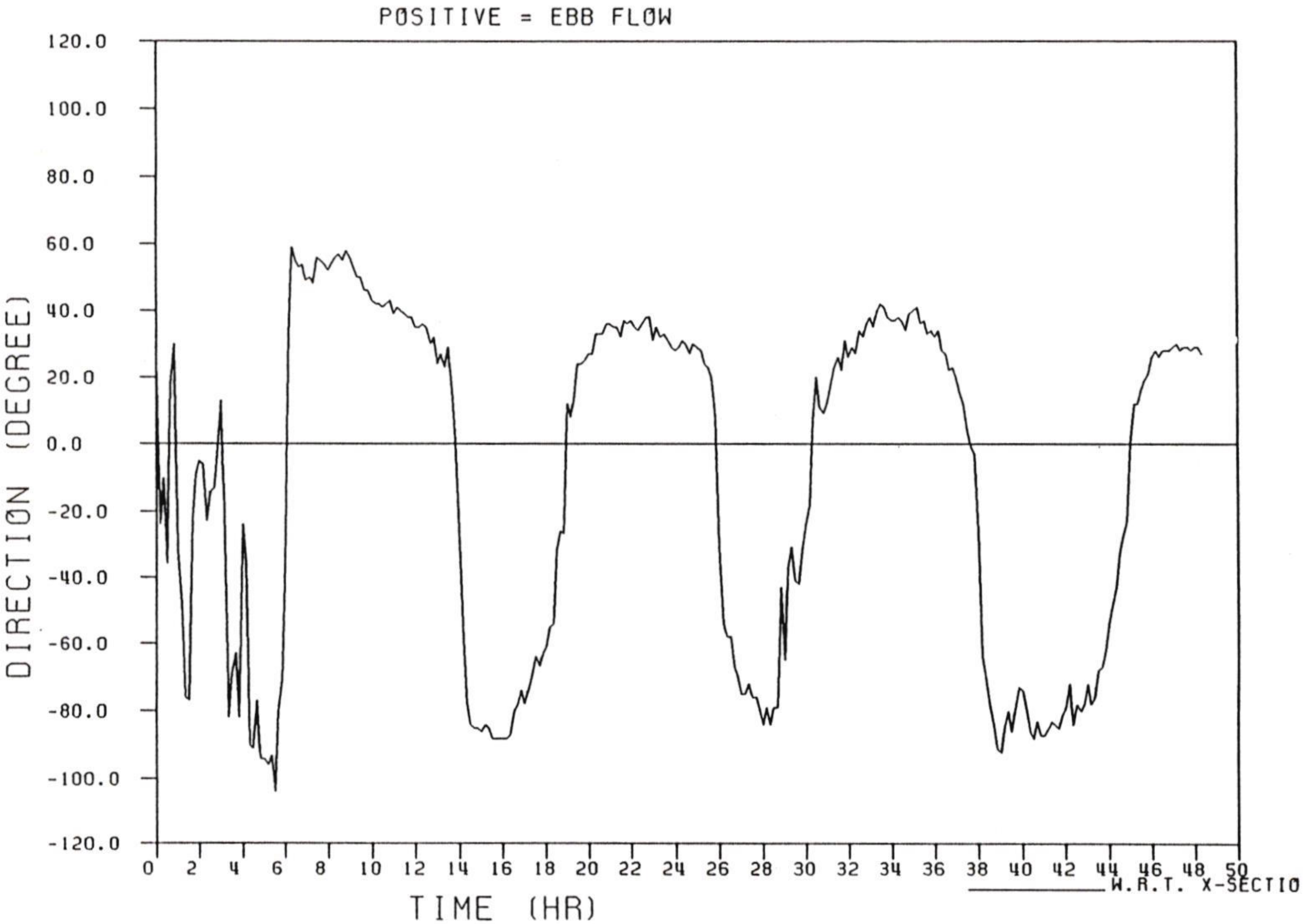
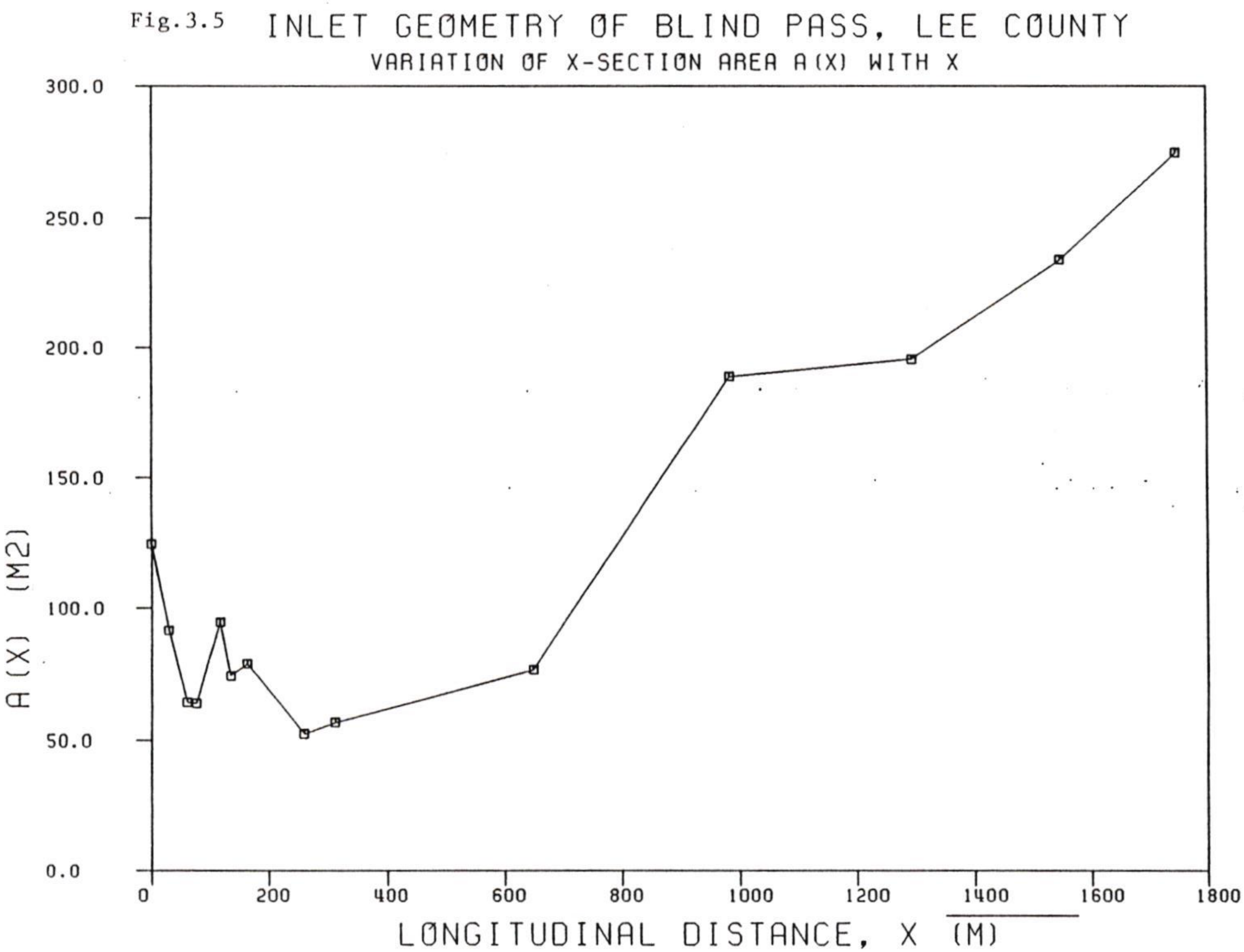


Fig.3.5



INLET GEOMETRY OF BLIND PASS, LEE COUNTY
VARIATION OF X-SECTION AREA A(X) WITH X
300.0
250.0
200.0
150.0
100.0
50.0
0.0
A(X) (M2)
0
200
400
600
800
1000
1200
1400
1600
1800
LONGITUDINAL DISTANCE, X (M)

Fig.3.6 INLET GEOMETRY OF BLIND PASS, LEE COUNTY

VARIATION OF MEAN DEPTH H(X) WITH X

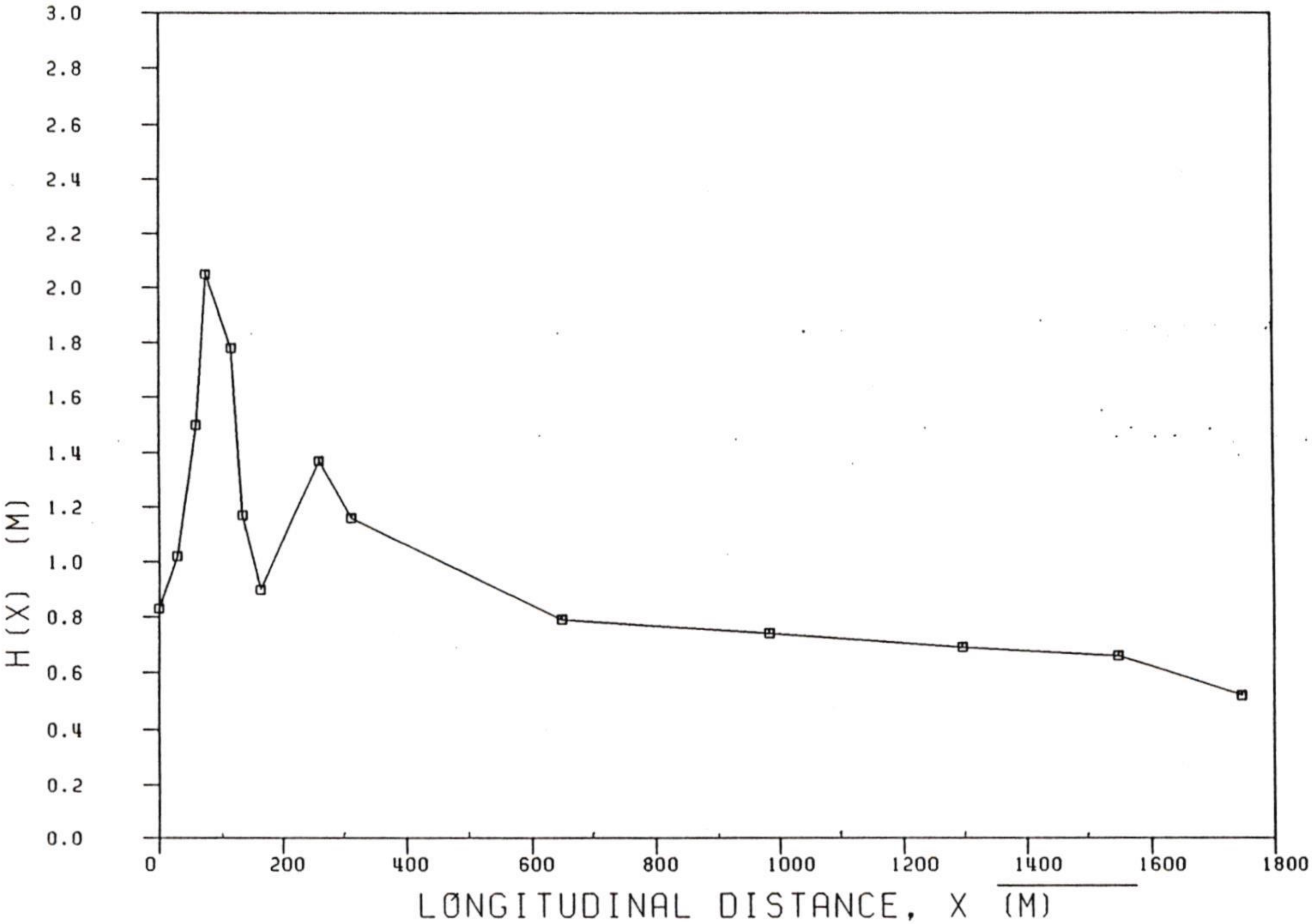


Fig. 5.1 Variation of Flow Area with Time
(Different Gulf Tide Ranges)

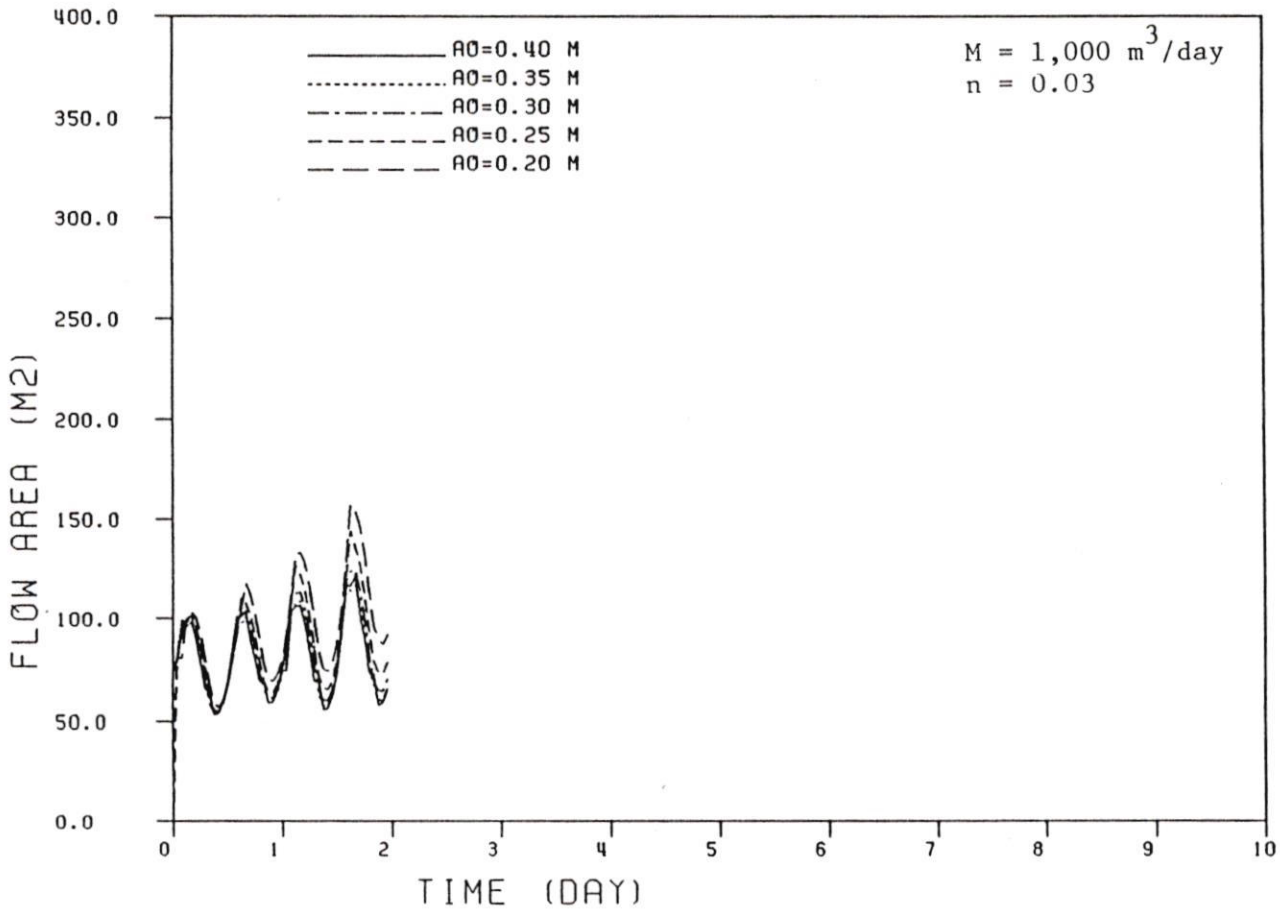


Fig. 5.2 Variation of Flow Area with Time
(Different M Values)

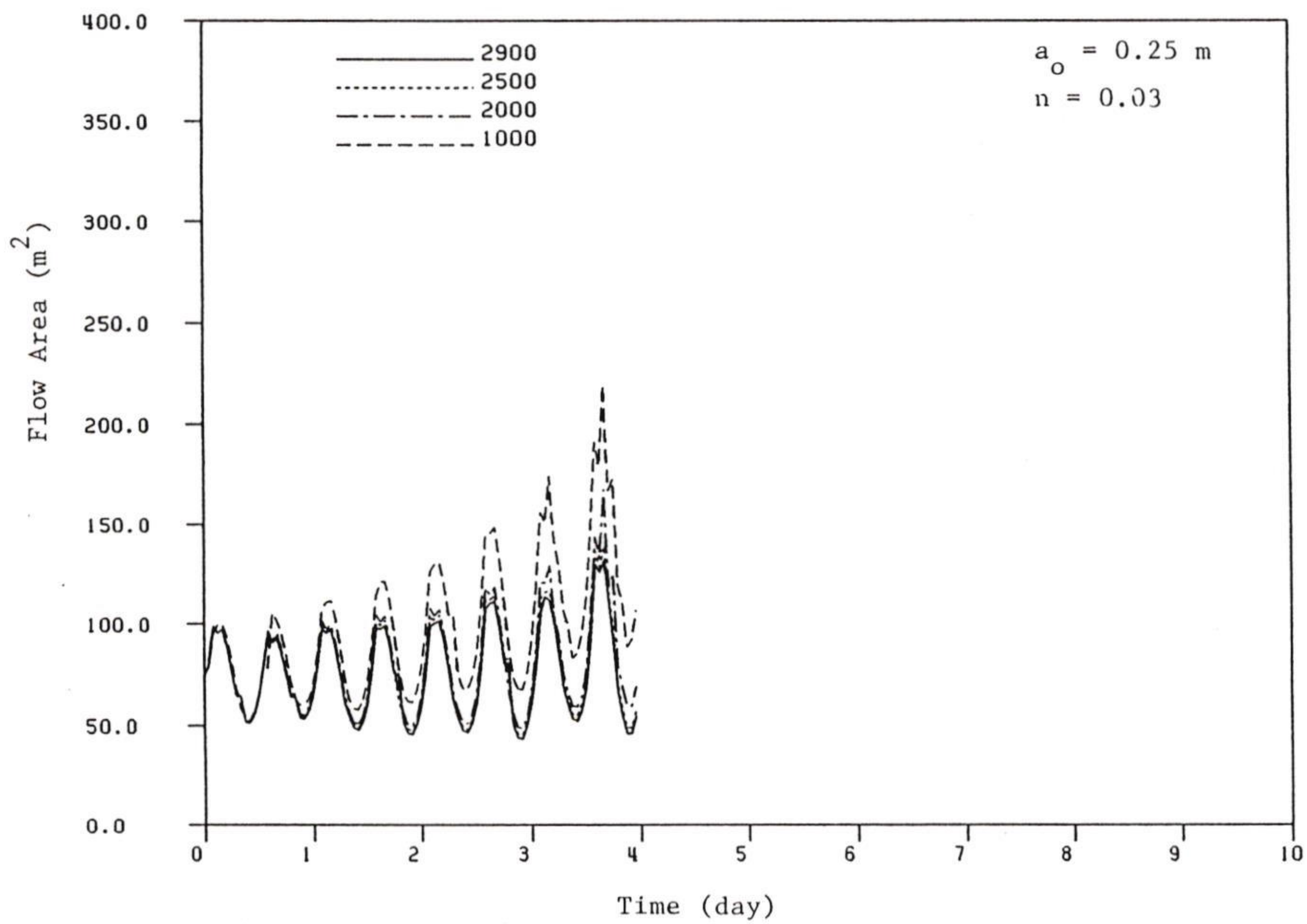
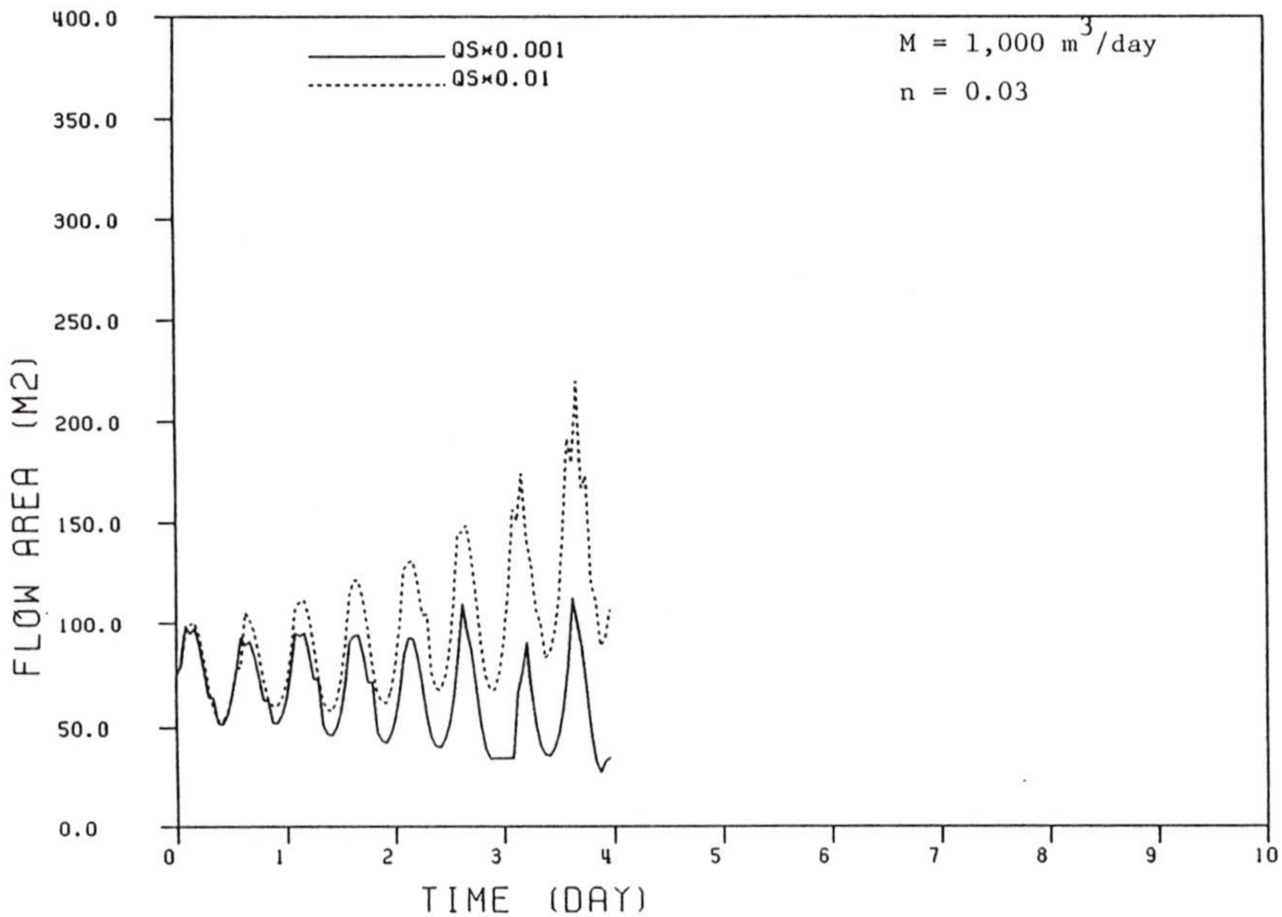


Fig. 5.3 Variation of Flow Area with Time (Different Q_s Reduction Factors)



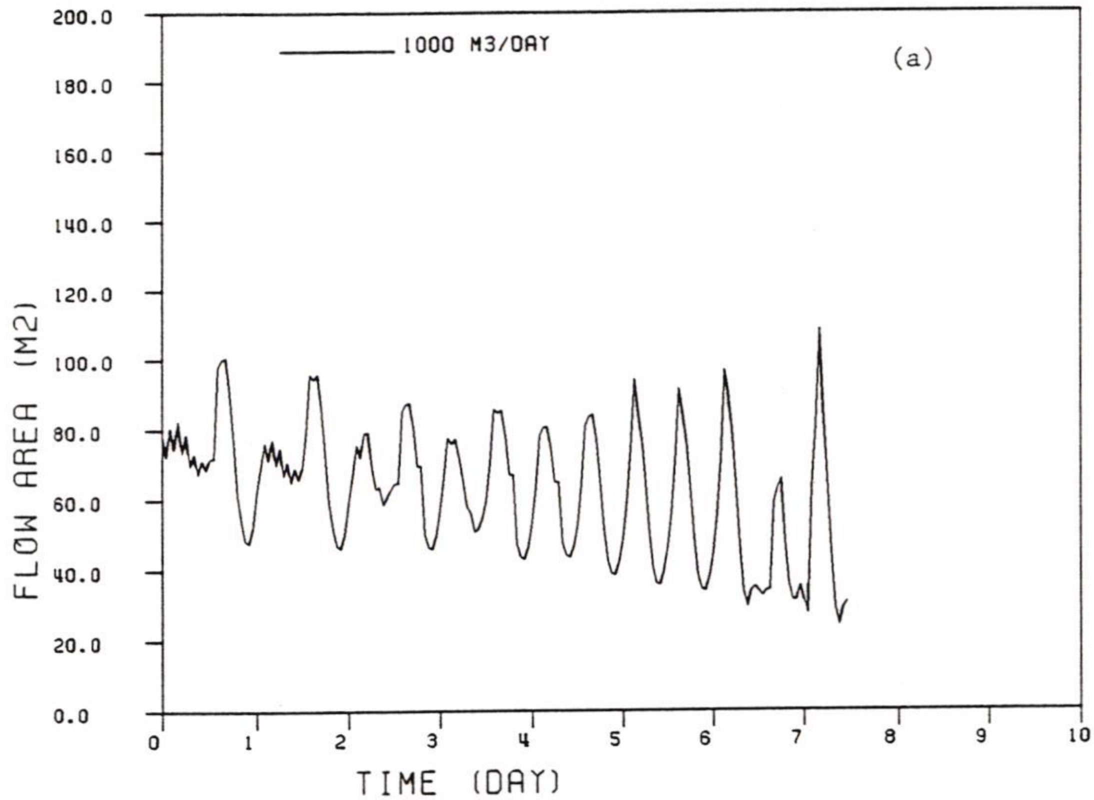
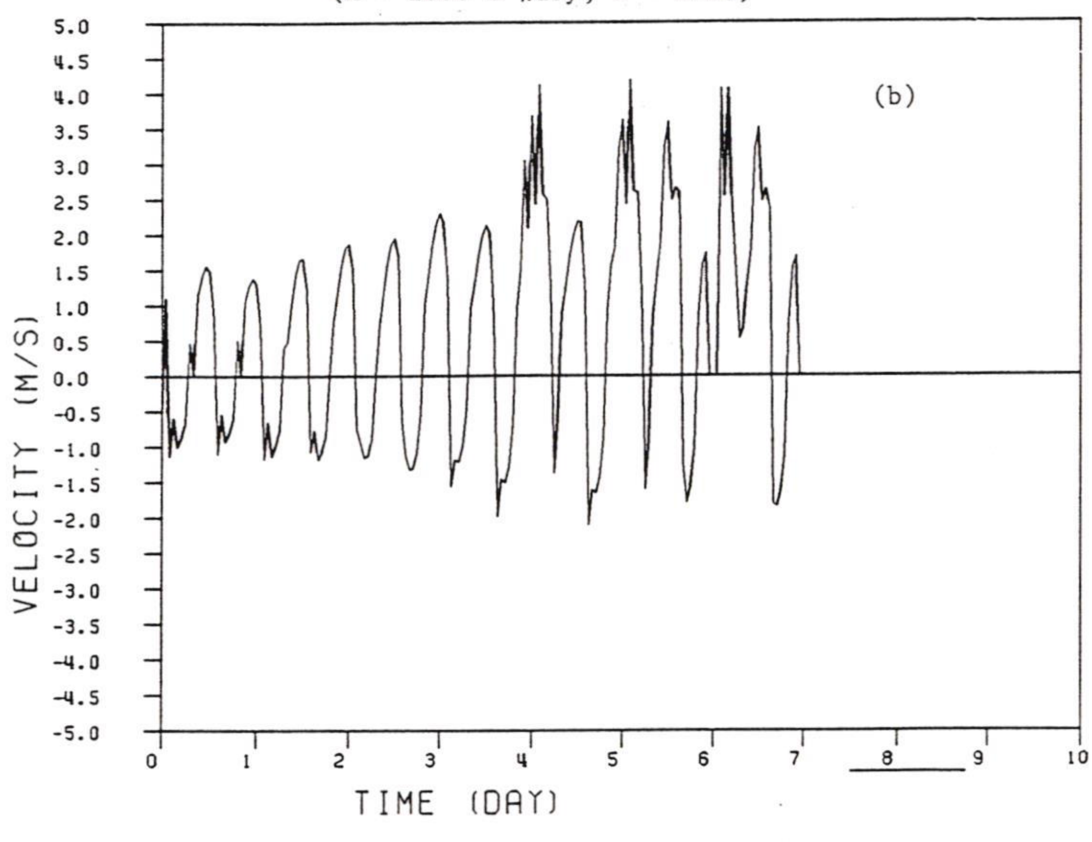


Fig. 5.4 Variation of Flow Area/Velocity with Time
($M = 1000\ m^3/day$; $n = 0.03$)



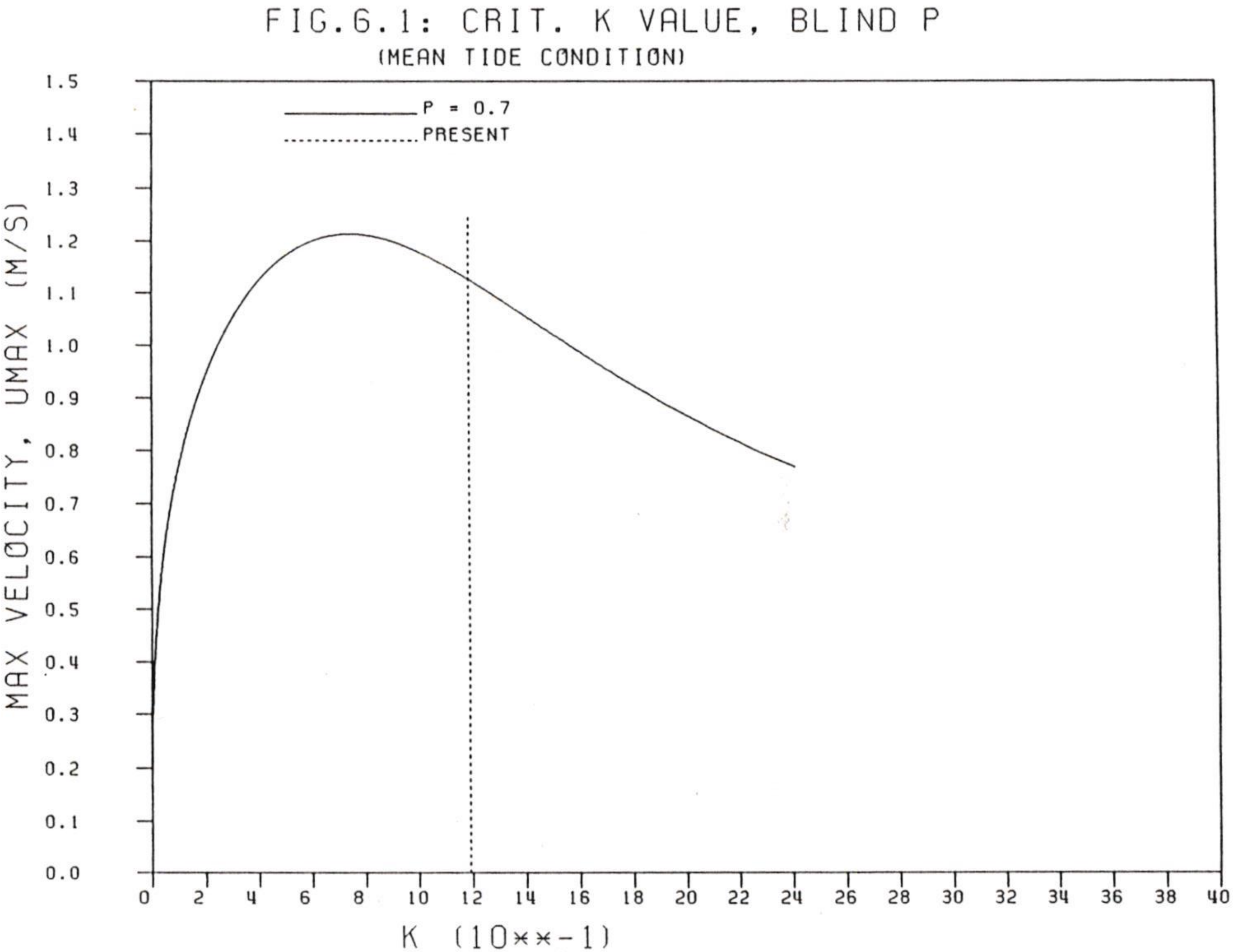


FIG.6.1: CRIT. K VALUE, BLIND P
(MEAN TIDE CONDITION)
P = 0.7
PRESENT
MAX VELOCITY, UMAX (M/S)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
K (10**-1)

FIG.6.2:CRIT. REPLETION COEFF., BLIND P.

(MEAN DIURNAL TIDE CONDITION)

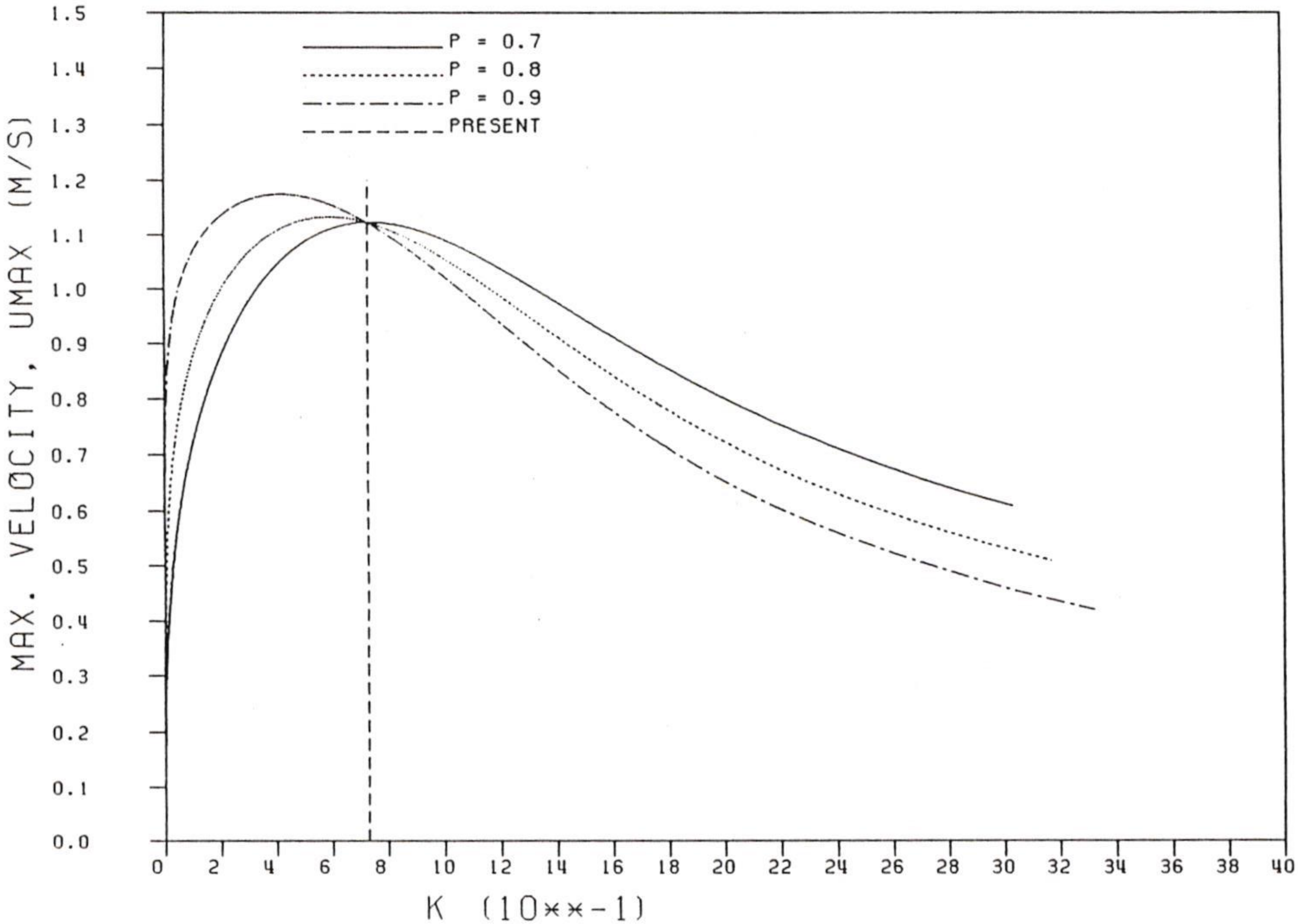


FIG. 6.3: STABILITY DIAGRAM, BLIND P.

(MEAN TIDE CONDITION)

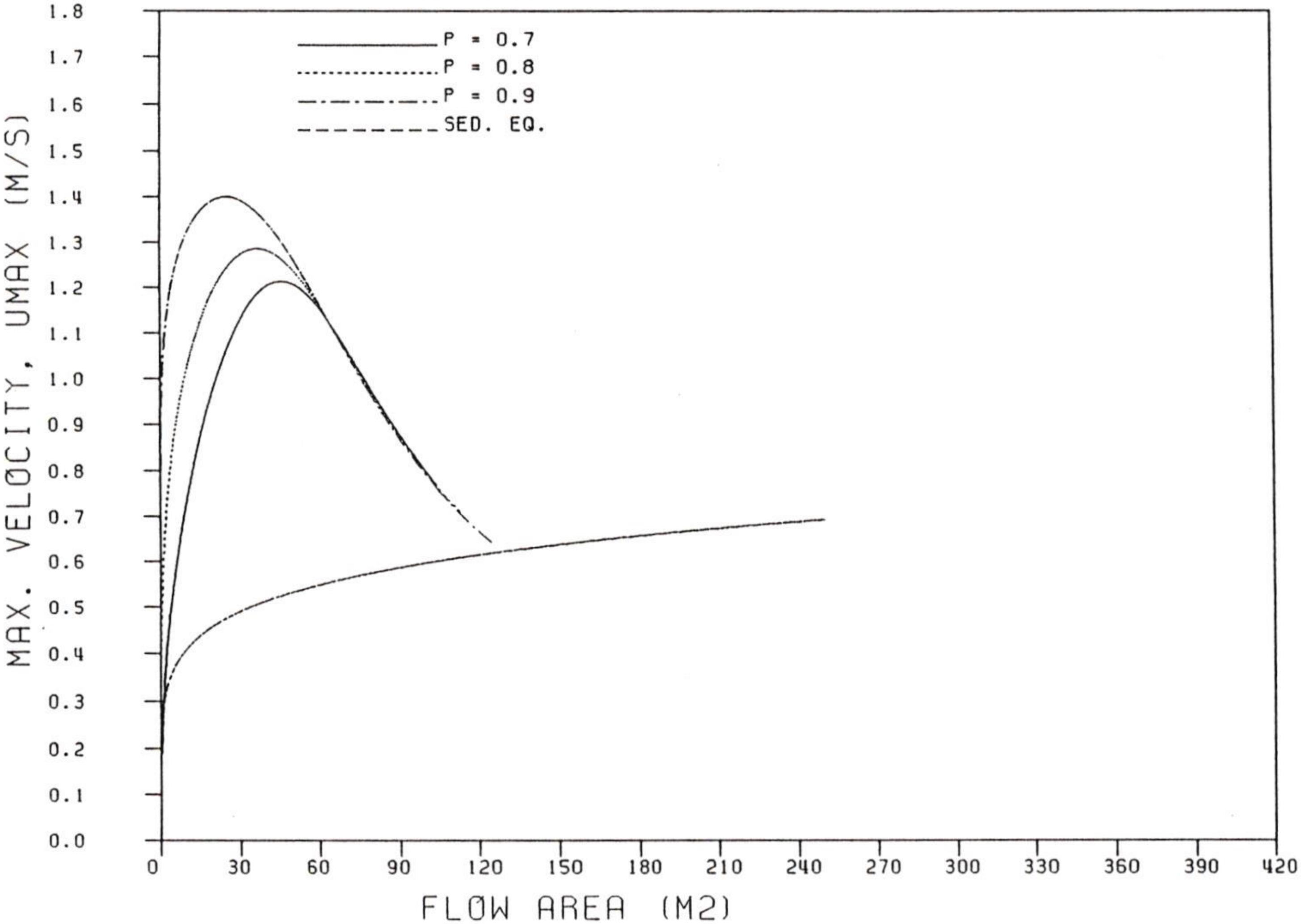
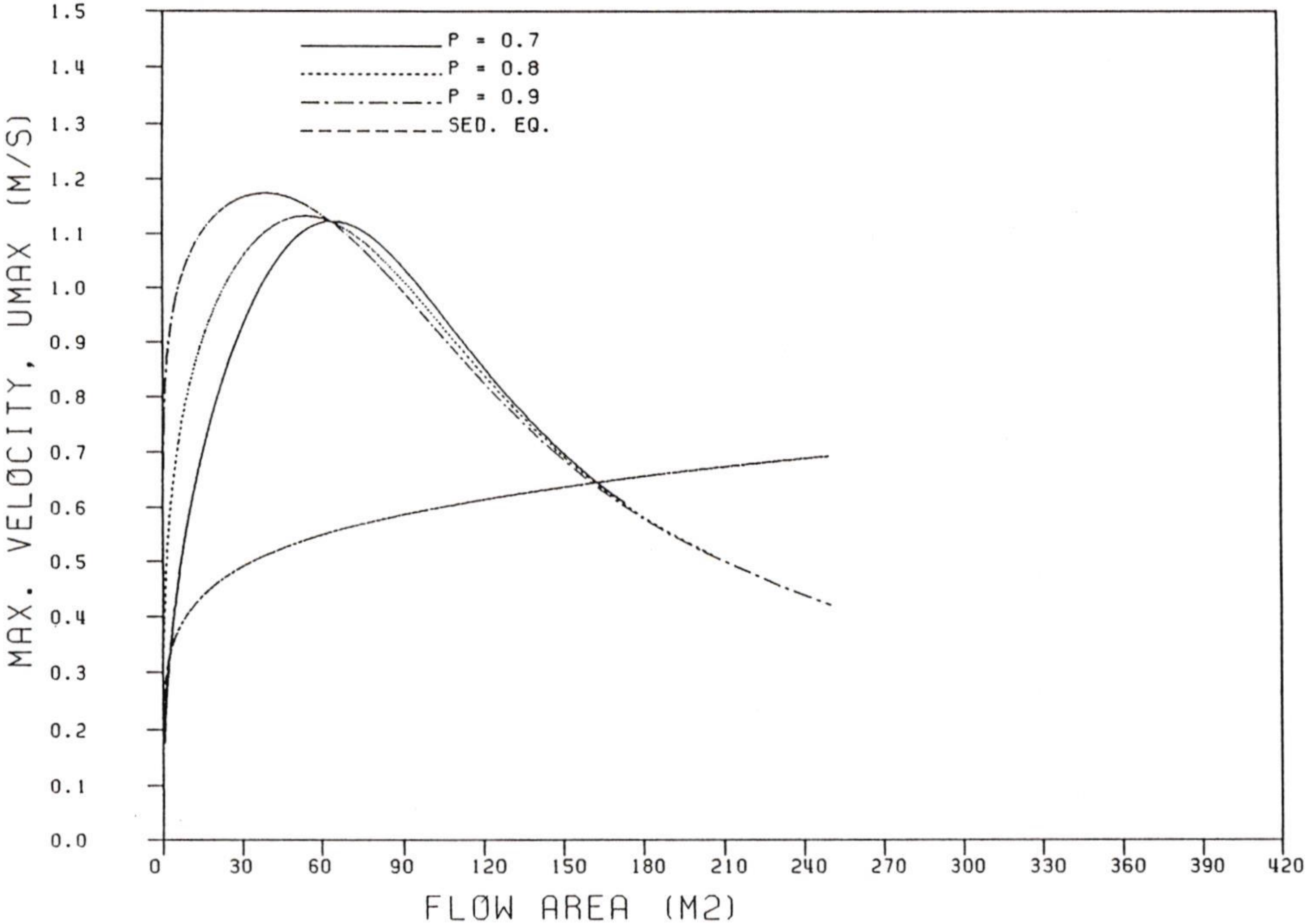


FIG.6.4: STABILITY DIAGRAM, BLIND P.
(SAME PARAMETER INPUTS AS MODELS)



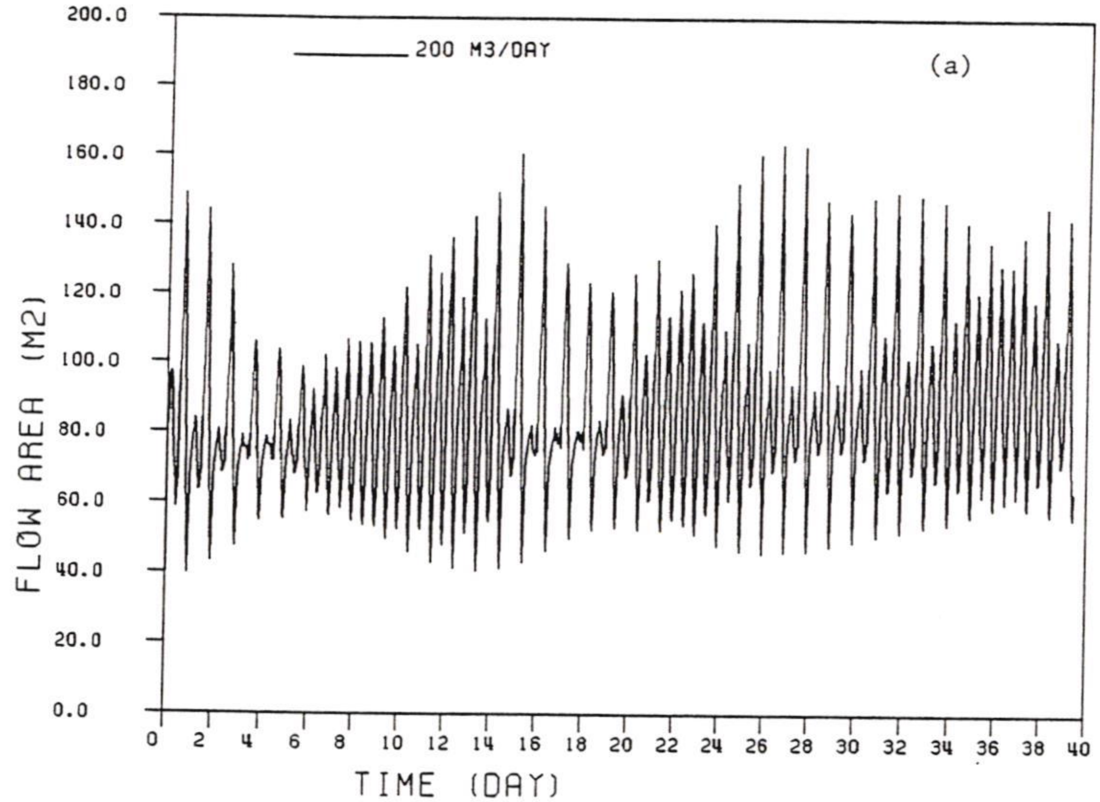
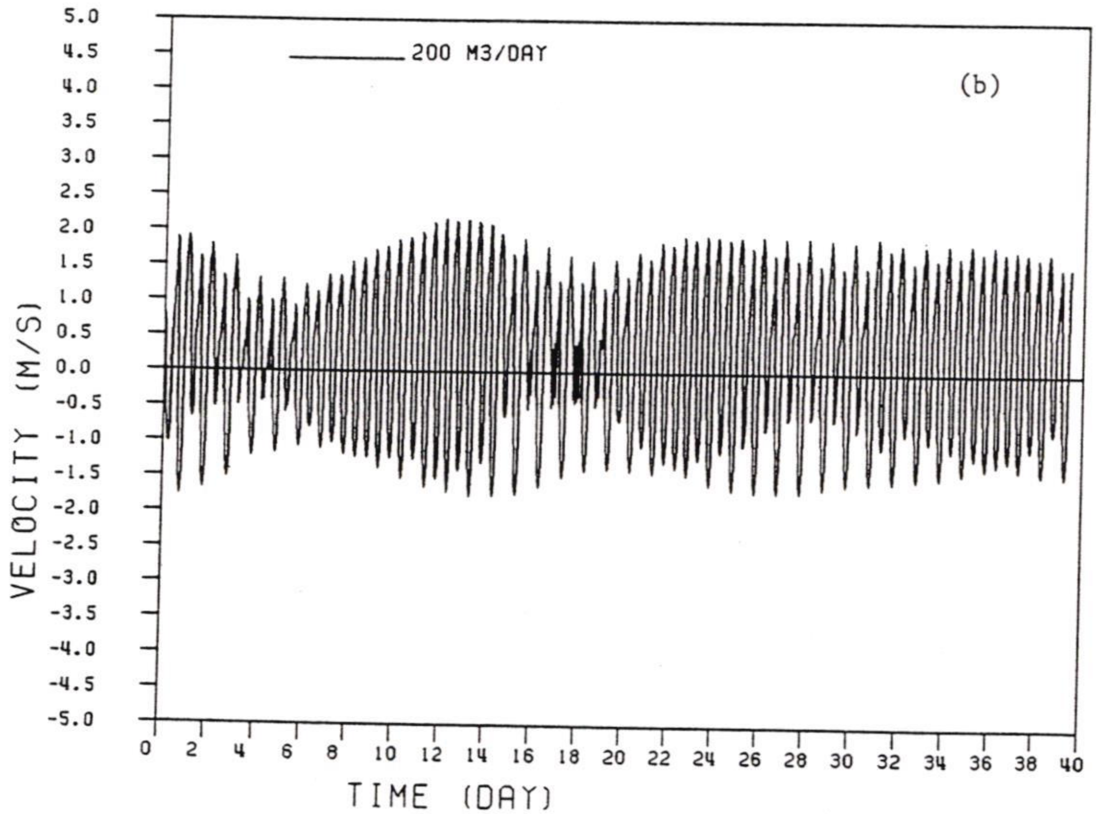


Fig. 6.5 Variation of Flow Area/Velocity with Time
($M = 200\ m^3$/day)



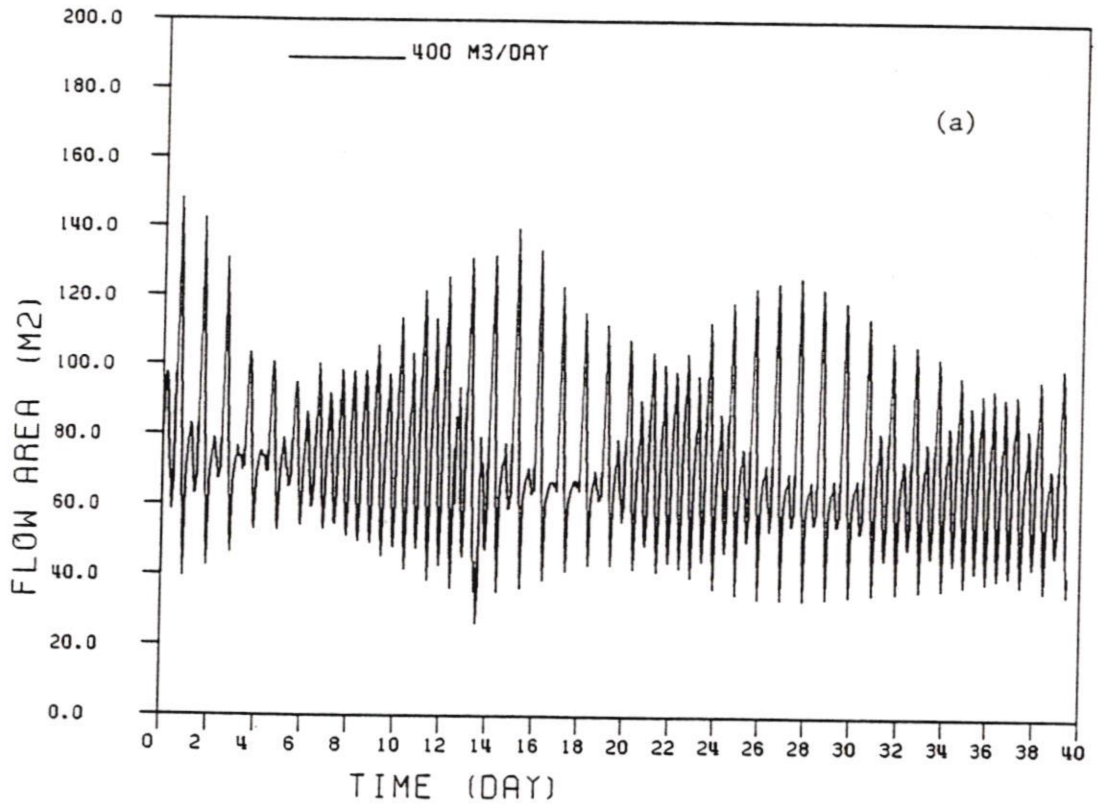
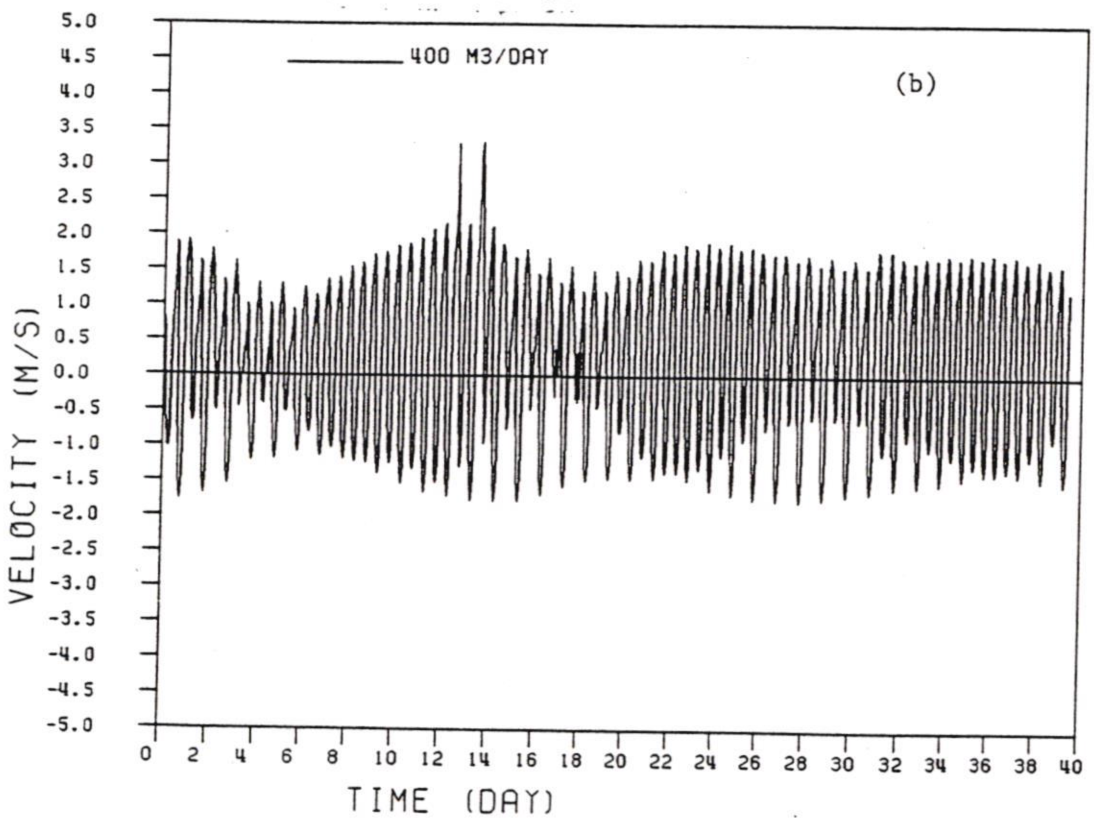


Fig. 6.6 Variation of Flow Area/Velocity with Time

($M = 400\ m^3/day$)



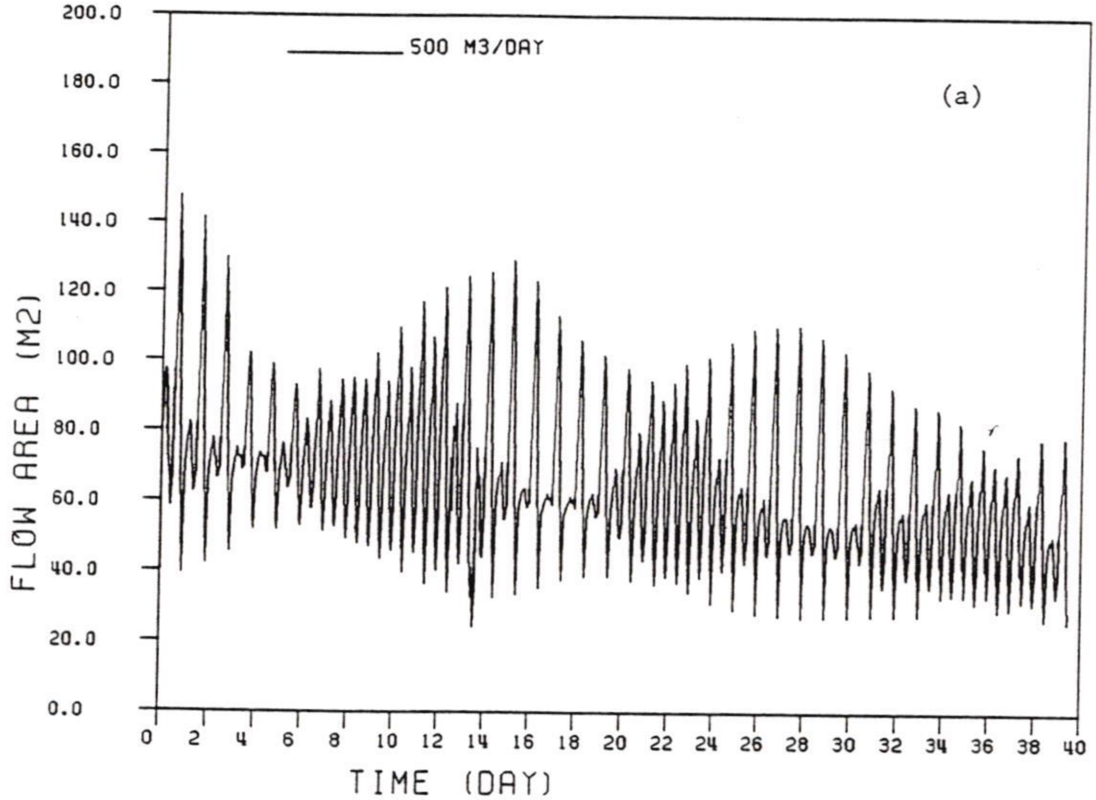
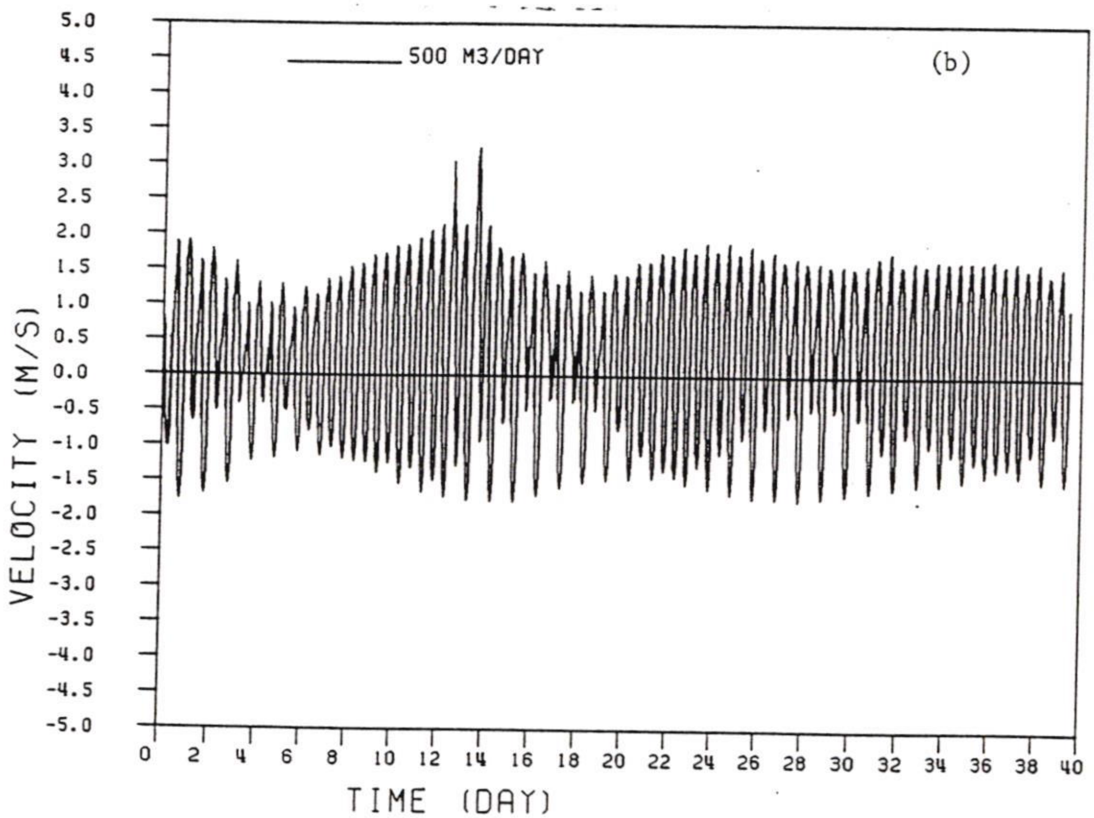


Fig. 6.7 Variation of Flow Area/Velocity with Time

($M = 500\ m^3/day$)



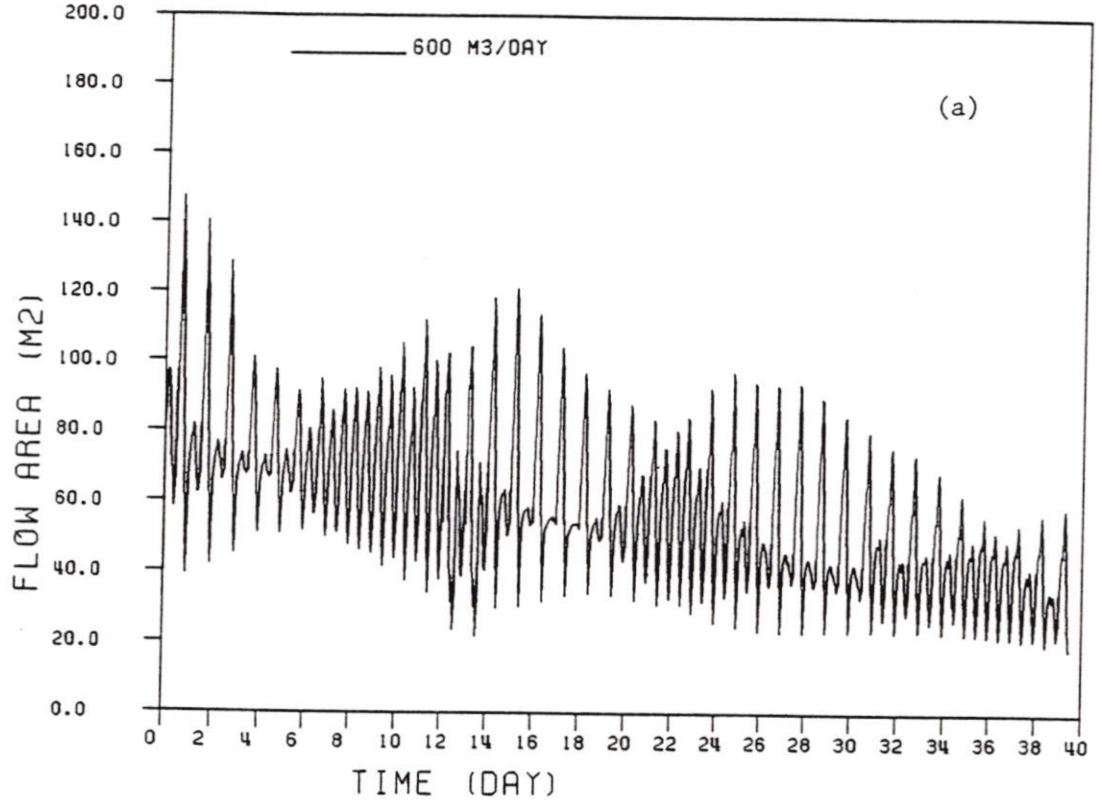
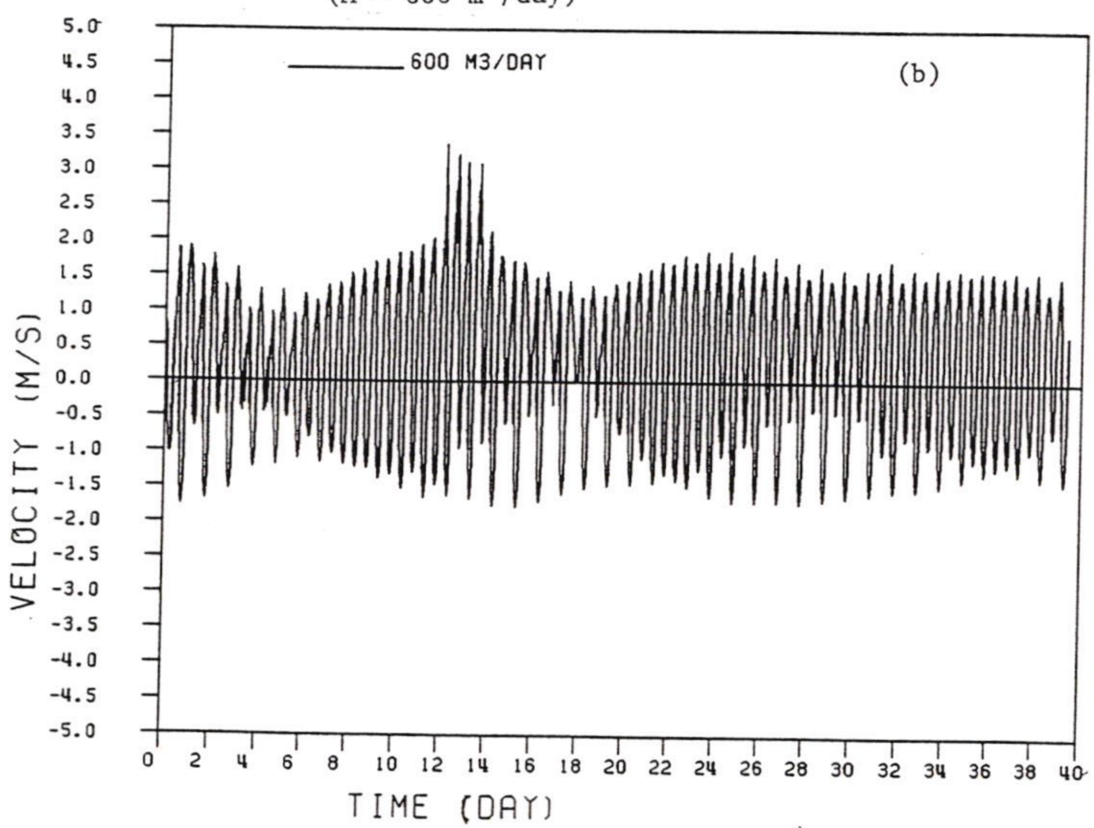


Fig. 6.8 Variation of Flow Area/Velocity with Time

(M = 600 m^3/day)



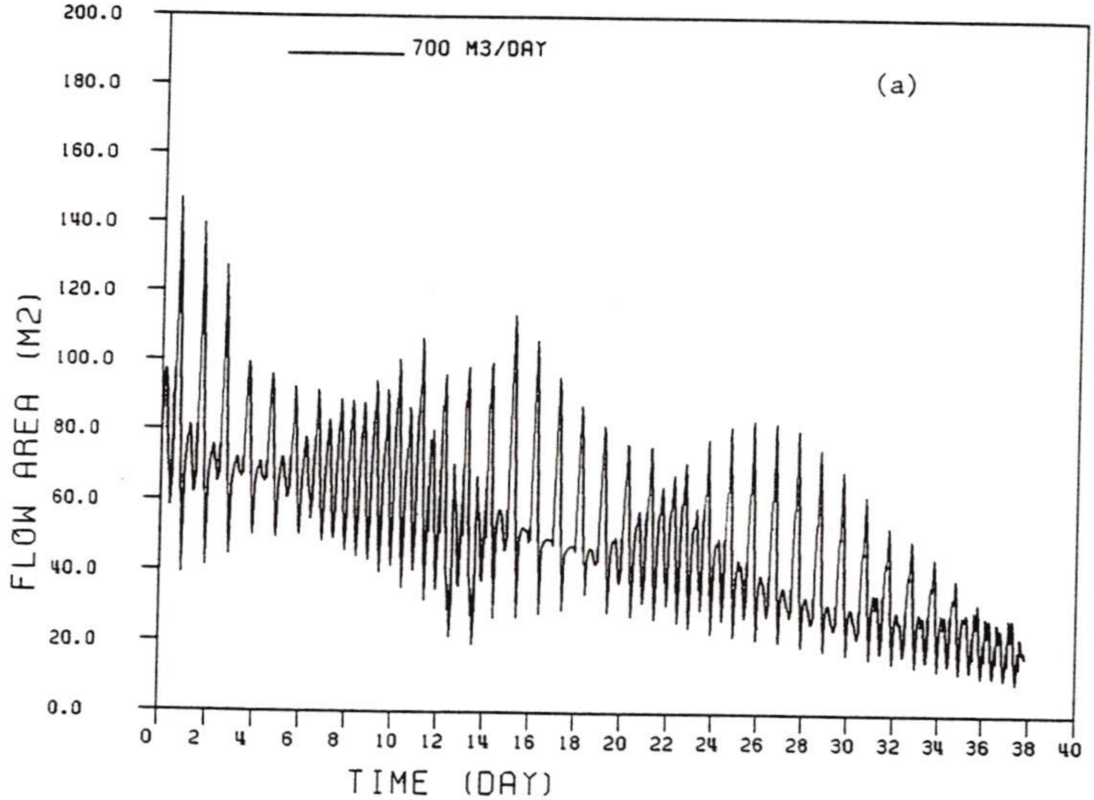
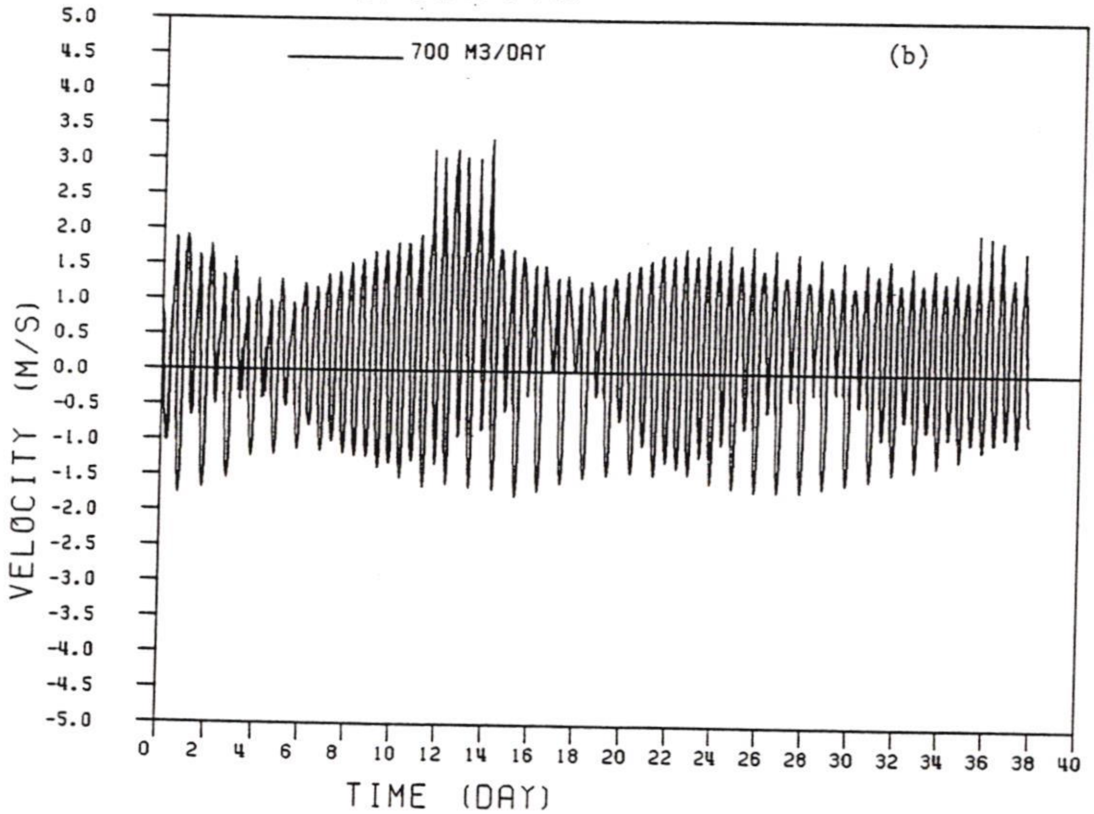


Fig. 6.9 Variation of Flow Area/Velocity with Time

($M = 700\ m^3$/day)



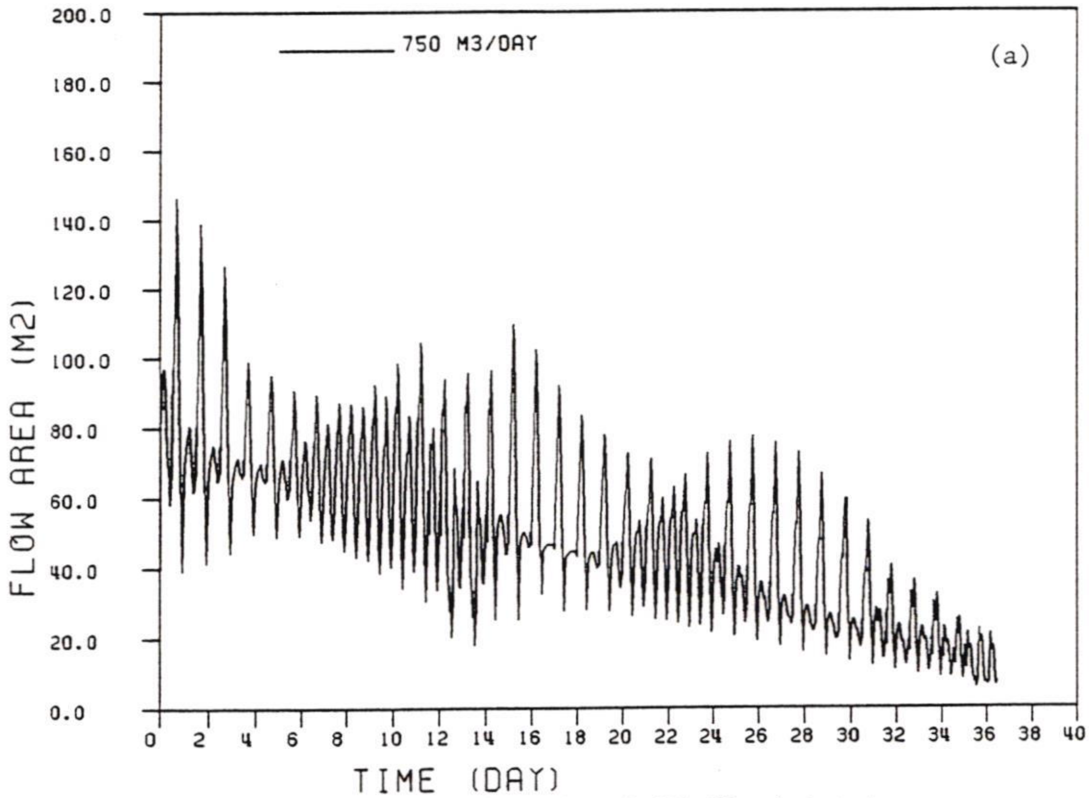
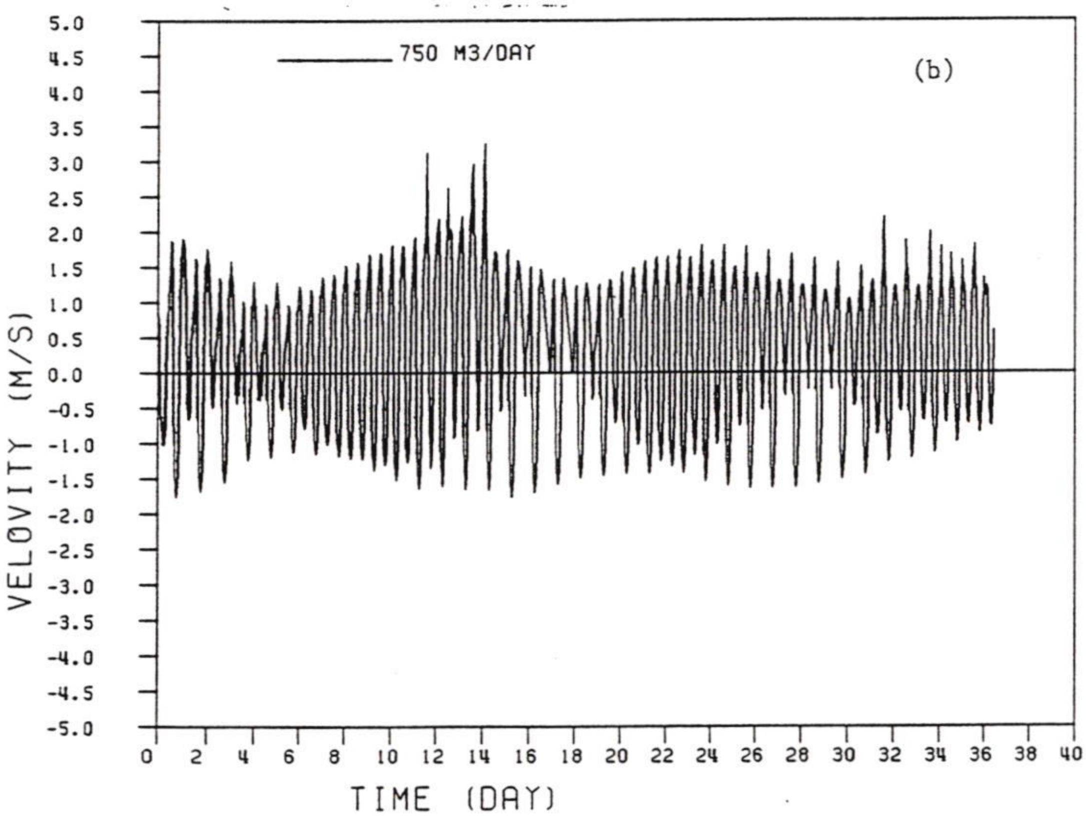


Fig. 6.10 Variation of Flow Area/Velocity with Time

($M = 750\ m^3/day$)



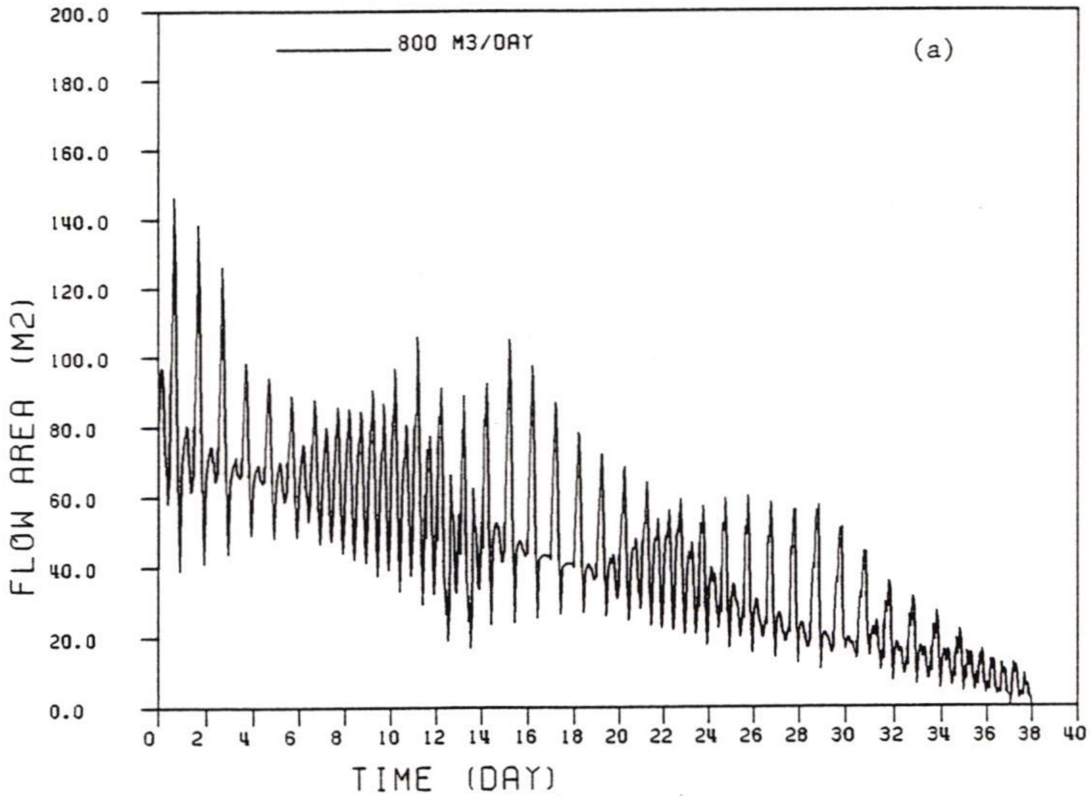
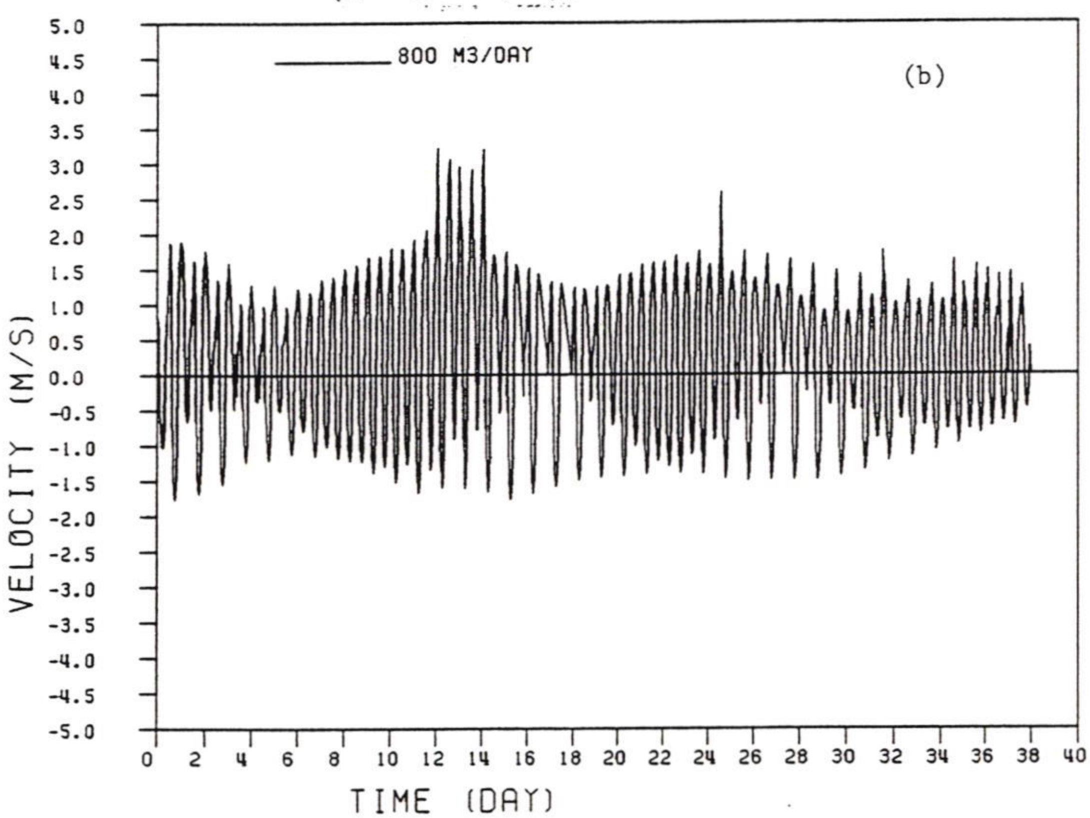


Fig. 6.11 Variation of Flow Area/Velocity with Time

($M = 800\ m^3/day$)



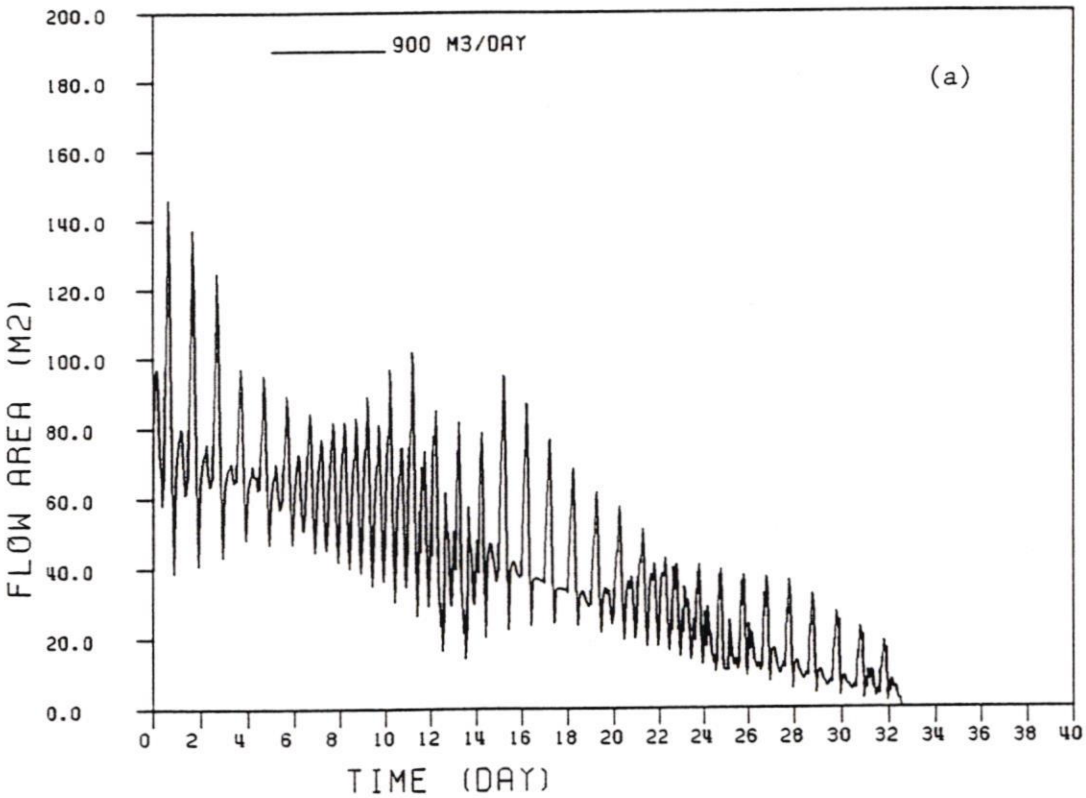
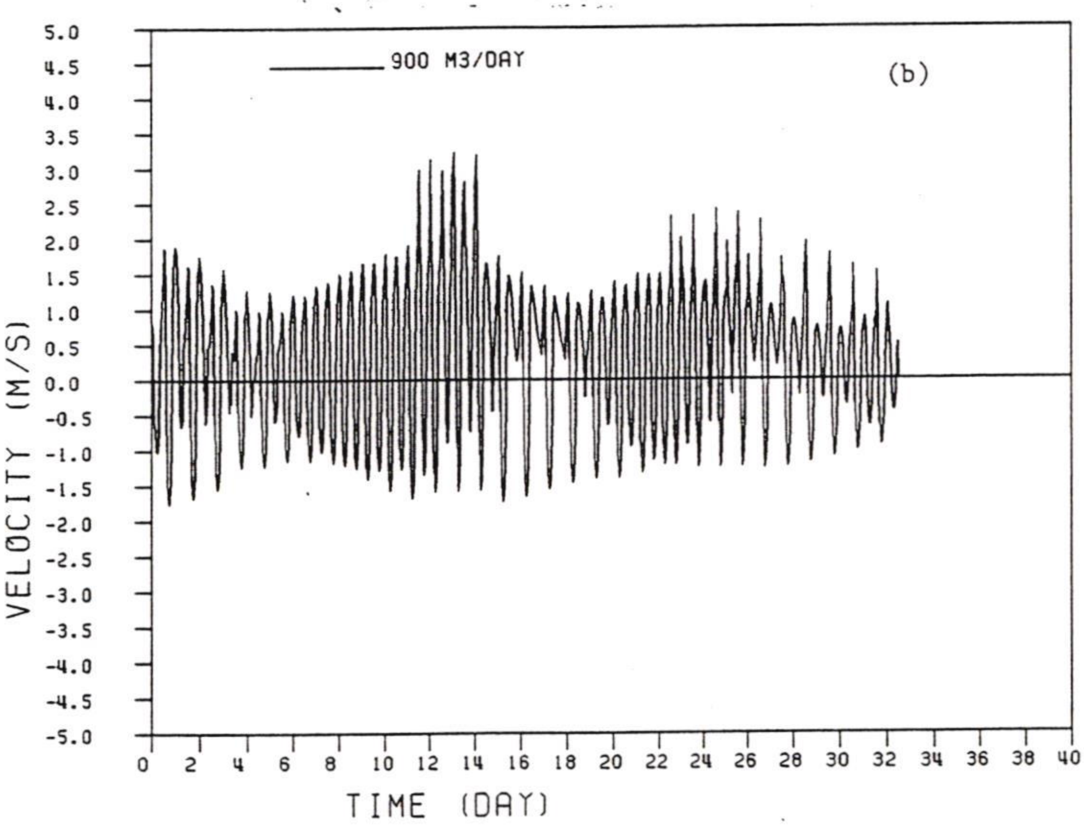


Fig. 6.12 Variation of Flow Area/Velocity with Time
($M = 900\ m^3/day$)



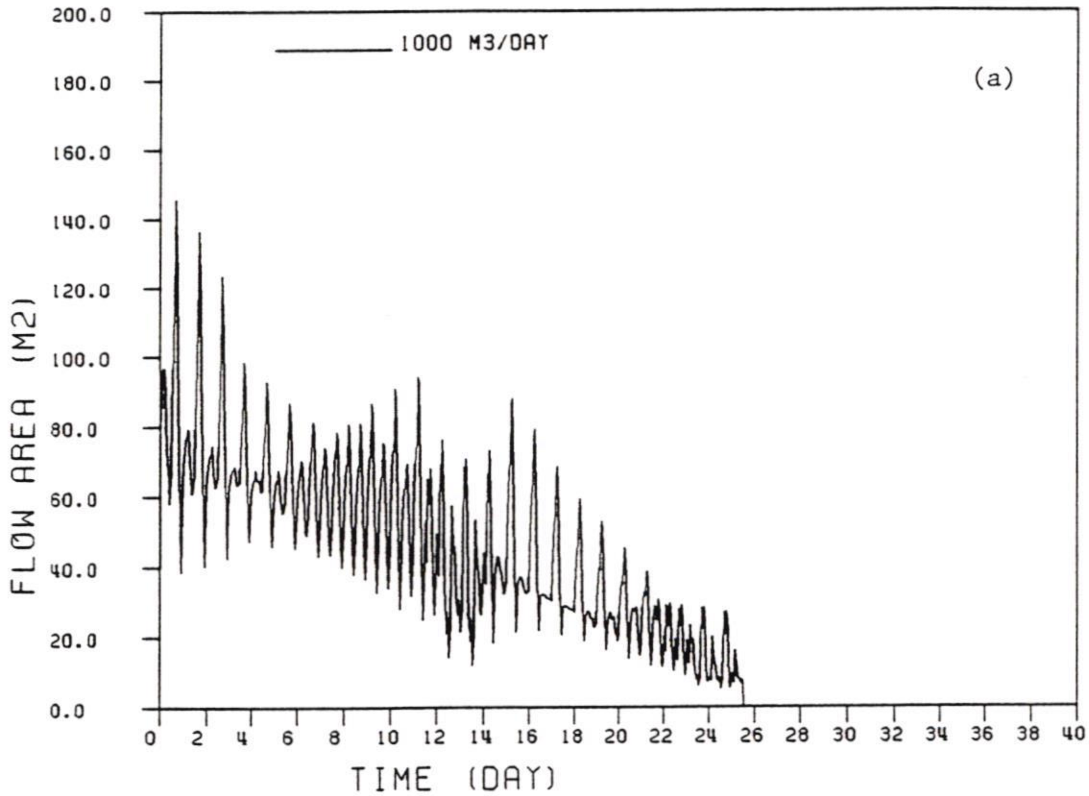
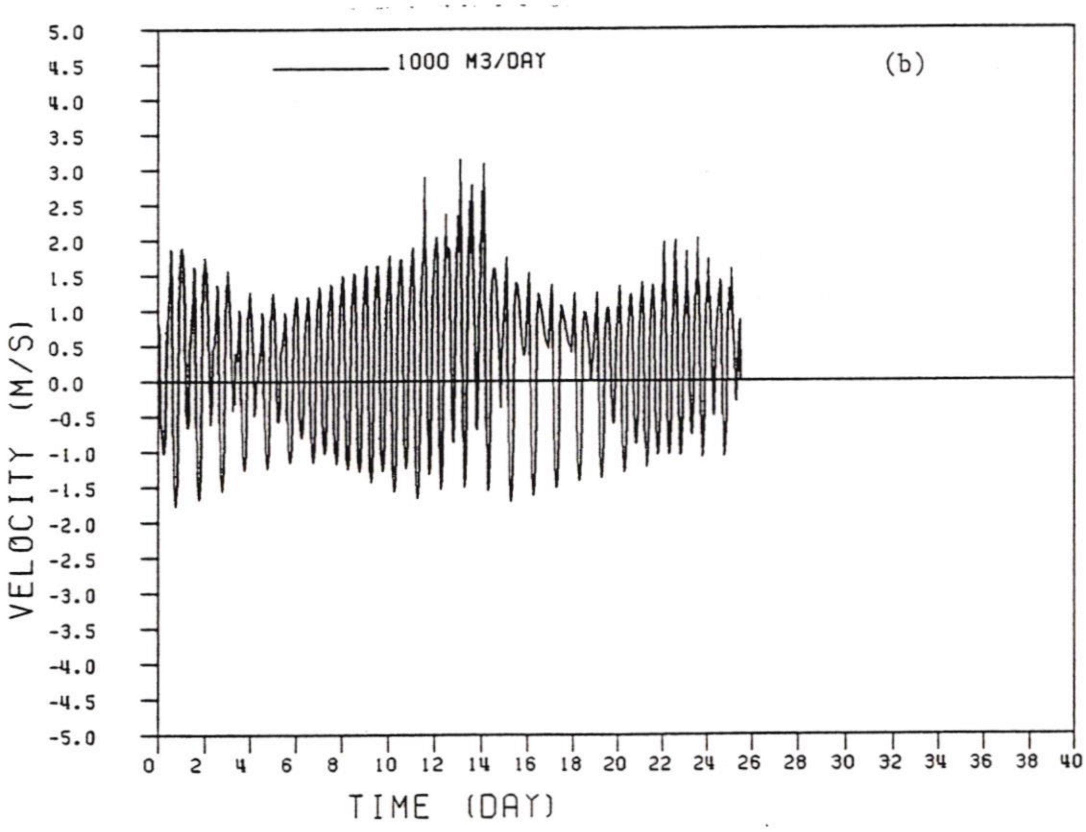


Fig. 6.13 Variation of Flow Area/Velocity with Time
($M = 1000\ m^3/day$)



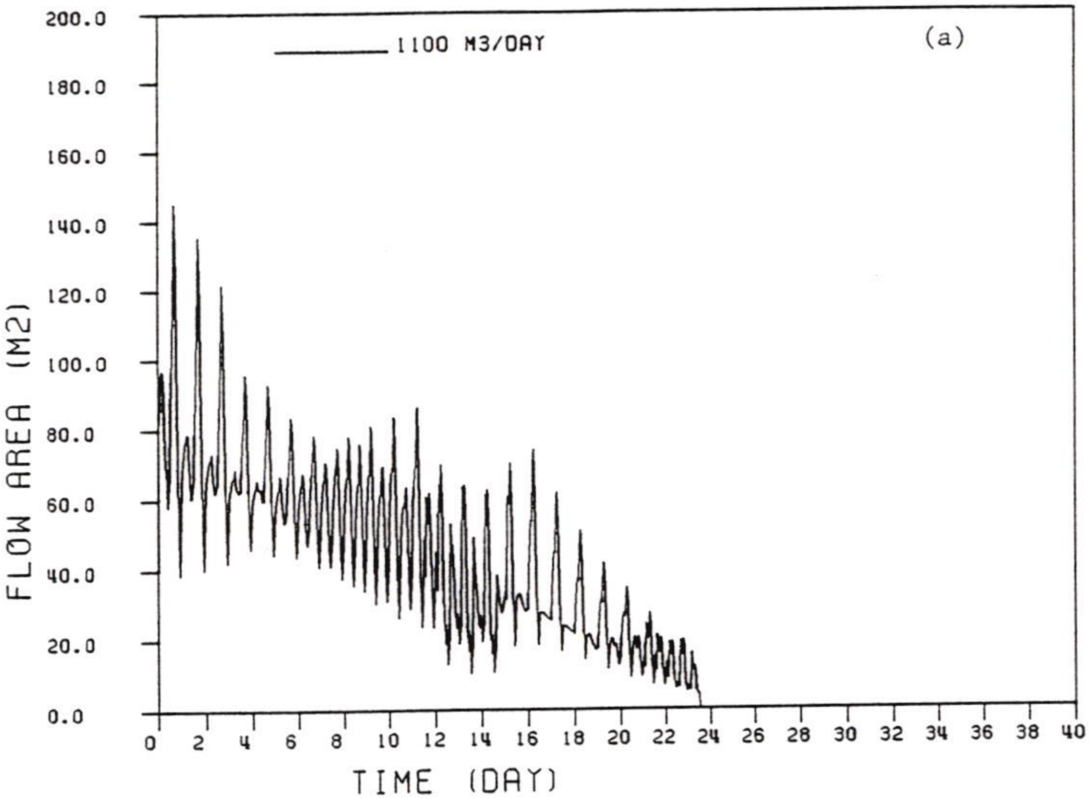
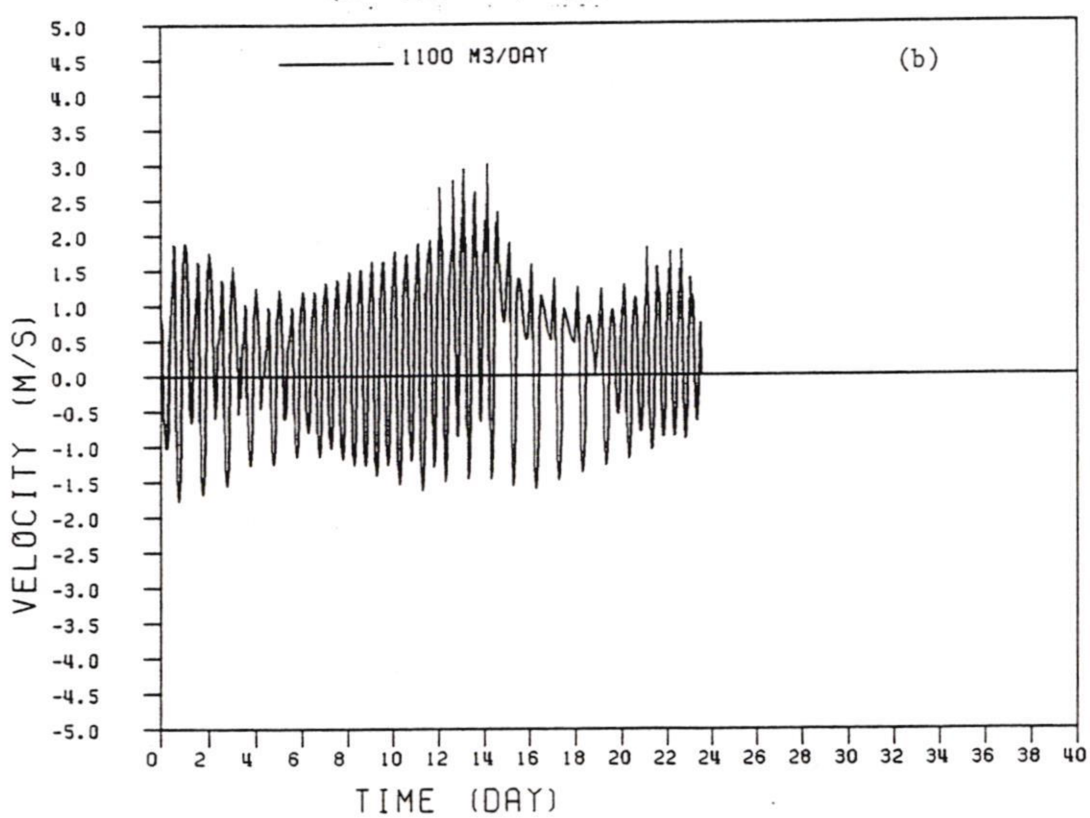


Fig. 6.14 Variation of Flow Area/Velocity with Time
(M = 1100 m^3/day)



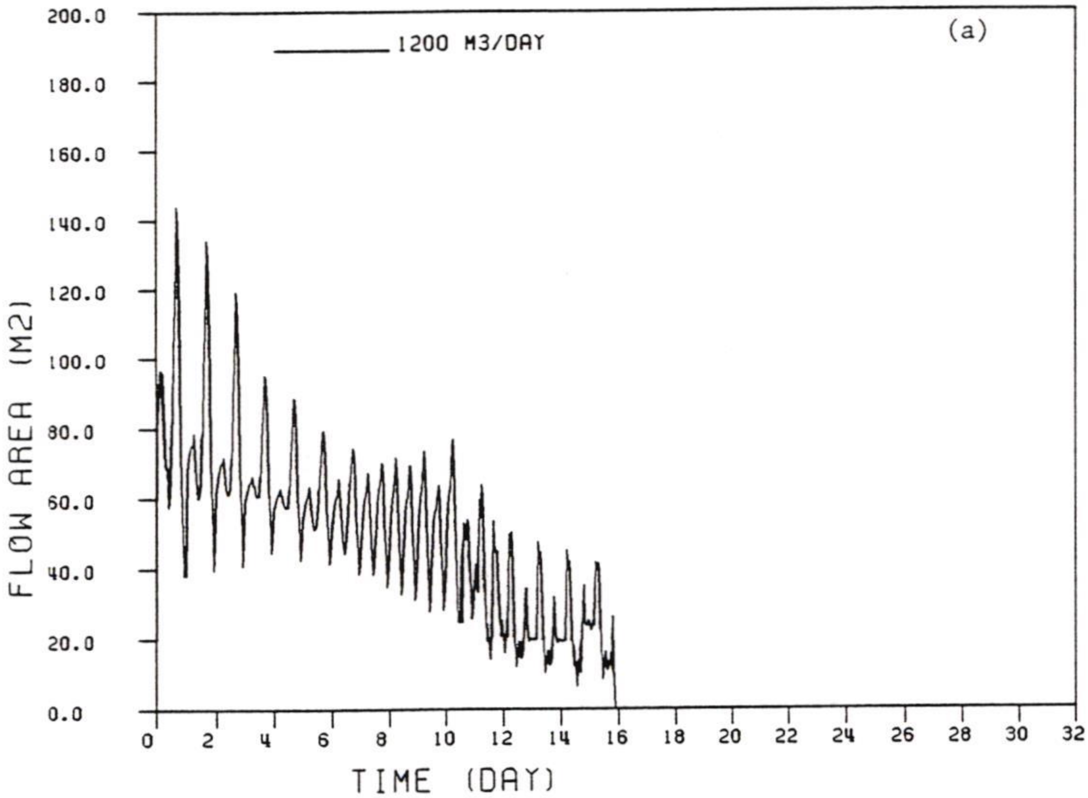
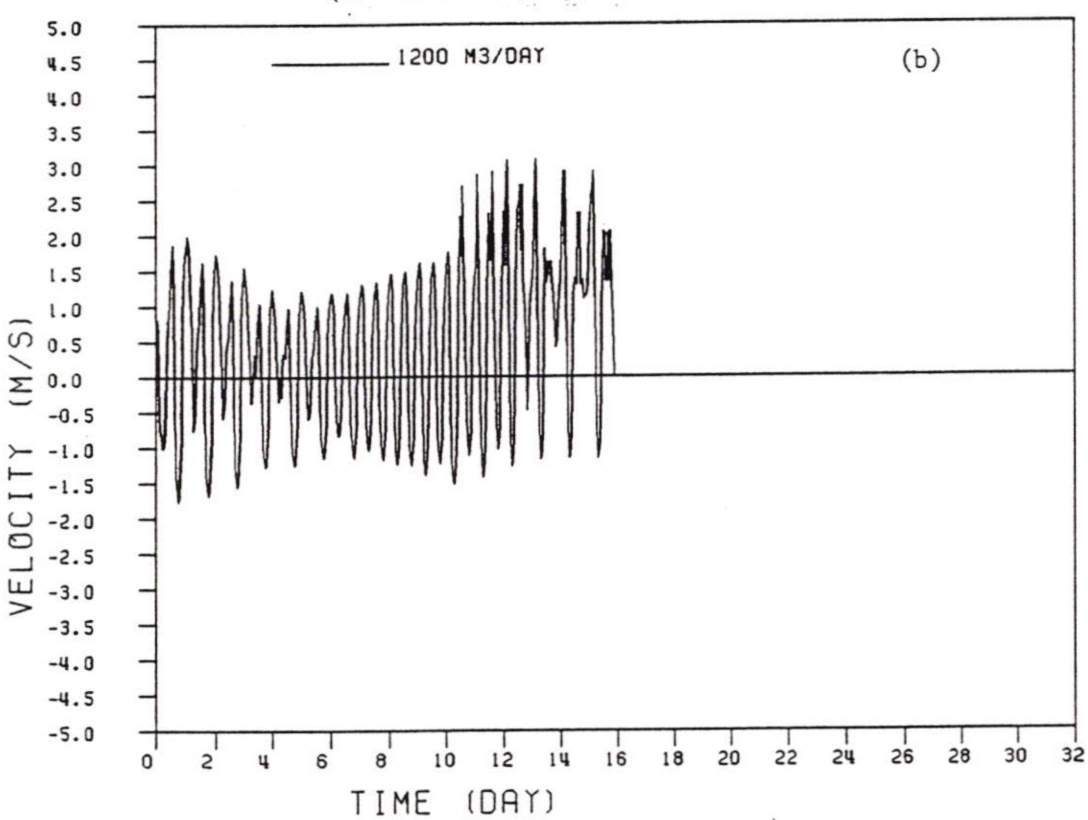


Fig. 6.15 Variation of Flow Area/Velocity with Time
($M = 1200\ m^3/day$)



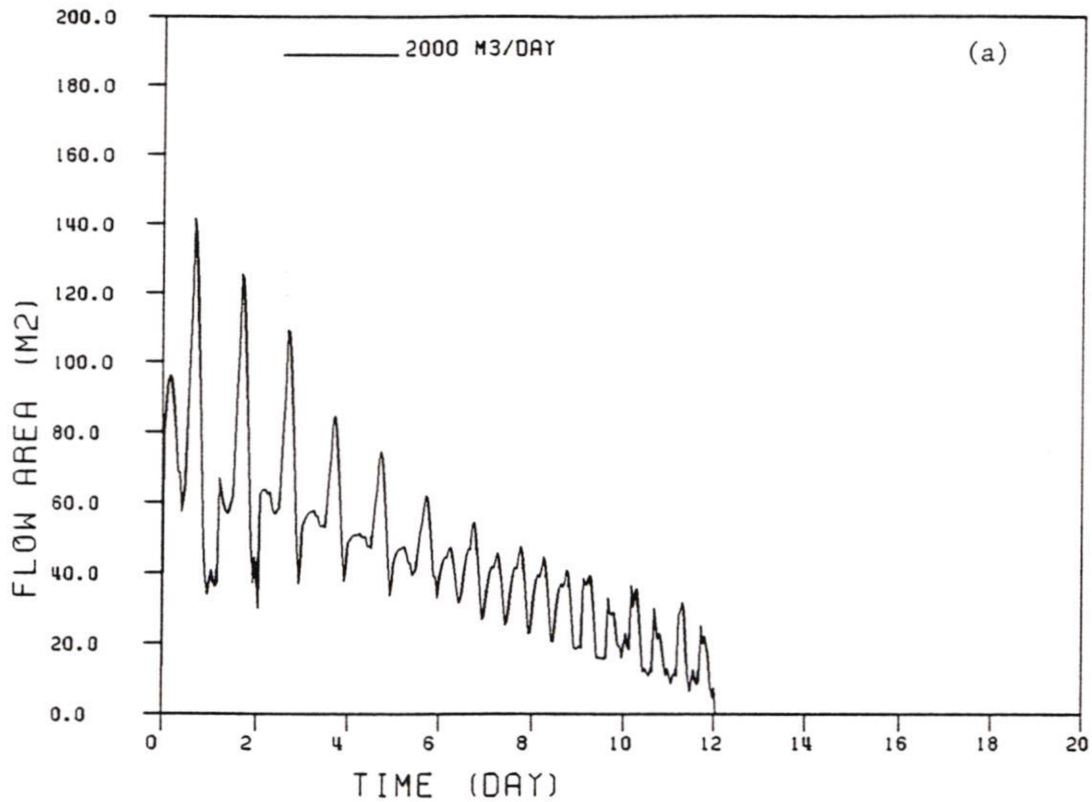
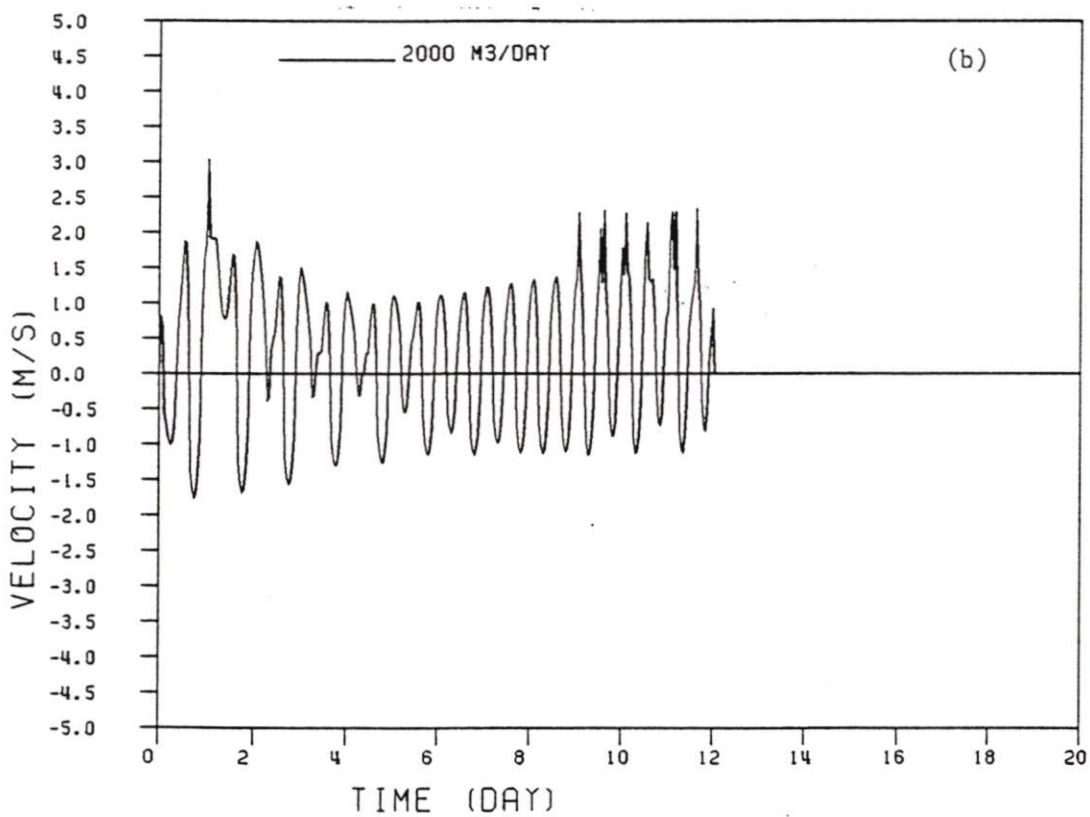


Fig. 6.16 Variation of Flow Area/Velocity with Time
($M = 2000\ m^3/day$)



APPENDIX F

PERTINENT CORRESPONDENCE

COASTAL PLANNING & ENGINEERING, INC.

COASTAL & OCEAN ENGINEERING
COASTAL SURVEYS
BIOLOGICAL STUDIES
GEOTECHNICAL SERVICES

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JACKSONVILLE: 1542 KINGSLEY AVENUE, SUITE 142E, ORANGE PARK, FL 32073 (904) 264-5039 TELEFAX: (904) 264-5039

8401.75

February 21, 1992

Mr. Ralph Clark
Florida Department of Natural Resources
3900 Commonwealth Boulevard
Tallahassee, FL 32399

Dear Mr. Clark:

I have received your comments on the Blind Pass Inlet Management Plan Interim Report No. 2. We have taken steps to address comments that we have received by revising Interim Report No. 2. Our response to your comments are as follows:

Page 29 - Alternative 1.a. - questions about flushing culverts.

> We agree with your concerns about flushing culverts. As a result of that, we have deleted flushing culverts from the plan. In place of these culverts we have left some of the fill out fronting Clam Pass Bayou area. This should recreate similar conditions that prevailed before extensive erosion took place in this area. It is expected that the pass will open and close periodically as has been the case historically.

Alternative 3 - to address your concerns.

> We do believe that removal of the jetty extension would cause Blind Pass to be less stable than it was before the beach nourishment project was constructed in 1988/89. On the basis of our analysis, our conclusion is that from 1955-1974 (for most of that time period there was no jetty at Blind Pass) Blind Pass was closed for most of that time. After the county groin was constructed in 1972, sand quantities were reduced from 68,000 to 38,000 cubic yards per year. The inlet closed in 1977 and was reopened by the "No Name" storm in 1982 during that period. Therefore, with 38,000 cubic yards moving past Blind Pass, it appears to be closed about a third of the time. If the jetty extension were removed, sand quantities leaving Captiva Island would greatly exceed the rates experienced from 1955-1974. During most of that time period the inlet remained closed. That is the basis of our evaluation and conclusion that the inlet would be closed without the jetty extension if the beaches of Captiva were continually nourished.
>
> We do not consider beach fill removal on Turner Beach and transferring that sand to northern Sanibel as feasible. This would create an eroded condition of the beaches at Turner Beach and make the hurricane evacuation route vulnerable to storm damage on the northern approach road to the Blind Pass bridge.

If this alternative were implemented, one source of funds could be the surety bond, as you suggested, to have the groin extension removal funded. The source of funds is beyond the intent of this particular section of the report which deals specifically with feasibility. The surety bond is a consideration in the sections concerning funding.

Alternative 4

Alternative 4 would likewise affect the stability of Blind Pass at a point further offshore. Based on a study by Dr. Mehta, we have concluded that the longer jetties have added to the stability of the inlet, making the inlet more capable of handling higher sediment loading. Therefore, under alternate 5, sediment transport would be higher, but the inlet would be more hydraulically capable to handle the extra sediment load and be less likely to close.

Alternative 6

Although this option is much lower cost, it is felt that it would allow erosion of northern Sanibel to continue unabated. At some point in time the erosion would impact other structures and eventually the rerouted evacuation route. For this reason, we don't feel this alternative is viable. Based on your comments, we have added additional discussion to alternative 6 which addresses these concerns.

Alternative 7

We had not viewed Alternative 7 as a desirable option because we felt that it allowed the beach to erode totally away. The shoreline opposite the road would be a hardened shoreline and the beaches south of the revetted area would continue to erode. However, this option does indeed solve the storm protection problem for the evacuation route and removes a number of structures from the surfzone area. We have modified the write-up of this section to remove the term "not desirable option."

Alternative 9

We have added a sentence to the discussion of this option indicating that the option does not achieve the sand bypassing and erosion control goals of the program.

Alternative C.1.

We believe that the implementation of a sand bypass system with a crane on a public beach area would inhibit the use of the public beach. Also, it is our finding that dredging sand from the beach at Turner Beach would provide for a narrower beach most of the time. We don't feel that the concerns are biased to the beach on Captiva Island.

Alternative C.3.

We have modified Alternative C.3. to include your concerns about the experimental nature of the dewatering project and DNR's possible requirement that the experiment wait the outcome of the Fort Pierce installation.

Comments on Page 52

We have changed the recommendations on D.3. to a maybe so it will be considered further as you suggested. Alternatives B.6. and B.7. are also changed from no to maybe in recommendations. Alternative C.3. remains a maybe, however, the concept of waiting for the Fort Pierce installation to prove valid is included in the text.

Comments on Inlet Closure

The text has been modified to address your concerns. We still feel, however, that permanent closure of the pass would lead to degraded water quality within the waters of the pass and possible reduction of water quality in portions of Pine Island Sound.

Comments on Page 57 - 3.

See our response to your comment on page 37.

Comments on Page 59

Our comments on the environmental acceptability of dredging the shoal assumes a small dredge would be used. While it may be true that mechanical transfer of sand is possible from these shoals, we still feel that the feasibility of using this limited source of sand doesn't warrant further consideration.

Comments on Page 62

Currently we don't know what the impacts of dewatering are on the infauna community off of Sailfish Point. By copy of this letter I am requesting that our environmental department investigate this matter further and report back to me.

Comments on Page 67, Paragraph 5

It is quite possible that the county groin impacted the beach while the groin extension does not impact the beach. That is because the groin extension was built in conjunction with a beach restoration program which widened the entire island a comparable amount.

Therefore, sand transfer from Captiva Island is probably as much as, if not greater than, the sand transfer that was occurring before the project was initiated.

I disagree with your analysis that CEPD's level of involvement is not related to the level of mitigation that will be required due to their structure. The structure extension was needed to avoid extensive losses of the beach fill from the project. The level of involvement and the reason why CEPD is involved in the program has a lot to do with the potential impacts that the structures that have aided their project have on adjacent beaches. However, I have modified the paragraph to include your comments relative to this issue.

Comment on Page 69

The purpose of page 69 is to suggest levels of funding that engineer feels would be appropriate based on his study to date. We have deleted this section of the report from the revised document.

Comments on Page 70

The next workshop meeting is to be held on February 25, 1992.

I have sent a copy of the revised Interim Report No. 2 to Lonnie for your review and comment.

Sincerely,

COASTAL PLANNING & ENGINEERING, INC.

Thomas J. Campbell, P.E.
President

cc: Steve Cutler
Alison Hagerup
Chuck Listowski
Gary Price
Lonnie Ryder
Jim Armstrong - WCIND
Bob Dean
Ashish Mehta, Ph.D
Mark Leadon

COASTAL PLANNING & ENGINEERING, INC.

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8401.75

February 21, 1992

Mr. Steve Cutler
16790 Captiva Road
Captiva Island, FL 33924

Re: December 1991 Letter - Blind Pass Inlet Management Plan

Dear Steve:

In response to the letter we received dated December 19, 1991 from Sanibel and my discussions with the CEPD, we have developed a series of goals for the inlet management plan to be included in the revised version of Interim Report No. 2. A copy of those goals is attached. We suggest that a detailed review of goals be undertaken at the next meeting of the ad hoc committee.

Sincerely,

COASTAL PLANNING & ENGINEERING, INC.

Thomas J. Campbell, P.E.
President

TJC:jo

bpl01:840175.120

cc: Ralph Clark
Lonnie Ryder
Gary Price
Jim Lavender, Lee Co. Parks & Recreation
Jim Armstrong, WCIND
Alison Hagerup

GOALS OF THE INLET MANAGEMENT PLAN

The following goals are a composite of goals suggested by the State program and local governments.

A. Mitigate erosion caused by the inlet.

B. Re-establish littoral drift to downdrift beaches that are being affected by the existence of the inlet.

C. Maintain flushing and navigation to pre-1988 levels.

D. Protect the evacuation route from storm damage.

E. Control erosion north and south of the pass to protect County parks and private homes.

F. Accomplish goals A - E addressing long term environmental impacts.

G. Accomplish goals A - F in an economically responsible manner.

H. Quantify the impacts that the 1972 groin built by Lee County may have had on the beach in northern Sanibel Island.

I. Quantify impacts that the 1988/89 Captiva beach restoration/groin extension project may have had on the beach in northern Sanibel Island.

J. Develop intergovernmental programs to implement the Inlet Management Plan.

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8401.75

February 21, 1992

Mr. Steve Cutler
Chairman of the Ad Hoc Committee
for the Blind Pass Inlet Management Plan
16790 Captiva Road
Captiva Island, FL 33924

Dear Mr. Cutler:

We have revised the Interim Report No. 2 of the Blind Pass Inlet Management Plan to address concerns raised at the ad hoc committee meetings and comments received through Sanibel and from the State of Florida. Two letters, dated November 22, 1991 and December 4, 1991, from Humiston Moore Engineers contained a number of comments relative to the reports. Our response to those comments is as follows:

On the November 22, 1991 letter, Question 1:

> The conversion factor on Captiva was established based on a berm elevation of +6 and a depth of closure for active littoral movement of -12. On Sanibel Island the conversion factor varies because there are a number of areas where water bodies are captured by land masses.

Question 2:

> Conversion factors in the revised Interim Report have been further developed to demonstrate the reduced volumes associated with captured water bodies. Detailed justification is shown in the revised Interim Report No. 2.

Question 3:

> Boundary conditions have been thoroughly explained in the revised Interim Report No.2. The southern boundary condition is based on measured accretion rates in southern Sanibel Island.

Question 4:

> Both 1988 and 1989 have been analyzed in the revised report to demonstrate changes from when the groin was constructed and when the beach was completed.

Question 5:

Most of the sand in the Blind Pass ebb shoal is directly seaward of the northern beaches of Sanibel Island. It is unclear at this time whether that will remain a permanent shoal or will migrate to the beach. The revised report analyzes the beach volume with and without the shoal. It should be noted that a portion of the shoal volume is included in the profiles that are taken from northern Sanibel. The revised document addresses the distinction between ebb shoal materials and beach volumes.

Question 6:

This section has been revised. The source of all numbers has been stated.

Question 7:

This section has been revised. A full explanation of source of erosion and shoreline data is included.

Question 8:

Overwash quantities have been measured and are included in the revised report.

Question 8b:

Overwash probably did occur prior to Keith.

Question 8c:

There probably has been overwash due to some storms on Captiva Island.

Question 8d:

There is documentation of overwash which has occurred after Keith and it is included in the report.

Question 9:

The difference between Figure 1 and the 36,000 cy as previously analyzed, has to do with the term of the evaluation that was made. This section has been revised, however, to include a more accurate determination of land vs. water mass in Sanibel.

Question 10:

Alternatives that provide for placement of sand on a beach equivalent to the sand to the littoral drift quantities is consistent with the inlet management plan goals as established by the FDNR. Therefore, any plan that places sand on a downdrift beach to reinstate littoral drift quantities is a sand bypassing option.

Question 11:

We have never stated that the closure of Blind Pass is more important than erosion of Sanibel Island. We have changed the goal relative to Blind Pass to achieve a level of stability no less than that which existed prior to the Captiva Island beach nourishment project. The intermittent closure of Blind Pass as a condition would not preclude the implementation of one of the options as the plan is currently formulated.

Question 12:

We are aware that there are a number of jetty configurations that could affect inlet performance, however, we do not feel in this case that any other jetty modifications need be considered to improve sand bypassing. If Humiston/Moore has specific suggestions relative to jetty configurations they feel are potential improvements, they should indicate what those are and ask them to be considered. At this time we are not proposing to expand the number of inlet sand transfer options to include further jetty modifications.

Question 13:

This section of the report has been modified. It has not been determined that the preparation of an inlet management plan would relieve CEPD of obligations under a FDNR permit.

Responses to December 4, 1991 letter, Paragraph 2:

We have included a list of goals.

Paragraph 4:

The suggested goals of the plan have been modified to maintain Blind Pass at a level of flushing and navigation consistent with pre-1988 conditions.

Paragraph 5:

The goals of the plan do include restoration of natural littoral processes, storm protection of the evacuation routes and environmental protection.

Page 2, Paragraph 1:

We have included a goal to identify impacts of coastal structures on the beach.

Paragraph 2:

Jetty extension removal has no longer been rejected because it results in pass closure.

Paragraph 3:

Mr. Moore's comment in this regard is noted.

These comments will be reviewed at the next planned review committee meeting. The State has been invited to attend all of the ad hoc committee meetings of the inlet management plan and we will continue to discuss with the State how the plan can be developed to meet FDNR guidelines.

If you have any questions concerning the above responses to comments by Humiston Moore, please contact me. I suggest that we discuss these further at our next ad hoc committee meeting.

Sincerely,

COASTAL PLANNING & ENGINEERING, INC.

Thomas J. Campbell, P.E.
President

TJC:jo

cc: Alison Hagerup
Bob Dean
Ralph Clark
Chuck Listowski
Gary Price
Lonnie Ryder
Jim Armstrong
Ashish Mehta, Ph.D.
Mark Leadon

bpl:84017502.120

City of Sanibel

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Recycled paper

December 19, 1991

Mr. Steven Cutler, Chairman
Captiva Erosion Prevention District
P. O. Box 365
Captiva, FL 33924

Re: Blind Pass Inlet Management Plan

Dear Steve:

At its regular meeting of December 17, the Sanibel City Council discussed the Blind Pass Inlet Management Plan interim report.

Council instructed me to send you a copy of Humiston and Moore's letter dated December 4 with their comments on the interim report prepared by Coastal Planning and Engineering, Inc.

Council also discussed the goals that should be considered when evaluating any particular "solution". Their discussion led to the final "list" as follows:

1. Maintain a hurricane evacuation route.

2. Restore natural functioning of the pass and adjacent beaches to historical performance levels.

3. Use no hardening device that affects the day-to-day natural functioning of the beach.

4. Control erosion south of the pass, including the area of the County park, Sanibel-Captiva Road, and developed upland properties.

Council instructed me to also send you this list of goals requesting that the possible solutions be judged against these goals. I trust that this is sufficient; if not, please let me know.

HAPPY HOLIDAYS!!

Respectfully,

Gary Price

Gary A. Price,
City Manager
GAP/VJS

cc: Sanibel City Council
Lee County Commissioner John Manning
Acting County Administrator Bob Gray
Lee County Parks & Recreaction - Jim Lavender
Lee County Marine Sciences - Chuck Listowski
State Div. of Coastal Engineering & Regulation - Kirby Green
State Div. of Beaches & Shores - Lonnie Ryder
State Div. of Beaches & Shores - Ralph Clark
West Coast Inland Navigation District - Jim Armstrong
Captiva Erosion Prevention District - Alison Hagerup
Sanibel City Attorney Bob Pritt

OFFICE: 1010 NW 39th STREET
GAINESVILLE, FL 32605 PHONE: 904-373-1230

NUTECH CONSULTANTS, INC.

December 9, 1991

Doug Mann
Coastal Planning and Engineering
2481 NW Boca Raton Boulevard
Boca Raton, FL 33431

Dear Doug:

With reference to your communication of November 19, I have decided to respond via this letter as opposed to a phone call as you suggested. Please consider these comments, together with the report on the stability analysis already delivered, and my letter to Tom dated September 10, as the final communication for the work for which I was contracted by CPE.

I have reviewed the various Blind Pass (Lee County) Management Plan alternatives in relation to "potential effects that inlet modifications might have on the nature of the inlet" (vide Scope of Work, p.4). In my evaluation of the alternatives I have had to recognize that I have looked at the stability of Blind Pass, but have not been involved in the study of Clam Bayou, which was beyond the scope of my analysis work, although it does constitute an important component of the overall plan. I therefore will not comment on issues related to the stablity or impacts on Clam Bayou.

As for Blind Pass, let me make the following comments relative to the three categories of alternatives listed in the table with the decision matrix: A (I?). Close the Inlet, B. Inlet Bypassing Systems, and C. Experimental Systems.

A. Close the Inlet: For both the sub-categories A.1 and A.2 you have recommended nos, with which I agree.

B. Inlet Bypassing Systems: For items B.1 through B.10 please refer to my letter to Tom (copy enclosed); you will note that my recommendations are inherently at some variance with those being considered for the following reasons: 1) Given the scope of my work, I have given paramountcy to the need to maintain a channel that will not close, hence 2) I have not considered the beach nourishment needs which in any case I was not directly concerned with, and 3) I have not made any ecological impact evaluation. Given these factors it is not surprising that I do not concur with all the nos and maybes indicated in the decision matrix. On the other hand, what I have in mind for Blind Pass alone has been stated in my letter, although I would further recommend that no plan that involves either beach nourishment and/or jetty construction near Blind Pass be implemented without a thorough examination of inlet response (via physical and/or numerical modeling) to the proposed changes. Specifically I would be concerned with: 1) the potential for closure without any south jetty, since in my opinion closure in this case is rather likely, and 2) shape, length and orientation of the south jetty (note the difference between my proposal and yours e.g. for alternative B.5). My own design, which is rather arbitrary and one that would require modification in tandem with the beach nourishment needs, is for conceptual purposes only, and I cannot recommend it without a separate extensive study. Personally I would not be potentially interested in carrying out such a study however.

C. Experimental Systems: From my perpective we must differ again since I would favor C.1 or C.2 over C.3. In any event I question the practicality of instituting in the recent future any of the three alternatives considered.

Sincerely

Ashish J. Mehta

Ashish J. Mehta

8401.75
to: Tom Norm
Sue File

COLLEGE OF ENGINEERING

COASTAL AND OCEANOGRAPHIC
ENGINEERING DEPARTMENT
336 WEIL HALL

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FAX: (904) 392-3466

November 18, 1991

Tom Campbell
Coastal Planning & Engineering
2481 NW Boca Raton Boulevard
Boca Raton, FL 33431

Dear Tom:

It was good to have met you at Captiva and to discuss with you issues related to Blind Pass. Let me congratulate you once again on your presentation effort; it demonstrated your hard work in grasping the key elements in the complex project, as well as your dexterity in answering the questions posed.

As you indicated during your presentation, my comments on possible solutions to the stability matters at Blind Pass were the outcome of the stability analysis and did not constitute a component of the options then presented. I do however wish to reiterate my opinion, which is however quite tentative, considering the limited scope of my involvement in the overall study, and I trust I would not be over–extending the charge in re my part of the work.

As a result of the beach nourishment related projects that have taken place in that area, the interior environment of Blind Pass can by no means be considered to be undisturbed; for one thing, sand from the beach seems to have accumulated in the interior. At any rate, aerial photographs suggest that although visible sand accumulation may have been due to normal littoral transport along that shoreline, that the intake of sand by the inlet has been enhanced by the nourishment project, even though long term, post-jetty data suggest that the average rate of influx has dropped due to the jetty. Our examination of the stability issue does indicate that the stability of this inlet has been marginal for years, but that the jetty has helped reduce the potential frequency of closure of the mouth, although by no means eliminating that likelihood. On the other hand, the interior area has become shallower hence hydraulically less efficient that before.

While the decision to keep the inlet open or close it (by active means or by "default") may be dependent on the management option chosen, it is my position that the inlet should be kept open actively as an integral component of any management plan, for reasons of the quality of the waters immediately interior of the mouth, for the health of the bird preserve, and for fish and larval transport. I therefore support your Alternative B.6 to remove the flood shoal, which will only cause a temporary perturbation to the system. In addition I suggest that a small relief channel (of dimensions and configuration to be decided) should be considered to improve water ingress and egress. The assertion that a small a channel would cause the inlet to widen to the size of Redfish Pass is entirely unsupported by engineering calculations. Also, the sand that has accumulated in the interior will not leave that area of its own accord, and in fact there is some danger that if allowed to accumulate unchecked then, since the (elevation) relief in that area is very low, a significant storm could open an alternate passage through the barrier in that region.

Alternative B.5 shows a jetty that may be suitable for the nourishment project, but if such a nourishment project were not an issue, then I would recommend a much shorter structure as I have sketched (attached). Note that this sketch is wholly qualitative, unsupported by any coastal engineering investigation on my part. Note also however that since the dimensions of the inlet are controlled to some extent by the bridge, the B.5 structure may not serve as an effective jetty for the inlet; it may actually cause sand to become trapped between the two jetties and enhance the possibility of closure, as for example occurred at Blind Pass in Pinellas County. The structure I have sketched could be extended somewhat, parallel to the north jetty, if the beach immediately south is nourished. However it should not be extended too much in the beginning at least; later if necessary that can be accomplished. The idea here is to minimize human perturbation as far as possible, and monitor impact before further action.

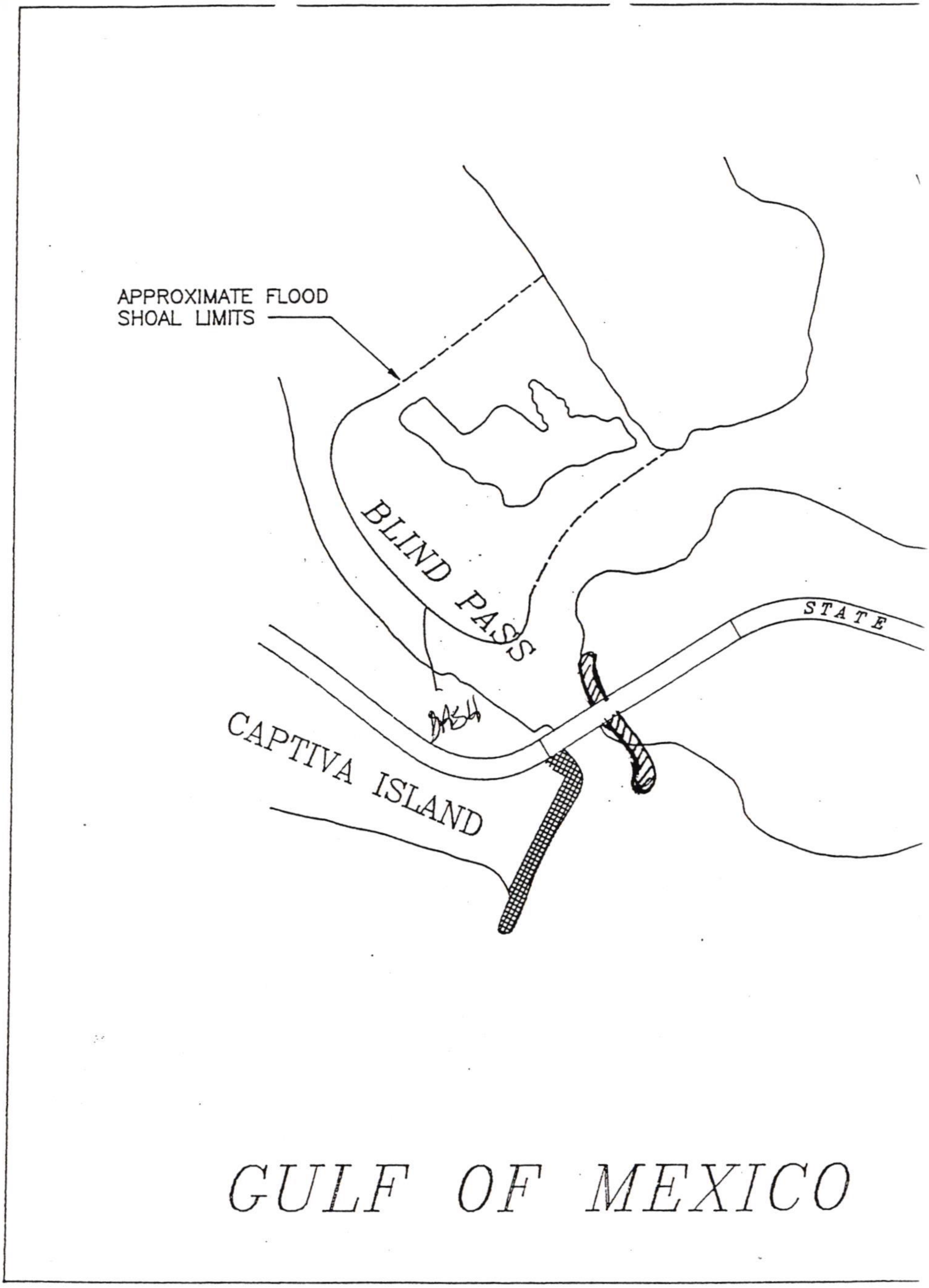
These comments are mere suggestions and are for your information only; they do not constitute a part of the stability report I have submitted. Nevertheless I trust they will serve some useful purpose in your well thoughtout management study.

Sincerely yours,

Ashish J. Mehta

Ashish J. Mehta
Professor

AJM/cjv


APPROXIMATE FLOOD
SHOAL LIMITS
BLIND PASS
STATE
CAPTIVA ISLAND
GULF OF MEXICO

December 5, 1991

City of Sanibel

800 Dunlop Road
Sanibel, Florida 33957

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RECEIVED DEC - 9 1991

Mr. Ralph Clark
State of Florida
Department of Natural Resources
Office of Beach Management
Marjory Stoneman Douglas Building
3900 Commonwealth Blvd.
Tallahassee, FL 32399

Re: Blind Pass Inlet Management Plan

Dear Mr. Clark:

Enclosed is a copy of the questions the City's consulting engineer, Ken Humiston of Humiston & Moore, has given to Coastal Planning & Engineering regarding the Blind Pass Inlet Management Plan interim report.

On December 3 the Sanibel City Council heard a presentation regarding the study by Mr. Thomas Campbell. Council took no action, but instructed our consulting engineer to return on December 17 with an analysis of the findings of the report. I will send you a copy of his analysis and would appreciate, in turn, copies of any correspondence from you to the inlet management plan consultant.

Thank you for your cooperation in this matter.

Respectfully,

Gary A. Price

Gary A. Price,
City Manager

GAP/VJS

cc: Sanibel City Council
Ken Humiston, Humiston & Moore
Sanibel City Attorney
Dr. Robert G. Dean
Captiva Erosion Prevention District
Thomas J. Campbell, Coastal Planning & Engineering

HUMISTON
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December 4, 1991

Mr. Gary Price, City Manager
City of Sanibel
800 Dunlop Road
Sanibel, Florida 33957

Re: Review of Blind Pass Inlet Management Plan Interim Report #2
H&M File No. 1-035

Dear Gary,

We have completed our review of the Interim Report and are providing the following comments. Our comments primarily have to do with our concern that the Interim Report does not adequately address the goals of the State Inlet Management Guidelines.

Inlet Management Plan Goals

The interim report states that its purpose "...is to provide the basis for discussion of inlet management options for Blind Pass", but it doesn't state the purpose of inlet management.

The general purpose of inlet management plans, under section 161.161 of the Florida Statutes, is to "evaluate each improved (developed) coastal inlet and determine whether the inlet is a significant cause of erosion", and "..to mitigate the erosive impact..".

Blind Pass is considered to be an improved (developed) inlet by virtue of the fact that there is a north jetty. The jetty was constructed to protect the upland from erosion by trapping littoral drift, and later extended to reduce end losses from the Captiva beach nourishment. It was not built to maintain Blind Pass as a navigable inlet. Based on this, and discussions at the December 3rd City Council meeting, the goals of this plan need not include keeping Blind Pass or Clam Bayou open.

The goals of the inlet management plan for Blind Pass should therefore include restoration of the natural littoral processes that have been disrupted by the jetty, and should provide an adequate beach in those areas that have been adversely impacted. An adequate beach would provide recreational area, storm protection for the upland including the road which is a critical evacuation route, and an environmental resource for sea turtle nesting.

It is our understanding that another goal of the management plan was to resolve controversy over a DNR directive regarding implementation of a jetty extension permit condition. That permit condition calls for removal of the extension and mitigation of erosion on Sanibel. What the plan does, however, is restate the terms of the DNR directive, and does not address resolution of this issue.

Management Alternatives

Several recent investigations have identified the north jetty as a cause of the erosion on the north end of Sanibel Island. The Interim Report recognizes this but does not recognize removal of, or modification of that structure, as a viable part of the management plan. The reason given for rejecting any alternative involving removal of the structure is the assumption that it would result in pass closure, and that the pass must be maintained for water quality purposes. The Interim Report instead focuses on a variety of alternative solutions involving additional structures and beach nourishment.

It should be understood that the above comments pertain to the Interim Report as a preliminary document, and that CEPD's consultant is still in the process of formulating the plan. You have already provided CEPD's consultant with a list of our questions pertaining primarily to technical issues, which CEPD's consultant indicated would be addressed in the next draft of the report. However, we also believe that more emphasis should be directed toward adverse impacts which have resulted from the jetty, and management options should begin by addressing the cause of the erosion.

Recommendation

We recommend that these comments be presented for review at the next Inlet Management Plan Review Committee meeting. We also suggest that it would be beneficial to have technical representation from the state at these meetings to discuss issues that concern compliance with DNR guidelines.

Sincerely Yours,

HUMISTON & MOORE ENGINEERS

Ken Humiston

Kenneth K. Humiston, P.E.

City of Sanibel

800 Dunlop Road
Sanibel, Florida 33957

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December 9, 1991

Mr. Steven Cutler, Chairman
Captiva Erosion Prevention District
P. O. Box 365
Captiva, FL 33924

Re: Blind Pass Inlet Management Plan Subcommittee

Dear Steve:

For quite some time, in the spirit of cooperation and the desire to accomplish a mutually satisfactory conclusion, I have been faithfully attending the Blind Pass Inlet Management Plan Subcommittee meetings, at no small sacrifice to the City of Sanibel.

I have attended these meetings in spite of my serious concerns that the report prepared by Coastal Planning and Engineering, Inc., as the same firm that is involved in the groin/Department of Natural Resources permitting issue, could not be unbiased and would not fairly represent the actual circumstances; creating a situation where the City could have little confidence that an accurate report was being discussed.

At almost all of these meetings one or more of the representatives from the affected agencies (i.e. Department of Natural Resources, Lee County, or West Coast Inland Navigation District) was absent. In fact, at some meetings only the Captiva Erosion Prevention District and the City of Sanibel were represented.

In the meantime, the beach continues to erode, homes and properties are increasingly threatened, the City's and Captiva's evacuation route has become even closer to the active beach, and nothing definite has been accomplished.

The proper consideration of an appropriate plan which will affect us all far into the future demands that full representation be provided. Without complete cooperation from all sides, it is useless to continue in this process.

By copy of this letter, I am notifying all parties involved how non-productive this process has become and urging more cooperation.

Respectfully,

Gary A. Price,
City Manager

GAP/VJS

cc: Sanibel City Council
Lee County Commissioner John Manning
Acting County Administrator Bob Gray
Lee County Planning - Jim Lavender
Lee County Marine Sciences - Chuck Listowski
State Div. of Coastal Engineering & Regulation - Kirby Green
State Div. of Beaches & Shores - Lonnie Ryder
State Div. of Beaches & Shores - Ralph Clark
West Coast Inland Navigation District - Jim Armstrong
Captiva Erosion Prevention District - Alison Hagerup
Sanibel City Attorney Bob Pritt

City of Sanibel

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November 25, 1991

Mr. Steve Cutler
Chairman
Captiva Erosion Prevention District
11550 Chapin Lane
P. O. Box 365
Captiva, FL 33924

Dear Steve:

This letter is to confirm Thomas Campbell is scheduled to appear before the Sanibel City Council on December 3, 1991 at 1:30 PM to present the draft Blind Pass Inlet Management Plan.

The City has retained the services of Ken Humiston, Humiston & Moore Engineers, to review this plan and advise the City Council. In this regard Ken has submitted the attached questions. These are forwarded to you so that the responses can be addressed at the meeting. I have taken the liberty of faxing the questions directly to Tom to allow more time to prepare a response.

If you have any questions please feel free to give me a call.

Respectfully,

Gary A. Price
City Manager

GAP:PAK

HUMISTON
& MOORE
ENGINEERS

COASTAL
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FAX 813 261 5297
PHONE 813 261 5160

November 22, 1991

Mr. Gary Price, City Manager
City of Sanibel
800 Dunlop Road
Sanibel, Florida 33957

SENT VIA FAX

Re: Blind Pass Inlet Management Study, Review of CEPD Interim Report. H&M File No. 1-035

Dear Mr. Price,

As a follow up to our discussions today, we are providing you with the following list of questions regarding the Blind Pass Inlet Management Study Interim Report No. 2. The answers to these questions will help us to complete our review of the report.

1. The littoral budget analysis is based on horizontal changes in shoreline position which are converted to representative volume changes by application of a conversion factor. It is stated in the Interim Report that the conversion factor was determined through a "coastal engineering analysis" but that analysis is not presented.

Q1. How was the conversion factor established? (Please provide a copy of the "coastal engineering analysis").

2. The conversion factor of .67 cubic yards per square foot of beach is reduced by half, to .33, to account for overwash along a short section of the first mile of Sanibel Island. This means that half of the erosion on Sanibel is being attributed to overwash.

Q2. Is this based on assumptions or is there justification for this modification, and if so what, in detail, is that justification? (Please provide any data that was used to establish this conversion factor).

3. The transport rates given in Figures 1, 2, and 3 correspond to the volume changes, in terms of the volume change equaling the difference between the transport in and the transport out, but any number of other levels of transport rates could also satisfy this condition.

Q3. How were the transport rates determined from the converted volume changes, ie. what boundary conditions were used to establish the transport rates?

4. Page 13 refers to the post construction period as starting in 1989, but the jetty extension was completed in September 1988. Some of the most severe post construction erosion occurred on Sanibel immediately following completion of the extension.

Q4. Why is this not considered as part of the post construction time period and has it been consistently neglected throughout the analysis?

5. Paragraph 2 on page 13 presents a volume change on north Sanibel which includes sand which accumulated on the ebb tidal shoal at Blind Pass between Sanibel and Captiva.

Q5. Why is the sand on the Blind Pass ebb shoal considered to be part of Sanibel Island?

6. The last paragraph on page 13 states that 1989/91 was an "atypical period" and the beach erosion north of the Blind Pass groin "suggests" that during a more typical year the inlet would bypass 53,000 cubic yards.

Q6a. How was the 53,000 cubic yard figure computed?

Q6b. Was consideration given to the possibility that the pre-nourishment period may have had "atypical periods" as well?

7. The third paragraph on page 14 states that since August 1988 the beach in Sanibel has eroded at 40,000 cy/yr.

Q7. Why is 40,000 cy/yr used here instead of the 20,000 cy/yr that is given in Figure 1?

8. Paragraph 2 on page 15 states "The major cause of the recent rapid shoreline recession on Northern Sanibel is the continued overwash of the Sanibel Island at two locations in the first mile. This process was initiated by Tropical Storm Keith and continues through today".

Q8a. Have overwash quantities been measured?

Q8b. Did overwash ever occur prior to Keith?

Q8c. Has there ever been overwash due to storms on Captiva Island?

Q8d. Is there documentation of overwash occurring after Keith?

9. Paragraph C. on page 15 states that the jetty extension in 1988 caused approximately 36,000 cy more erosion in northern Sanibel from November 1988 through April 1991.

Q9. How would you explain the discrepancy between this and the erosion rate given in Figure 1?

10. There are ten alternatives listed under inlet bypassing systems.

Q10. What do alternatives 1, 2, 4, 5, 6, 7, 9, and 10 have to do with sand bypassing?

11. The conclusion is made that the jetty extension has caused erosion on Sanibel Island, but that its removal would destabilize Blind Pass and may close it, and that therefore this is not recommended as an alternative management plan.

Q11. Given the fact that Blind Pass was intermittently closed prior to the jetty extension, how was it determined that the potential closure of Blind Pass is a more serious concern than the erosion on Sanibel Island?

12. In addition to jetty removal and jetty extension removal, there are many other possible modifications to the jetty that would improve natural sand bypass.

Q12. Why were no other jetty modifications considered?

13. The last paragraph on page 67 says that CEPD's contribution to the inlet management plan should be equated to their obligation to mitigate erosion damages to the Sanibel shoreline, as required by DNR under an existing permit condition, and that $35,000 contributed toward the management plan should reduce the permit condition obligation.

Q13. How was it determined that preparation of an inlet management plan by CEPD would relieve CEPD of their obligation under the DNR permit condition?

We suggest that these questions be forwarded to CEPD's engineer so that they will be able to address them at the December 3 City Council meeting.

Sincerely yours,

HUMISTON & MOORE ENGINEERS

Ken Humiston

Ken Humiston, P.E.

Tom Gardner, Executive Director

FLORIDA DEPARTMENT OF NATURAL RESOURCES

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399

November 14, 1991

Mr. Thomas Campbell, President
Coastal Planning and
Engineering, Inc.
2481 Boca Raton Boulevard
Boca Raton, Florida 33431

Dear Tom:

I recently reviewed the draft Blind Pass Inlet Management Plan Interim Report No. 1 and gave my comments to Norman Beumel. I understand that report is being updated or finalized now. I also understand that work is also underway on Redfish Pass and a first report will soon be available.

I am sorry that I missed the recent meeting with the Captiva Erosion Prevention District. We will have contracted studies of about seventeen inlets this year (plus five last year) and, given our budget constraints, we can not possibly attend all the inlet study briefings and meetings. Enclosed is a draft of maps showing the inlet locations for each fiscal year of studies. The future FY's are not cast in stone but will give you some guidance on our current prioritization.

I have been reviewing the Blind Pass Interim Report No. 2 and have the following comments and questions. I may have more comments as I continue a review of this report but these are my initial thoughts.

p. 29 <u>Alternative 1a.</u>

What is the survivability of these flushing culverts? Where in Florida do these culverts exist and what is their repair and maintenance history? What threshold erosion/tide/wave conditions will damage these culverts and what is the annual frequency of these threshold conditions? What is the annualized maintenance costs of these culverts?

p. 37 <u>Alternative 3</u>

What is the basis for believing that the removal of the groin extension will close Blind Pass? Why not consider beach fill removal north of the groin extension and transfer to Sanibel? Why not consider using the surety bond to cover the groin extension removal cost?

p. 37 <u>Alternative 4</u>

How can 4 be recommended and 3 not be recommended when their disadvantage is the potential closure of Blind Pass?

p. 39 <u>Alternative 6</u>

What is the basis for not recommending this option? It's a substantially lower cost than 2 or 4 which were recommended and there are no stated adverse impacts.

p. 41 <u>Alternative 7</u>

On what basis is it not a desirable option?

p. 43 <u>Alternative 9</u>

It should also be mentioned that this alternative does not address the mandate for bypassing as set forth in Chapter 161, F.S.

p. 47 <u>Alternative C.1</u>

Why does it have to be considered a loss of public beach? If the natural bypass quantity is being mechanically transferred and if sand is transferred from one beach to another, why do concerns have to be biased to the beach on Captiva Island?

p. 49 <u>Alternative C.3</u>

It should be noted that an experimental beach dewatering project is to be installed south of Ft. Pierce Inlet. The results of the Ft. Pierce experiment need to be evaluated before consideration on Sanibel Island.

p. 52 Alternative B.3 should be considered further. Alternatives B.6 and B.7 should also be considered further. Alternative C.3 should not be considered further at this time unless the Ft. Pierce dewatering project proves successful.

p. 53 VII.A. When Big Hickory Pass, Dunedin Pass, and Midnight Pass closed, the water quality and D.O. did not decrease, so how is closure of Blind Pass going to decrease water quality and D.O. in Pine Island Sound? How are organisms going to be induced to perish? Will not fish just use other open inlets? Are not they just opportunistic when it comes to using an open Blind Pass?

p. 57 3. See comments for p. 37 (Alternative 3). The transfer of sand by truck from Captiva Island to Sanibel Island would have different impacts than dredging from either an offshore source or the inlet shoals.

p. 59 7. The armoring in conjunction with continued erosion will result in the loss of beach. This loss of beach will have an impact on infauna and nesting sea turtles and will provide habitat for other species.

p. 59 8. The physical feasibility of nonhydraulic removal of flood shoal material leaving a perimeter buffer should be investigated when further consideration is given this option. This was a viable option following the subtropical storm of June, 1974, when a substantial quantity of material was transported northward into the inlet off of Sanibel Island's beach. In its current configuration this option might not be physically feasible, but if it is, its environmental impact could be limited.

p. 62 3. What is the impact of dewatering on the infauna community? Was this factor investigated at the Sailfish Point project site?

p. 64 D. Has it not been established that the groin extension and erosion control project has been affecting the northern shoreline of Sanibel Island, notwithstanding any differences of professional opinion as to the quantity of the impact? A most important fact has been excluded - the CEPD is the local sponsor of this study.

p. 67 Paragraph 5. How can it be concluded that the groin which Lee County constructed impacted the beach, yet the extension of the same groin constructed by this study sponsor may or may not have impacted the beach? The purpose of the CEPD's placement of 15,000 cubic yards of material on Sanibel Island is to mitigate the impact of their permitted erosion control project not to maintain the natural bypassing of the inlet. The CEPD's level of responsibility in sand bypassing is subject to further discussion but should not be affected by their responsibility to mitigate for damages caused by their project.

p. 69 The levels of governmental responsibility should be reviewed in greater detail and be subject to debate. It may be prudent to identify levels of government funding only for those alternatives which are to be considered further and not raise debate over funding levels for projects which will not receive further consideration.

Mr. Thomas Campbell
November 14, 1991
Page Two

p. 70 What is the target date for the fourth workshop meeting? Can each agency's review comments be circulated prior to meeting?

Sincerely,

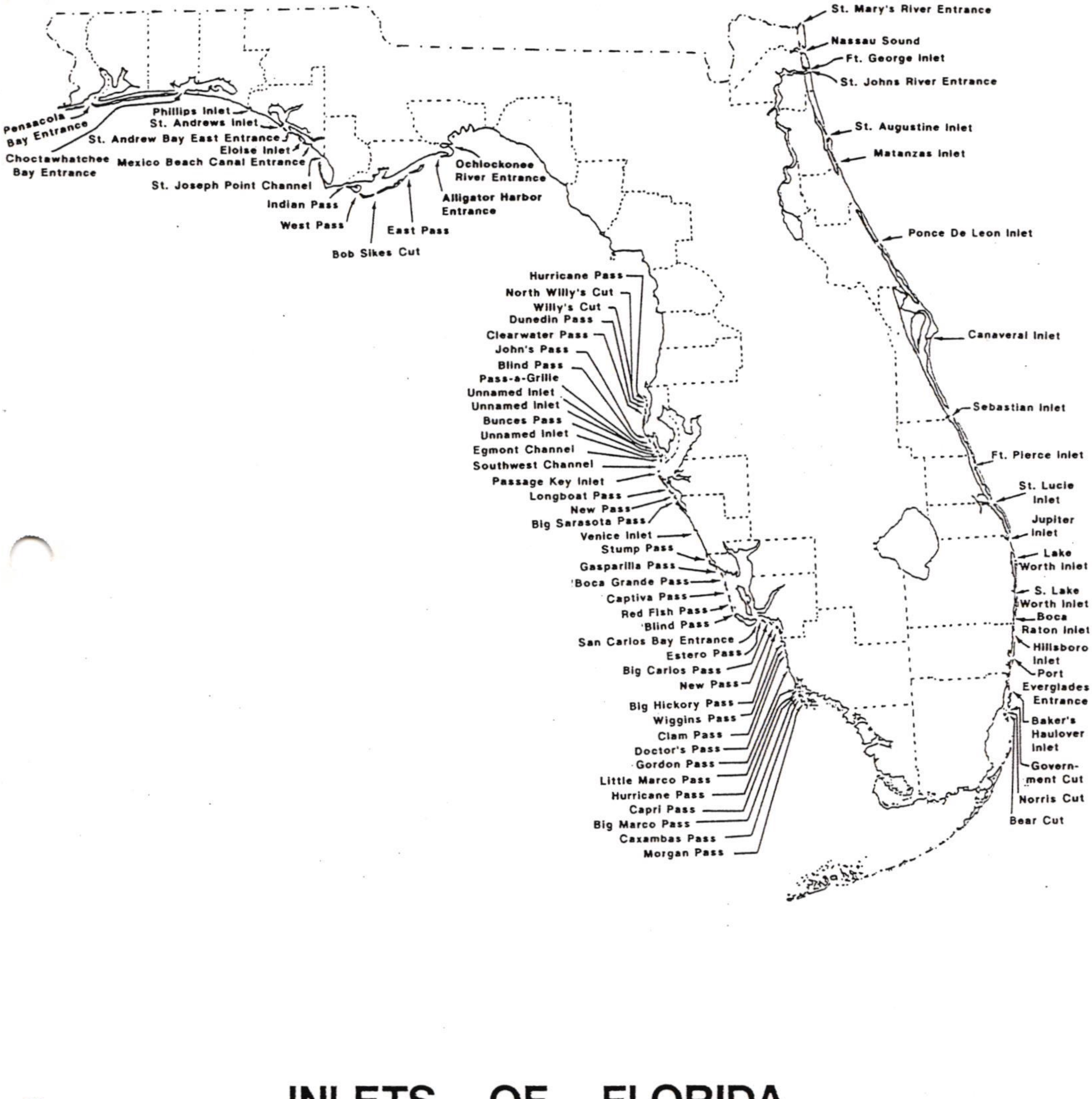
Ralph R. Clark

Ralph R. Clark
Office of Beach Management

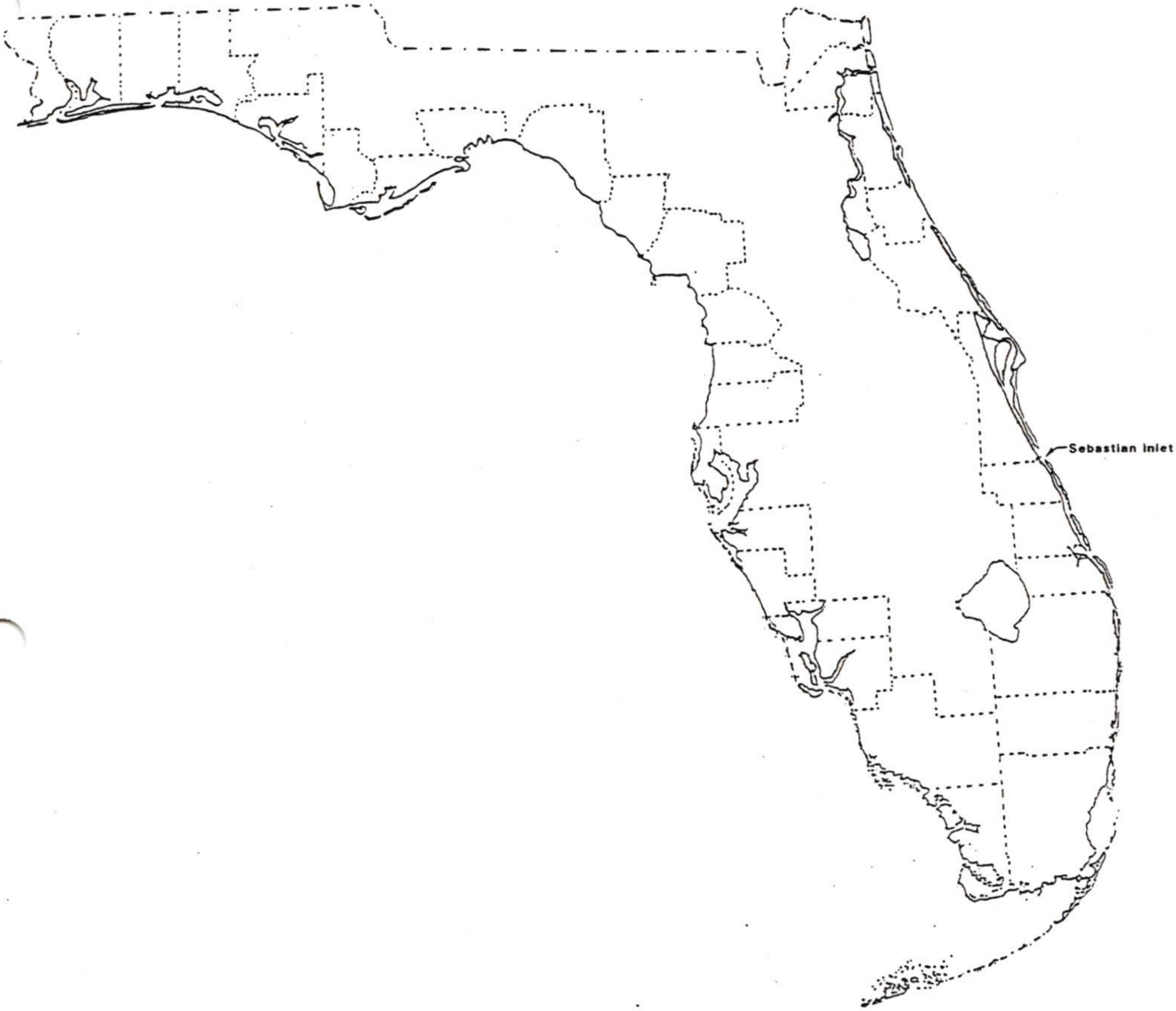
RRC/bc

cc: Alison Hagerup
Gary Price
Chuck Listowski

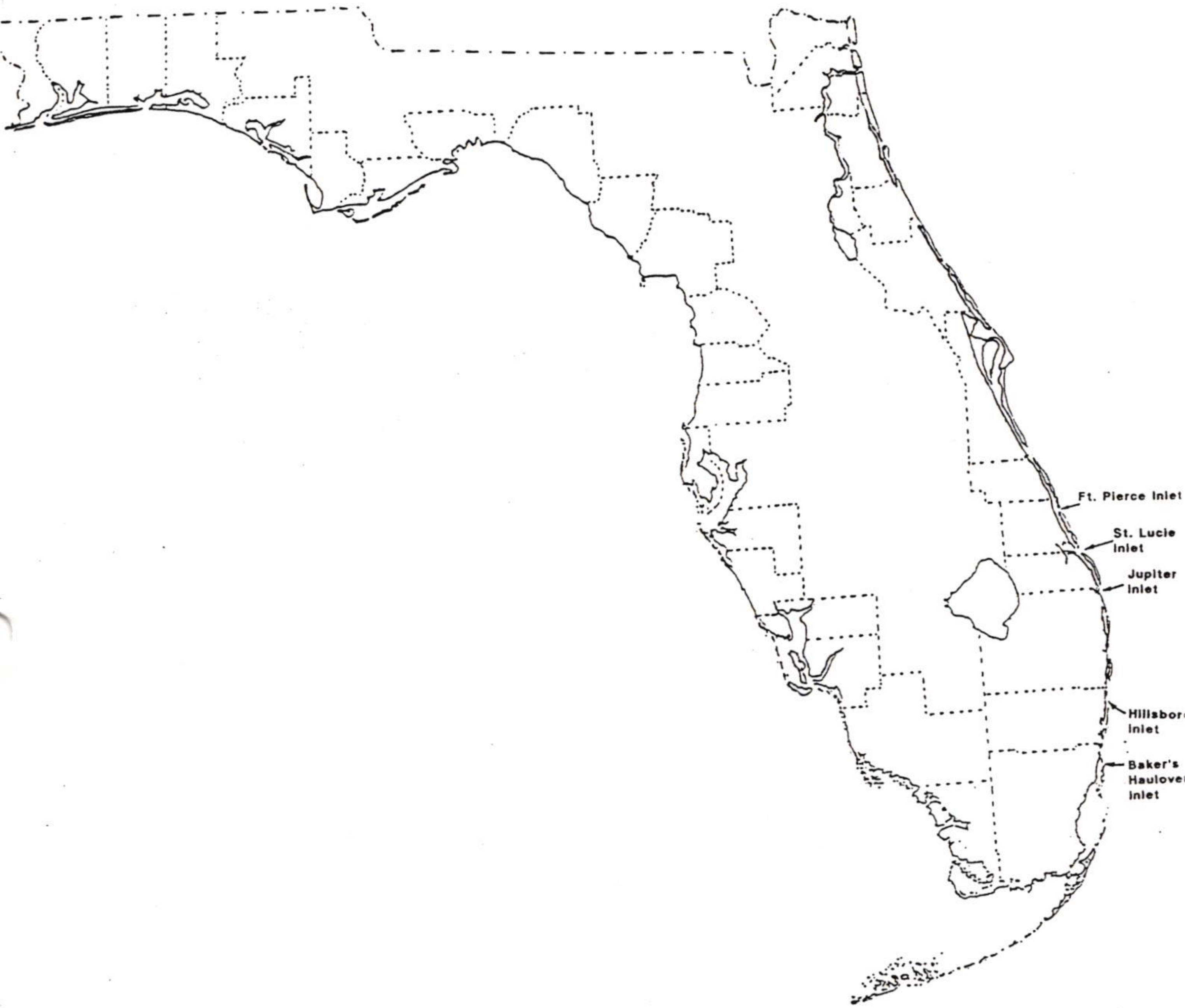
DRAFT



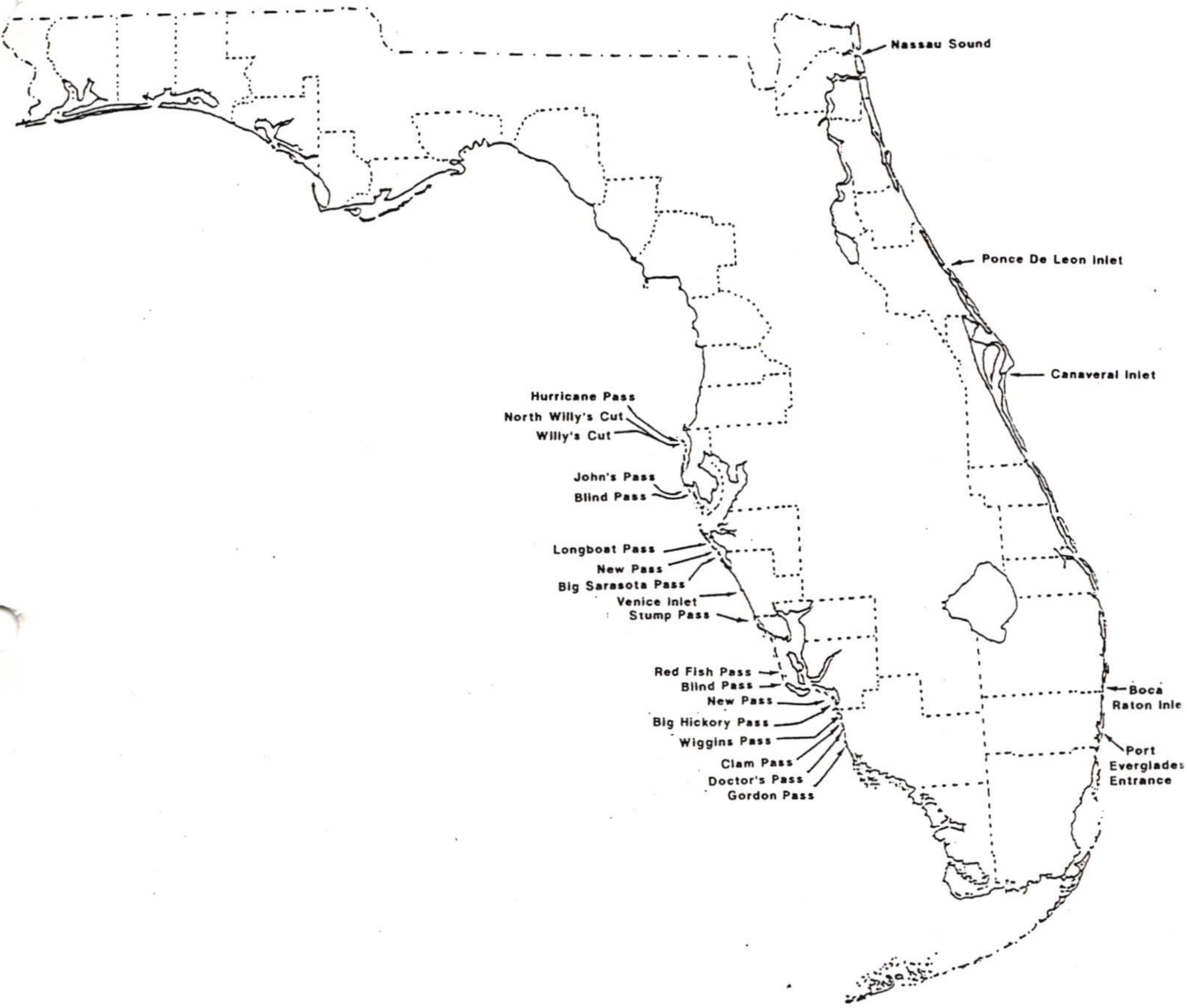
INLETS OF FLORIDA



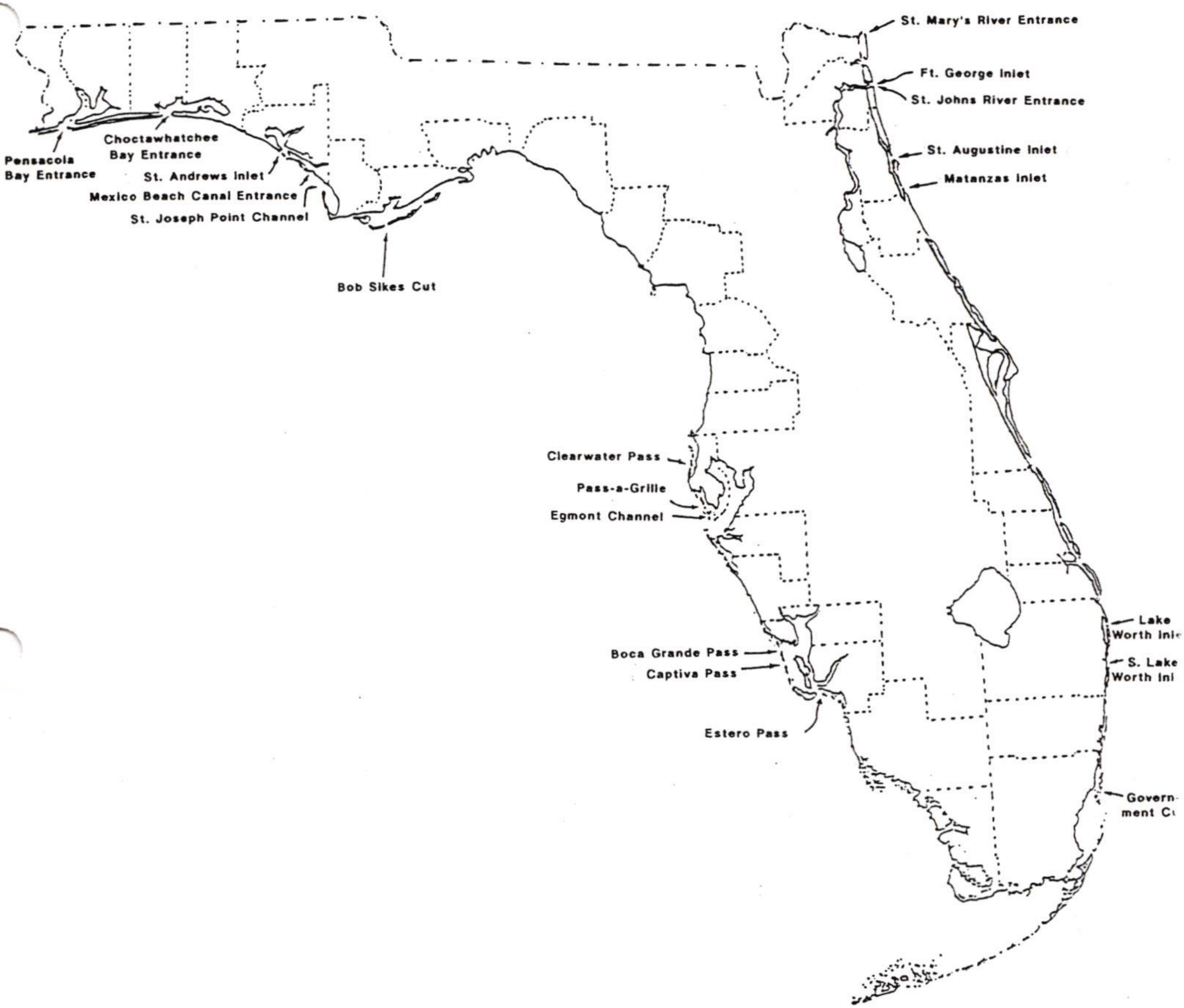
Status of
Inlet Management Planning
FY 1988-89



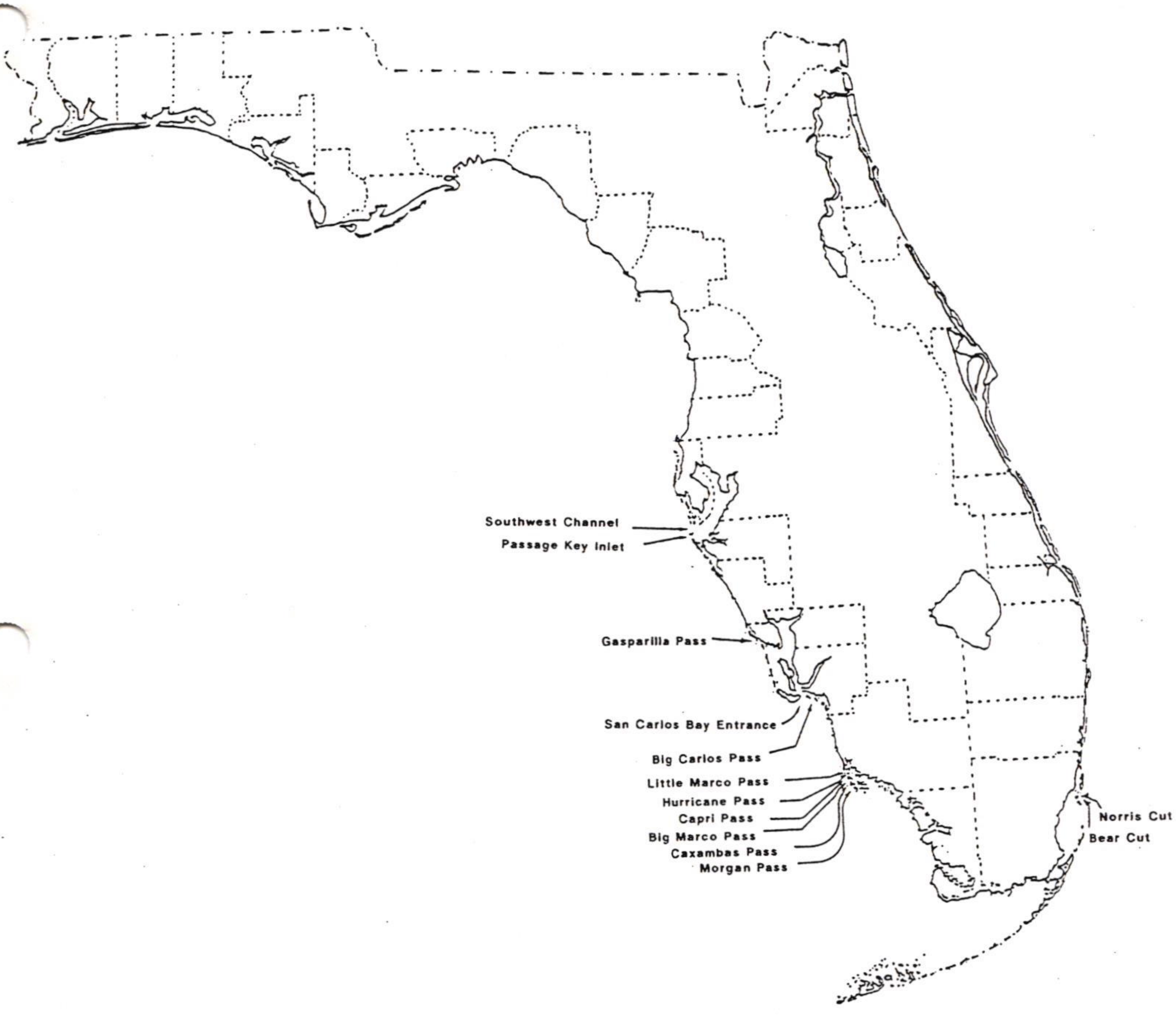
Status of Inlet Management Planning FY 1990-91



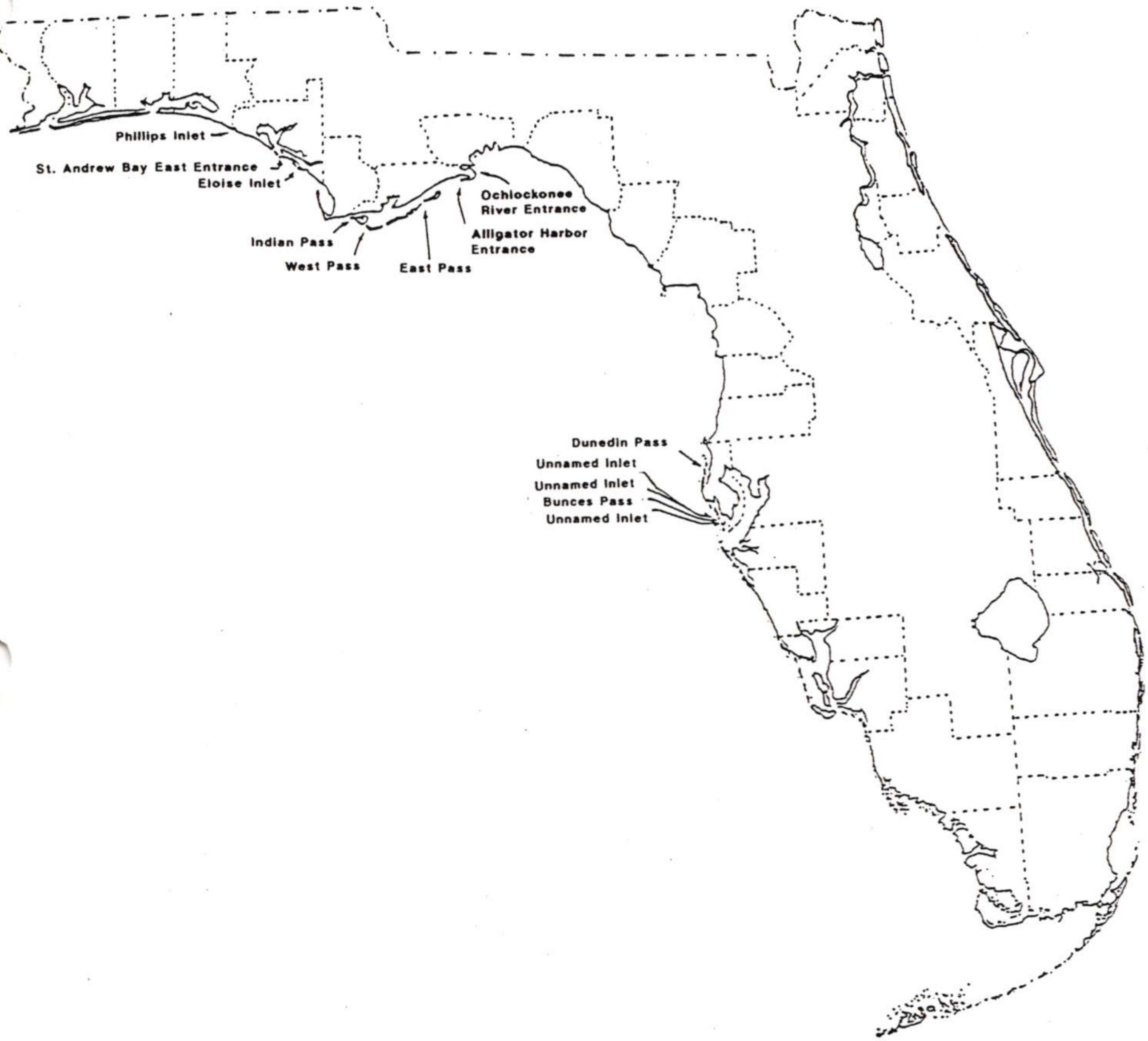
Status of Inlet Management Planning FY 1991-92



Proposed Inlet Management Planning Studies For FY 1992-93



Proposed
Inlet Management Planning Studies
For FY 1993-94



Proposed
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COASTAL PLANNING & ENGINEERING, INC.

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8401.75

August 2, 1991

Ms. Alison Hagerup
Captiva Erosion Prevention District
P. O. Box 365
Captiva, FL 33924

Dear Alison:

We have received a copy of a letter from July 23, 1991 from Mr. Gary Price. We have taken the steps to incorporate his comments into the ongoing study of Blind Pass as you have directed.

Some of the comments require further discussion at the next committee meeting. The following details our response to Mr. Price's comments.

A. The study proposes one ebb tidal shoal survey. Mr. Price suggests a continual monitoring of the ebb shoal. The future monitoring program could be modified to include an ebb shoal survey as directed by the Board. This, however, would not necessarily be part of this study but could be a recommendation of the study. Concern about possible reduction of the ebb shoal will be addressed in the evaluation of inlet options.

B. Mr. Price's comments on Phase II (4) methodology. As suggested, we will consider the changing geography of Captiva and Sanibel in our historical review of sand movement along the islands. The model and analysis of today's conditions will reflect the current geography of the islands. We will model Dr. Dean's recommendation as one of the alternatives as suggested by Mr. Price.

C. The no action alternative will be evaluated to establish long term trends without further modification of the inlet (as suggested by Mr. Price).

D. We will take into consideration Mr. Price's concern about further disturbance to the inlet potentially causing problems. The analysis will identify the uncertainties with each potential solution so that the committee can assess the risks involved with further disturbance or modification of the existing inlet.

E. The term "adjacent beaches" in Phase II, C.3 on page 3 refers to the beaches that are adjacent to Blind Pass for a distance of beach that is affected by the pass. This distance will be determined by the evaluation of shoreline data.

Please advise if additional action is required to address Mr. Price's concerns.

Sincerely,

COASTAL PLANNING & ENGINEERING, INC.

Thomas J. Campbell, P.E.
President

TJC:jo
rpbp01:84017501.802

cc: Ad Hoc Committee Members
Dr. Dean
Dr. Mehta
Norman Beumel
Susan Beumel

City of Sanibel

800 Dunlop Road
Sanibel, Florida 33957

AREA CODE - 813

CITY COUNCIL	472-4135
ADMINISTRATIVE	472-3700
BUILDING	472-4555
EMERGENCY MANAGEMENT	472-3111
FINANCE	472-9615
[illegible]	472-1359
PARKS & RECREATION	472-3373
PLANNING	472-4136
POLICE	472-3111
PUBLIC WORKS	472-6397

July 23, 1991

Alison Hagerup, Administrator
Captiva Erosion Prevention District
P. O. Box 365
Captiva, FL 33924

Re: Blind Pass Scope of Work Agreement

Dear Alison:

I have reviewed the Blind Pass Inlet Management Plan Scope of Work and have the following comments:

Field Investigations:

- The health of the ebb tide shoal should be monitored to ensure that there are no negative impacts to this protective feature. Ebb tidal shoal is a natural protective barrier to waves and should be maintained. Ebb tide shoal should not be diminished by dredging or sand by-pass. Periodic surveys should continue to monitor shoal migration since situation has not been determined to be static. Monitoring should continue to project long term erosion. We need an extensive cooperative monitoring program.

PHASE 2 (4)

- This is speculative based on past geography which has been drastically altered. Should consider ongoing monitoring to include these techniques to verify validity of method used for interpretation.

- Mitigate Sanibel per Dr. Dean's recommendation.

- Leave pass be and monitor stability to see if inlet really needs modification.

- Further disturbance could be disastrous.

Finally, in PHASE 2 C3, on page 3, we need a definition of "adjacent" beaches.

Respectfully,

Gary.

Gary A. Price,
City Manager
GAP/VJS