AD-A120 366 CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT F/G 13/2
DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT. SECTION 1--ETC(U)
NOV 81

UNCLASSIFIED NL

1 OF 4
AD A
120366

AD A120300

DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A120366	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Detailed Project Report and Environmental Assessment: Section 111, Shores East of Diked Disposal Area, Lorain Harbor, Ohio		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, Buffalo 1776 Niagara St. Buffalo, N.Y. 14207		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE November 1981
		13. NUMBER OF PAGES 320
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

beach erosion
shore erosion
Lake Erie
Lorain Harbor
diked disposal areas

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A study of the impacts of the Lorain diked disposal area on the shoreline east of the area. The report found that the disposal area had not caused the total erosion problem and recommended no federal action.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(*When Data Entered*)

SECURITY CLASSIFICATION OF THIS PAGE(*When Data Entered*)

DEPARTMENT OF THE ARMY
BUFFALO DISTRICT, CORPS OF ENGINEERS
1776 NIAGARA STREET
BUFFALO, NEW YORK 14207

NCBPD-EB 18 November 1981

SUBJECT: Section 111 Detailed Project Report and Environmental Assessment for Shores East of Diked Disposal Area, Lorain Harbor, OH - Supplement No. 1

Commander, North Central Division
ATTN: NCDPD-PF/M. Dixon

1. Reference attached Draft Detailed Project Report (DDPR) and Environmental Assessment, dated January 1981, SAB.

2. This letter provides additional information which finalizes the subject report and upholds the subject report's finding that the diked disposal area affects shoreline erosion. It also updates information since preparation of the draft regarding public interest in the land acquisition plan, policy decisions, and recommendations.

3. Diked Disposal Area Affects on Erosion. The subject report indicates that the diked disposal area shelters the study area from westerly waves resulting in entrapment which in the "worst case" promotes additional shoreline erosion. Since the post-dike resultant wave climate is similar to that which influenced the shoreline just east of Black River prior to the construction of the East Breakwater shore arm in 1963, a comparison of those shoreline conditions should support the premise that the diked disposal area does influence the shoreline east of the shore arm in much the same manner as the shore arm influenced the shoreline east of the river.

4. Before 1963 and prior to the east shore arm, the shoreline from the Federal east pier to Colorado Avenue exhibited a severe erosion condition. That condition is specifically documented in literature dating back to the 1940's and generally even further back. Also, through analysis of the city of Lorain's lot surveys and other mapping, considerable land loss is indicated in the area since 1892 in spite of numerous private shore protection works and backfill operations. The severe erosion condition was probably due in part to a loss of sediment in the active littoral zone. The sediment was transported so far west that it either moved lakeward along the oblique angled pier into the entrance channel where it was probably removed by dredging, or, it was sheltered by the harbor structures prohibiting westerly waves from transporting this sediment back toward the east. In summary, prior to 1963 a severe erosion condition was associated in part with harbor conditions.

5. In 1963, the East Breakwater shore arm was constructed. This did provide a further barrier to westward movement of littoral material; however, the material barred from westward movement was not as susceptible to entrapment because northwesterly waves could transport some of the material back eastward. Lake residents did, however, claim the East Breakwater shore arm caused increased shoreline erosion. The Corps performed a Section 111 Reconnaissance Study because of those claims which found that the shoreline was experiencing increased erosion but that was attributable to high lake levels, not the shore arm.

6. The subject report describes the diked disposal area built in 1977 as having similar effects on the shoreline today as did conditions of the harbor prior to 1963. The attachment of the diked disposal area to the East Breakwater shore arm prevents westerly waves from transporting eastward materials moved westward by the littoral process. The shore arm did not shelter the subject shore from northwesterly waves. The result of diked disposal area construction is the creation of a wave climate similar to the pre-1963 condition. That wave climate causes entrapment that in the "worst case" promotes additional erosion. Also, the dike construction extended the harbor eastward, resulting in an eastward migration of the erosion zone. Therefore, an analysis of conditions prior to 1963 and post-dike conditions furthers the conclusion of the subject report that the diked disposal area had not caused the erosion problem experienced by shores east of Lorain; however, the diked disposal area has contributed to shoreline erosion.

7. Land Acquisition Plan. At a September 1980 public meeting, Buffalo District recommended no further Federal Involvement under Section 111 authority based on the lack of a local sponsor for a proposed revetment plan. Events up until that time are documented in the subject report. In October 1980, the city of Lorain and Corps officials met at the request of the city to discuss land acquisition as an alternative. City officials were interested in the Corps land acquisition plan but expressed concern about the high cost of the plan and possible high cost of the local share. Buffalo District agreed to review land acquisition costs upon receipt of additional funding. Meanwhile, city officials met with residents of the study area and developed a land acquisition proposal of their own. The proposal was later rejected by the Corps because over 50 percent of the properties proposed for acquisition were subject to accretion, not erosion.

8. A Corps review of the land acquisition plan was made to refine the real estate values which would be the primary cost associated with that plan. So the basis for comparison for all alternatves would not change, August 1980 price levels and a 7-1/8 percent interest rate were used. The revised data are shown in Table 1. The resultant refinement of costs, when combining

total first costs with other costs, results in an increase in total cost from $2,174,000 to $2,243,000 or an increase of $69,000. A cost allocation was not performed once policy clarifications were made.

9. Policy Decisions. While the subject study was underway, several policy questions arose regarding nonstructural alternatives - land acquisition in particular. Final clarification of policy regarding the implementation of a land acquisition plan under Section 111 Authority was not resolved until after completion of the subject report. Final clarification of policy by DAEN-CWP-A letter dated 7 May 1981 stated that Section 111 of Public Law 90-483 authorizes construction projects but does not authorize implementation of nonstructural measures. This has a profound impact on this study because the nonstructural land acquisition plan sought by local interests cannot be implemented or cost-shared by the Federal Government under this study authority.

10. Recommendations. The subject report, finalized by this supplement, found that the Federal diked disposal structure does entrap materials with the effect being accelerated erosion along the shoreline east of the dike. However, the quantity of the impounded materials is so small that the effect on the shoreline is immeasurable due to the complicating influence of high lake levels, storms, and the effects of privately constructed shore protection. Further findings showed no feasible plan exists which will only mitigate the accelerated erosion effects. The structural total erosion control plan recommended to local interests as stated in the subject report was unacceptable to local interests for legal reasons regarding protection of private property and land acquisition is not implementable under Section 111 Authority.

11. Based on findings in this study, the recommendation is that no Federal action be taken as there is no solution to the problem within the scope of the current Congressional authorization and in the overall public interest.

1 Incl
as

GEORGE P. JOHNSON
Colonel, Corps of Engineers
Commanding

Table 1 - ALTERNATIVE II ACQUISITION PLAN COST/BENEFIT ANALYSIS

FIRST COST ITEMS

Estimated Property Value	$1,355,700
Contingencies, 20% (for possible payments over and above the appraised value)	271,100
Acquisition Costs	72,000
Demolition Costs	140,500
TOTAL FIRST COSTS	$1,839,300

SUPERVISION $ ADMINISTRATION OF PLAN

@ 15% of Acquisition Costs	$ 10,800
Overhead on S&A @ 27%	3,200
TOTAL	$1,853,300

ANNUALIZED COSTS

Amortization of First Costs @ i = 7 1/8%/yr for 50 yrs CRF = .07361 1,853,300 x .07361 = 136,421 say	$136,400

ANNUALIZED BENEFITS

1&2) Savings on Private Protective Structures @ $17,900/yr	
3) Intangible Benefit - Alleviation of Concern	
TOTAL	$17,900

BENEFIT/COST RATIO 17900/136400 — B/C = 0.13

OTHER COSTS[1]

Relocation Assistance	$374,000
Moving Expenses	15,500
TOTAL	$389,500

[1]Items considered under the Uniform Relocation Act (PL91-646) are not considered in the B/C Ratio.

DACW 49-80-C-0035
JANUARY 1981

DRAFT
DETAILED PROJECT REPORT
AND
ENVIRONMENTAL ASSESSMENT

SECTION 111
SHORES EAST OF DIKED DISPOSAL AREA
LORAIN HARBOR, OHIO

PREPARED FOR
U.S. ARMY CORPS OF ENGINEERS
BUFFALO DISTRICT

SECTION 111
DETAILED PROJECT REPORT
ON
SHORES EAST OF DIKED DISPOSAL AREA
LORAIN HARBOR, OHIO

MAIN REPORT

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS(cont.)

FIGURES

TABLES

APPENDICIES

TABLE OF CONTENTS (cont'd) PAGE

SECTION 111

Detailed Project Report

On

Shores East of Diked Disposal Area

Lorain Harbor, Ohio

THE STUDY AND REPORT

Lorain Harbor is located at the mouth of the Black River in Lorain County, Ohio, about 27 miles westerly of Cleveland Ohio. The physical features of the Federally authorized and constructed harbor structures are shown in Figure 1. The east and west breakwaters were constructed during the period 1901-1915, however, the east breakwater was not connected to the shore until a shorearm was constructed in 1963. The Outer Breakwater was constructed in 1964. The Diked Disposal Area, its purpose being to contain the polluted sediments from harbor dredging operations, was constructed during the period August 1976 to September 1977. The Spending Beach Revetment which extends from the Dike to the shore was constructed from June to November 1977.

Subsequent to the Dike Disposal Area construction, shore residents east of the harbor complained that this structure was causing significant shoreline erosion and failure of privately built shore protection structures. In a letter dated 19 July 1979, the Mayor of the City of Lorain officially requested that the Federal Government investigate the severity of the erosion problem attributable to the Disposal Dike. In response to this request, the Buffalo District Corps of Engineers completed a Reconnaissance study in February 1980 to determine whether the Dike Disposal structure had caused an increase in erosion of the shore to the east of the structures and, if so, develop preliminary alternative plans for mitigating the increased erosion. The Reconnaissance study concluded, based upon available engineering, economic, environmental, and social information, that the Diked Disposal area contributed to the erosion and therefore the situation warranted the preparation of a detailed project report(DPR). The DPR would formulate a basis for selection of the optimum plan for mitigation of damages attributable to the Dike Disposal structure provided the plan is socially acceptable, technically practical and economically feasible.

PURPOSE AND AUTHORITY

The purposes of this study are to determine the extent of shore erosion damage to the east of Lorain Harbor, Ohio due to the Dike Disposal area structure and due to natural processes. The study must also develop designs, cost estimates, and cost sharing responsibilities for appropriate alternatives which would provide shore erosion protection or mitigation of damages due to the Dike Disposal structure and natural processes.

This Detailed Project Report on shore damage to the east of the Dike Disposal area was prepared under authority of Section 111 of the River and Harbor Act of 1968 (P.L. 90-483). The Section 111 Reconnaissance Report on this study area was submitted on February 3, 1980 and that report recommended preparation of a Detailed Project Report. Subsequent endorsement and approval for funding was granted on February 6, 1980. Section 111 of P.L. 90-483 provides for the following:

> "The Secretary of the Army, acting through the Chief of Engineers is authorized to investigate, study, and construct projects for the prevention or mitigation of shore damages attributable to Federal navigation works. The cost of installing, operation, and maintaining shall be borne entirely by the United States No such projects shall be constructed without specific authorization by Congress if the estimated first cost exceeds $1,000,000".

SCOPE OF THE STUDY

Figure 1 shows the geographic location of Lorain, Ohio and the Federally constructed navigation works for the Harbor complex. The study area extends from the Dike Disposal revetment (Colorado Avenue) easterly to Indiana Ave., a distance of 2500 feet. The study limits were established by analysis of data on shoreline and offshore bottom changes and wave refraction analysis for conditions prior to and after construction of the Dike Disposal area.

Existing data supplemented by a hydrographic survey (April 1980) and aerial photography (April 23, 1980) were used during the course of this study. The scope of report coverage encompasses an investigation and assessment of

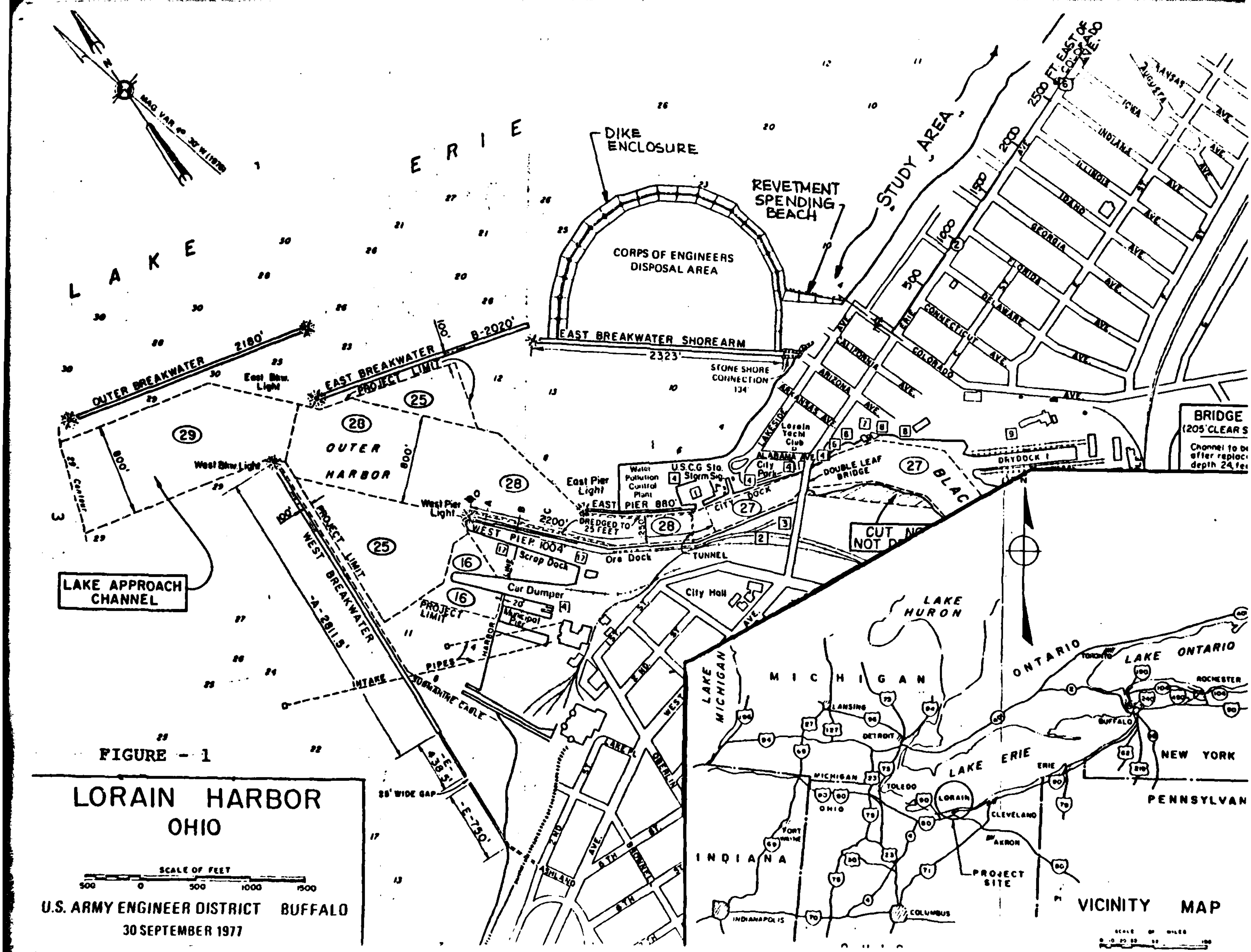


FIGURE - 1

LORAIN HARBOR
OHIO

U.S. ARMY ENGINEER DISTRICT BUFFALO
30 SEPTEMBER 1977

the physical factors pertinent to the problem and the development of appropriate mitigation alternatives for engineering feasibility and economic, social, and environmental impacts; a selection of the most feasible plan; and associated coordination with concerned agencies, local government, and the public.

STUDY PARTICIPANTS AND COORDINATION

The District Engineer has closely coordinated this study with the City of Lorain, State and Federal Fish and Wildlife agencies, the Environmental Protection Agency, and appropriate offices within the government of the State of Ohio.

Coordination efforts have included site visits, telephone conversations, letters, a public workshop, and a public meeting. Attention was given to encouraging participation and input from private interests (including affected property owners) as well as governmental agencies (refer to Appendix 3).

The public workshop for this study phase was conducted in Lorain on 31 March 1980. The workshop purpose was to inform interested parties that a Section 111 study was being conducted an to explain the study process and scope.

The public meeting was held in Lorain on 17 September 1980. This formalized meeting was conducted to present study results and tentative conclusions. Public input and comment was encouraged so that conclusions and recommendations could be finalized with full understanding of public reaction.

THE REPORT

The results of this study have been arranged into this, the main report, and technical appendicies. An Environmental Assessment (EA) is included in the study and appropriate components thereof are incorporated into the main report. The main report is a nontechnical summary presenting the physical aspects of the study area, the problems and needs, formulation of a plan for meeting these needs, an evaluation of environmental impacts, a summary of plan economics and related justification, and recommendations concerning plan selection.

The appendicies to the main report provide greater technical detail for related components of the main report and are entitled:

Appendix 1 - Problem Identification
Appendix 2 - Description of Alternative Plans
Appendix 3 - Public Views and Responses
Appendix 4 - Engineering Investigations
Appendix 5 - Economic Analysis
Appendix 6 - Inventory of Cultural Resources
Appendix 7 - Bibliography

PRIOR STUDIES AND REPORTS

Prior studies and reports pertinent to this Section 111 Detailed Project Report are summarized in the subparagraphs that follow.

House Document No. 229, 83rd Congress, "Appendix VIII, Ohio Shoreline of Lake Erie Between Vermilion and Sheffield Lake Village, Beach Erosion Control Study." This August 1949 report was prepared by the U.S. Army Corps of Engineers, Buffalo District, submitted through higher authority for review, and printed as the above indicated U.S. Congressional House Document. In regard to the shoreline east of Lorain Harbor, this report chronicled the attempts by the federal and city authorities and private property owners to halt erosion which had been "active over the entire period of record". These attempts have ranged from the dumping of massive quantities of spoil to the dumping of broken concrete paving and bricks. Neither of these efforts nor the many private shore protection structures built have been effective in stopping erosion along this shoreline.

22 January 1970, Section 111 Reconnaissance Report by U.S. Army Corps of Engineers, Buffalo District, entitled "Investigation of Effects of East Breakwater Shorearm at Lorain Harbor, Ohio on Adjacent Shore". This study was undertaken by the Corps in response to claims by residents that the east breakwater shorearm was causing increased erosion along the shoreline east of that structure. Although the Corps did recognize that the shore along Lakeside Avenue was suffering increased erosion, this was attributable to the near record high lake levels being experienced at that time. No further investigation was recommended.

"Design Analysis for Spending Beach Section of Dike Disposal Area, Lorain Harbor, Ohio", a report prepared in June 1975 by Parsons, Brinckerhoff, Quade & Douglas, Inc. for the U.S. Army Corps of Engineers, Buffalo District. This report was prepared to present the design basis and impact analysis justifying the construction of the revetment spending beach joining the dike disposal structures to shore at the foot of Colorado Avenue. It was expected at that time that the spending beach would increase the deposition of suspended material between the containment structure and the shoreline. It was also realized that the dike would provide protection to the shoreline from storm waves from the northwest, but no further protection of the privately owned shoreline was considered warranted as no adverse effects from the dike were anticipated.

Section 111 Reconnaissance Report on Shores East of Diked Disposal Area, Lorain Harbor, Ohio, a report prepared in February 1980 by Tetra Tech, Inc. for the U.S. Army Corps of Engineers, Buffalo District. Conclusions of this study were that the Dike Disposal Area had not caused the erosion problem experienced by the shores east of Lorain, however the Dike Disposal structure has contributed to shoreline erosion. A detailed feasibility study was suggested to formulate a basis for selection of an optimum plan for mitigation of dike attributable shoreline erosion.

RESOURCES AND ECONOMY OF STUDY AREA

ENVIRONMENTAL SETTING

The city of Lorain is located along the south shore of Lake Erie about 27 miles west of Cleveland, Ohio. The Black River meanders through the city and discharges into Lake Erie at the site of Lorain Harbor.

The general shore characteristics to the east and west of Lorain Harbor are comparable. With the exception of the approximate 3000 foot segment westerly of the Harbor, at and contiguous to Lakeview Park, where shore protection works and recreational facilities have substantially altered (improved) the shore characteristics. The harbor entrance structures have constituted a complete littoral barrier to alongshore sediment transport for the past 75 years (see Figure 1). As a result, littoral material movement to the west of the Harbor has no measurable effects on the shore characteristics east of the

Harbor and vice-versa.

The shore east of the Disposal Dike and its spending beach revetment is characterized by a bluff 20 to 25 feet high. Composition of the bluff varies, but, generally consists of fairly compact boulder clay containing less than 20 percent granular material, which would tend to remain in the beach and foreshore zone after the bluff erodes. Shale outcrops are a common feature along the Lake Erie shoreline, however they are not prevalent in the study area. The slope of the bluff is nearly vertical exclusive of shore segments where man-made structures influence the ground profile fronting the bluff.

The shoreline east of the dike disposal structure has been protected by numerous private protective structures since the early 1900's. In a 1974 survey by the Ohio Department of Natural Resources, an average of 46 structures per mile of shoreline were counted in the Lorain County reach 3 shoreline, which includes the study area. These structures were primarily seawalls and groins but breakwaters and piers were also evident.

These man-made structures play an important role in the control of bluff erosion. There is a direct correlation between the erosion rate and the presence and age of structural protection. The existence, or lack thereof, of a beach fronting the bluff can also be correlated with bluff recession rates. Historically the beaches fronting the bluff within the study area have progressed from wide natural beaches in the late 1800's to beaches trapped by man-made structures in the mid 1900's to practically no beach today. The well intentioned solution to the bluff erosion problem is now contributing to the recession by denying littoral material to the beach zone. Bluff erosion is the major source of beach building material in the study zone and without it the protective beaches will continue to erode.

Figure 2 presents comparative ground photographs of the shoreline and bluff in the study zone east of the dike disposal structure.

The predominant type of housing in the area is single family, multi-level, frame dwellings. Much of them date from the period of World War I through the mid 1920's.

Property values generally increase from west to east in the project area. The condition of structures varies widely.

Local terrain is typical glacial lake plain and is relatively level. Surficial materials are primarily unconsolidated pleistocene glacial deposits. Low relief, relic beaches and ridges can be found inland of present beaches and represent earlier higher, states in Lake Erie geological history. In the shallow nearshore zone fronting the study area, the benthic community is dominated by sludge worms and midge larvae and is characteristic of a moderately polluted bottom. The phytoplankton is typical of similar areas with blue-green, green, dinoflagellate, and diatom species present. The zooplankton consists of calanoid and cyclopoid copepods, cladocerans, miscellaneous crustacean nauplius larvae, and rotifers.

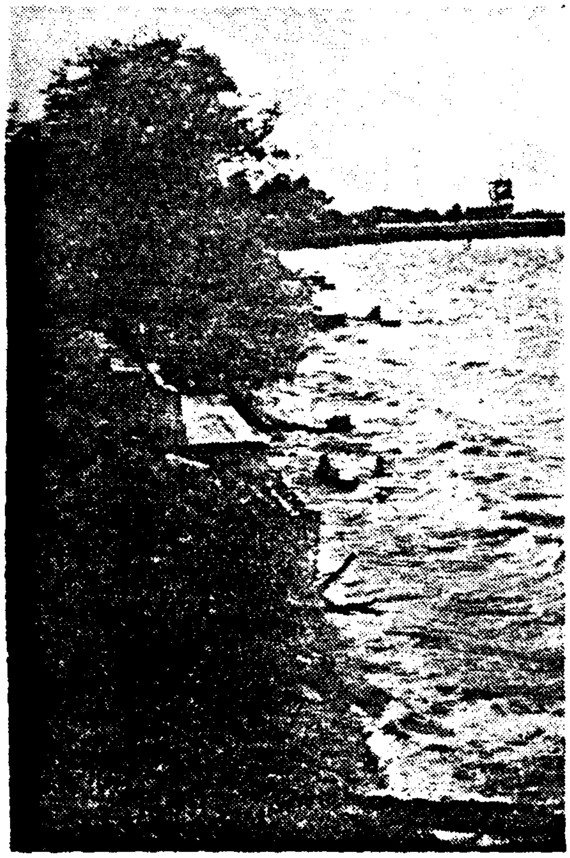
In order to assess the impacts of the proposed plans on significant cultural resources, the 18 March 1980 edition of the National Register of Historic Places and all subsequent revisions were consulted. While several properties were listed for the city of Lorain, only one, the Lorain Lighthouse, is located in close proximity to the Environmental Impact Area of this study. This structure will sustain no direct impacts as a result of this study, but may be subjected to visual impacts resulting from nearby construction. Based on a cultural resources report completed for the area in 1975 entitled: Inventory of Cultural Resources: Diked Disposal Site No. 7, Lorain, Ohio, by Dr. Don Dragoo, there are no potentially significant sites which would be impacted by any of the project alternatives. This report is contained in the Cultural Resources Appendix No. 6. In addition, the Regional Archaeological Preservation Officer, in Cleveland, has stated that no known archaeological sites exist in or adjacent to the study area.

Access to much of the shoreline, in the project area, is limited by residents who have posted the beaches behind their property.

Shoreline at East Breakwater Shorearm
Fall 1976

Shoreline at Spending Beach Revetment
Spring 1978

Figure 2



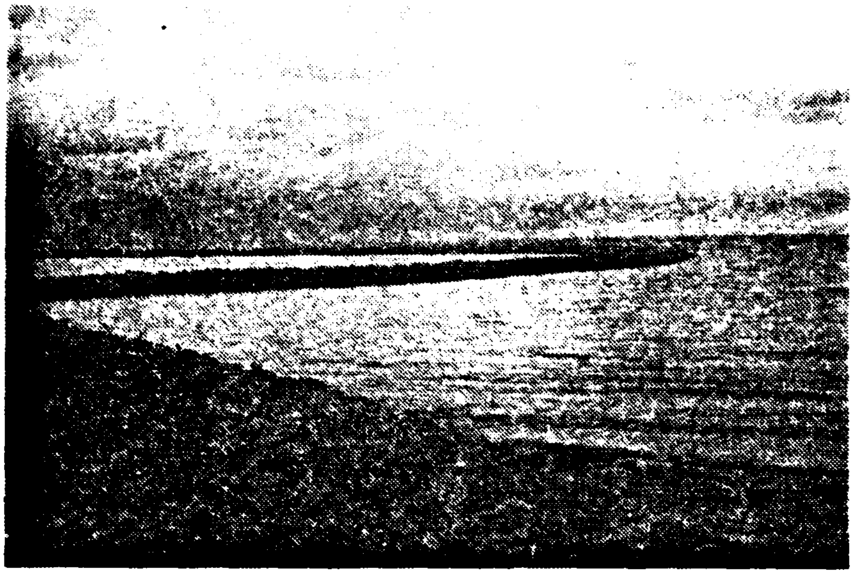
Looking West along
Shoreline toward Spending
Beach Revetment
October 1979

Looking west from House Lot #739
Fall 1976

Figure 2A

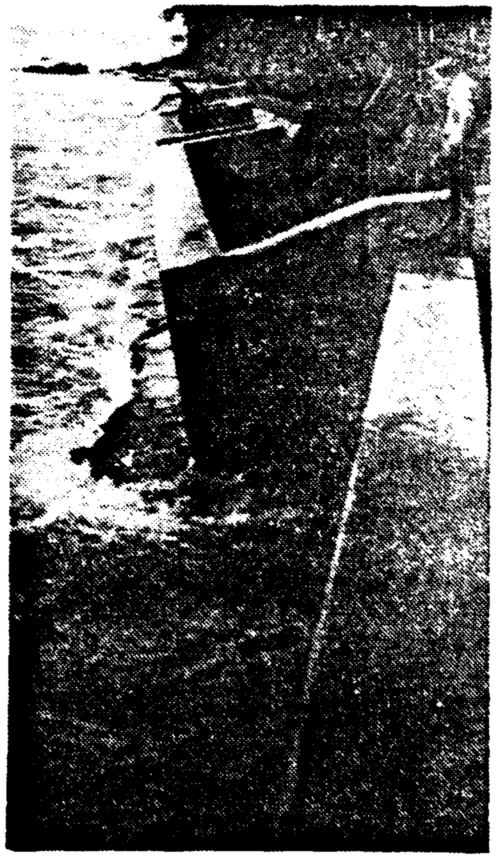
Looking West from Colorado Avenue
Fall 1976

Figure 2B



Spending Beach Revetment and
Disposal Retention Dike
October 1979

Looking East from Spending Beach
Revetment, October 1979



Seawall Condition at the foot
of Idaho Avenue, October 1979

Figure 2C

No wetland areas are located in the study area. The water quality of Lake Erie is generally regarded as degraded.

No species on the U.S. Fish and Wildlife Service's list of endangered and threatened wildflife and plants or on the Ohio Department of Natural Resources' list of endangered wild animals occurs in or near the study area.

RESOURCES AND ECONOMY

Due to its location at a juncture between lake, rail and highway systems and other lesser factors, Lorain has developed a diverse business-industrial base. Plants in the city employ over 24,000 workers with an annual payroll in excess of $250 million. The city has been a major port for a considerable period. It has facilities for shipping and receiving bulk cargo such as iron ore, coal, and gypsum. A nearly complete, multi-million dollar pelletized iron ore terminal, is now operating in the port. Vessels up to 1,000 feet in length can be handled at this facility. A major ship building firm is located on the Black River, just upstream of the main commercial docks. Repair and winter shelter for lake carriers is provided at several points along the river as well.

The economic dependance of the area upon the port is indicated by the fact that over 15,000 persons living in and around Lorain work in jobs which depend upon ship-carried iron ore supplies. An average of over 7 million tons of ore passes through the port each year. Ore carrier traffic on the Black River requires channel dredging. Materials removed from the river bottom during dredging would contaminate local waters and are prevented from doing so by isolating them in the dike disposal area located next to the east breakwater. Federal regulations require such a disposal method for polluted materials.

Industrial activity includes the manufacturing of steel pipe, ships, automotive components, vehicles, chemicals, building materials and electronic equipment. Lorain has a diversified employment base due to the existance of over 55 manufacturing plants. The largest single employer in the area is a major auto maker with 8,000 to 9,000 employees, in two plants. A major steel plant is second with 7,500 to 8,000 employees. A third firm, a builder of bulk cargo ships, also employees large numbers of Lorain residents.

Both primary metals and transportation manufacturing, employing over one third of the total county work force, are not anticipated to gain in absolute employment over the next 20 to 30 years; according to Northeast Ohio Demographic and Economic Projections 1970-2020. Employment in Lorain County has expanded at a moderate rate and is estimated to reach 91,350 by the end of 1980.

1970 census data indicated that an average property in the study area, house and lot, was valued at between $10,000 and $12,750. Present values for study area housing are estimated to range between $40,000-$70,000. Data from the city of Lorain indicates that 45 lakefront parcels are occupied within the study area. Using average figures, the total value of these occupied properties is about $2,000,000.

Lake related leisure time activities are an important element in Lorain recreational picture. Pleasure boating, fishing, swimming, walking, and running activities are commonly observed on or near the lakeshore. A shortage of public fishing piers exists in the area. As a result, a number of structures such as the dike disposal area, east breakwater shorearm and the groins located in Century Park are being utilized by the general public. Residents also use privately owned and built seawall structures for fishing. These structures are used to observe harbor and lake activities as well.

Approximately 3,000 small boats were registered in Lorain during the mid 1970's. The port authorities have indicated that the needs of such craft and their operators are of concern. Marina development plans have been formulated and additional planning activity is taking place at present.

PROBLEMS AND NEEDS

GENERAL

The Lorain Harbor Diked Disposal Area is a Federally constructed facility whose purpose is to contain the polluted sediments from harbor dredging operations. The Diked Disposal area was constructed during the period August 1976 to November 1977. Subsequent to this construction, residents east of the harbor have complained that the structure is causing significant shoreline erosion and has contributed to failure of shore protection structures. Prior reports, as cited in the first section of this main report, document the fact that the shores east of Lorain Harbor have had a long history of erosion problems. The Section 111 Reconnaissance Report, completed by the Buffalo District Corps of Engineers in February 1980, concluded that the Dike Disposal Area had not caused the entire erosion problem experienced by the shore east of Lorain Harbor; however, the structure has contributed, to some degree, an impact which may accelerate this natural condition. The purpose of this report is to determine what post 1977 shoreline damages are attributable to the Federally constructed diked disposal structure, evaluate alternatives, and select the optimum alternative providing that the selected plan is socially acceptable, technically practical and economically justified. Mandatory action on the part of the Federal government is not required under the regulations for a Section 111 study but considering the historical erosion problem along this shoreline, the need still exists for total erosion protection.

EXISTING CONDITIONS AND FACTORS PERTINENT TO THE PROBLEM

Existing conditions of the shore east of the Diked Disposal area have been summarized in earlier sections of this report, and in the attached appendicies. Physical factors and analysis pertinent to the problem are addressed in the paragraphs that follow.

Fluctuations in lake level may alter shoreline conditions extensively. The International Great Lake Datum (IGLD) for low water for Lake Erie has been established at 568.6 feet. The mean elevation of the lake surface for the period 1860 to 1977 has been 570.36 feet or 1.76 feet above low water datum. In addition to annual and seasonal fluctuations, cycles of high and low stages, (as related to either the IGLD or the average lake level for the past 117 years) extend over periods of several years with no historically consistent pattern. During cycles of high lake stages, incident wave energy is dissipated in a more shoreward location; thus, the shoreline bluff and man-made shore protection structures are subjected to direct wave attack. Shore recession and resultant addition of sediments to the littoral zone can be expected during these cycles of high lake state. In the transition period to and during the low stage cycles, there is a beach and foreshore profile adjustment, and the incident wave energy is dissipated in a more lakeward location. During the low stage cycles, additional beach area may be expected, the bluff will attain stability, and man-made shore protection structures designed to impound alongshore moving littoral materials can be expected to be more effective. In addition to annual fluctuations, storms produce local lake level changes of irregular duration and these can be of significant importance to shore process; particularly during cycles of high lake stages. The following is a tabulation of pertinent data on Lake Erie levels as provided by the U.S. Lake Survey Center for the gage at Cleveland Harbor, Ohio. These data are considered applicable to levels at Lorain Harbor:

Date	Mean Elevation (IGLD)*Feet	Variance From (IGLD)*Feet
Annual		
1968	570.92	+2.32
1969	571.54	+2.94
1970	571.10	+2.50
1971	571.27	+2.67
1972	571.89	+3.29
1973	572.71	+4.11
1974	572.52	+3.92
1975	572.27	+3.67
1976	572.13	+3.53
1977	571.24	+2.50
1978	571.48	+2.88
1979	571.[illegible]	+2.95
Longterm 1860-1977	570.36	+1.76
Highest Monthly Mean = July 1973	573.51	+4.91
Lowest Monthly Mean = Feb. 1936	567.49	-1.11

*IGLD = International Great Lakes Datum(1955) = 568.6 feet

For study planning and design a Lake level of 574.1(IGLD) has been selected. This is based on a 20 year return interval mean water level of 573.05 feet plus a 1.05 foot annual average peak rise in the mean level at Lorain Harbor.

Wind data for the study area was obtained from U.S. Coast Guard data at Lorain Harbor, Ohio for the period 1938 thru 1971. This data shows no predominance of wind from any particular direction, although there is a slight favor of winds from the West vs. winds from the East. There is also a slight favor of the higher wind speeds (25 mph and over) from the Northwest and West directions over those from the Northeast. These factors, are enough to overcome the inconsistency of fetch lengths (approx. 70 miles to the Northwest vs. approx. 200 miles to the Northeast) to produce the highest deep water wave heights from Western approach quadrants. Based upon a 10 year return interval extreme estimate of conditions offshore of the study area, a deep water wave height of 9.8 feet for waves approaching from the North thru Northwest direction will be used as the design storm wave for this study.

Aerial photographs (1974,1978,1979,1980) showing shore structures to the east of Lorain Harbor indicate a very slight predominance of east to west movement of littoral materials. This is not inconsistent with the estimate of extreme storm waves out of the west as mentioned above in that littoral movements are dependent upon the duration of wave activity and the angle of incidence with the shoreline as well as wave severity.

There are three possible sources of sediment supply to the littoral zone in the study area; stream discharge; bluff erosion; and supplies from outside the study area. The suspended sediment load of the Black River is confined by the federal navigation works from entering the littoral zone downdrift of the study area. Updrift, to the east of the study area, there are no streams which contribute significant quantities of sediment to the littoral zone.

Bluff erosion within the study area comprises the major contribution to the littoral zone supply. Because of the composition of the bluff, only a small portion (approximately 700 yd^3/yr/mi out of a total 3600 yds^3/yr/mi in Lorain County from Charles H. Carter, <u>Sediment Load</u>

Measurements Along the United States Shore of Lake Erie, 1977) is available as beach building material. Therefore, large portions of the bluff must erode to provide even small quantities of sediment in the littoral zone.

The Lorain Harbor navigation works present a complete littoral barrier to sediment transport from the west of the study area. To the east, numerous private shore protection works trap littoral sediments and provide a minimal quantity of material into the study zone.

Bluff recession rates have been calculated in the Problem Identification Appendix of this report. By using long term averaging of bluff line changes over the period 1937 to 1973, a pre-dike bluff recession rate has been quantified for the 2500 feet of shoreline in the study area. This 2500 feet has been broken down into smaller increments based upon sections of shore which remained stable or which receeded during the 1937 to 1973 period. These calculations resulted in the pre-dike recession rates shown in the tabulation below.

For the post-dike period, aerial photographs of the study area were compared to determine the position of the bluffline in 1978 and 1980. This type of analysis is subject to various inaccuracies which are listed in the Problem Identification Appendix. The most serious drawback is the small time frame over which these average recession rates were obtained. Two years is considered to be an insufficient time period for this analysis because it does not cover high and low periods of lake level. Therefore, the rates obtained may be biased toward excessive recession in this, a high lake level period. The predicted post-dike bluff recession rate per shoreline increment is also presented in the tabulation below and further discussed in Appendix 1.

Shoreline Increments*	1937-1973 Pre-Dike Rate	1978-1980 Post-Dike Rate
- 0 to 50	0.4 ft/yr.	0.0 ft/yr.
50 to 450	1.2	0.0
450 to 950	1.2	0.2
950 to 1950	0.8	1.5
1950 to 2350	0.7	2.9
2350 to 2500	0.0	1.1

*Refers to distance in feet east of the centerline of Colorado Avenue; further discussed on page 1-30 and 1-34 of Appendix 1.

The difference between the pre and post dike rates represents a worse case estimate of the effects of the dike disposal structure on the study shoreline. The influence of high lake levels and failing private protective structures could not be quantified for the short post dike period and therefore the increased recession rate has been attributed solely to the federal navigation works as an estimate of the upper limit of federal responsibility. A weighted average recession rate comparison for the 2500 feet of study shoreline reveals that the post-dike average of 1.1 ft/yr is not significantly greater than the pre-dike average of 0.8 ft/yr considering the inaccuracies of aerial photography bluff recession data.

Data to determine the volumetric bottom changes in the study area are limited to bottom soundings taken in June 1974, October 1979, and April 1980. Detailed analysis of these data is presented in Appendix 1. This analysis indicates that accumulation of littoral sediments in the nearshore zone for a distance of 800 feet east of the spending beach revetment has averaged 5400 cubic yards per year since November 1977 (completion date of Dike/Revetment construction). This accumulation serves as a beneficial factor in regard to shore protection for the 800 foot sector east of the revetment. From Station 8+00 to 25+00 bottom sounding data are sparse and reliable volumetric computation of changes between November 1977 and April 1980 is not possible. Qualitative analysis of data indicates erosion from Station 8+00 to 24+00, thence, slight accretion to Station 25+00, even though there is indicated bluff recession in the shore segment from Station 24+00 to 25+00.

Wave refraction analysis indicates that the Dike structure geometry causes waves from the Northwest to be masked for a distance of about 800 feet east of the Revetment (Colorado Avenue). Easterly transport of the accumulated material in the foreshore zone formed by the Dike, revetment, and shore is minimal. The quantity of material required to fill this zone until waves from the western quadrants transport material back to the east is estimated to be in the order of 400,000 cubic yards; thus, impoundment of westerly drift in this zone can be expected for many years in the future.

An analysis of waves from the northeast and resultant shoreward reflection off the Dike structure indicated that this factor would have minimal adverse impact on the study shoreline. Also, an evaluation of water level setup in the zone formed by the Dike, revetment, and shore, due to waves from the northeast quadrant, indicated that this factor would have minimal adverse impact.

IMPROVEMENTS DESIRED

The construction of the Dike for the Disposal Area was started in August 1976 and completed in November 1977. Therefore, claims by shorefront property owners that the Dike system has adversely affected their shoreline would be applicable for the period November 1977 to the present.

Some residents state in letters (on file with the Buffalo District Engineer Office) that they had between twenty to twenty-five feet of beach front on their property prior to the Dike construction and that no beach now remains. Statements in other letters indicate that the elevation of the beach fronting their seawalls has lowered four to five feet since Dike construction. They also state that, in the past, waves from the northwest would return sand to their shore frontage from the west. Now, however, the Dike construction is said to cause sand accumulation at the junction of the Dike and shoreline where waves from the Northwest cannot transport the sand in an easterly direction. A resident states that waves from the northeast reflect off of the Dike structure and increase in intensity as they break on the shoreline. Another resident claims that the Dike forms an embayment into which storms from the northeast drive the lake water and this increases the water level so that the waves attack the shoreline at a higher level.

The improvements desired by the affected residents and the city of Lorain are reflected in the 19 July 1979 formal request by the Mayor of Lorain. He requested a Federal investigation of the severity of the erosion problem attributable to the Disposal Dike. Statements from attendees at public hearings on the problem and by written communications to the Buffalo District Engineer also indicate desire for action. The local residents request that the Federal government accept the responsibility for increased erosion and for failed private structures along the study shoreline. The improvements considered by the Federal government for this study are commensurate with the limitations specified in Section 111 of P.L. 90-483; namely, that Federal financial responsibility be limited to the improvements which mitigate only the damages attributable to the Federally constructed Dike Disposal structure.

PLANNING OBJECTIVES AND CONSTRAINTS

In the planning objectives process, consideration must be given to national, state, and local water and related land resource management needs specific to the study area that can be addressed to enhance the National Economic Development(NED) or the Environmental Quality(EQ). The NED objectives include the consideration of tangible and intangible benefits and the EQ objectives include the enhancement of quality aspects of water, land, and air by control or prevention of erosion and avoiding irreversible commitment of resources to future uses. The planning objectives must be responsive to public concern with regard to regional population growth, economic development, land use, aesthetics, and insure that solution to a smaller area is consistent with broader or regional concerns. The planning objective must consider base conditions and future projection without changing existing or base conditions.

The specific planning objectives are:

(a) To improve National Economic Development by increasing the value of the nation's output of goods and services and improving economic efficiency;

(b) To enhance Environmental Quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

(c) To mitigate or prevent shore damages due to the dike disposal structure and natural processes.

(d) "Any additional objectives" eg. To provide for the health and safety of these people living along the shoreline east of the dike disposal area.

PLANNING CONSTRAINTS

Constraints on the planning process and on plan formul:tion include 1) legal, as defined in the limitations of Section 111 of Public Law 90-483, and policy as expressed in Engineering Regulation(ER) 1105-2-50, 2) environmental and 3) other.

The above cited law authorizes the Chief of Engineers to study, construct, and maintain works for prevention or mitigation of damages to both public and privately owned shores to the extent of the damages that can be directly identified and attributable to Federal Navigation works. The policy as expressed in ER 1105-2-50 sets forth that the objective of Section 111 is to provide mitigation measures for shore damages attributable to Federal Navigation projects, where equitable and in the public interest. Justification of mitigation measures should be made by comparing their costs with values represented by the damages preventable. Exercise of the authority of Section 111 to provide mitigation measures at Federal expense is not mandatory and a finding for or against its use should fully consider the pre-project conditions and the justification of incurring mitigation costs. Also, Federal expenditures are limited to 1 million dollars unless there is specific Congressional authorization.

Environmental constraints in the process of planning objectives involved the consideration of causing the least possible disturbance of the terrestrial and aquatic environments, of maintaining or improving the aesthetic value of the affected area, and of alleviation of concern.

Other constraints in the process of planning objectives involved the limited amount of quantitative data available for comparing the study area's physical changes relative to the pre and post dike construction.

FORMULATION OF ALTERNATIVE PLANS

Formulation of alternative plans to mitigate shoreline damages attributable to the Dike Disposal Area structure required the consideration of several measures. The establishment of alternatives also required the consideration of engineering feasibility, economic practicability, and environmental and social effects.

GENERAL FORMULATION AND EVALUATION CRITERIA

In accordance with established Federal policy on multiobjective planning for water resource studies, the impacts that must be assessed are specified as well as the conditions and criteria applicable to plan formulation. Formulated plans must meet needs of the area taking into account both tangible and intangible benefits and costs, and effects relating to the environment and social well-being of the area.

The process of plan formulation and screening of alternatives must be compatible with the planning framework established in the Water Resources Councils' "Principles and Standards for Planning Water and Related Land Resources", which requires the formulation of alternative solutions to the problem. The alternatives must serve the objectives of National Economic Development(NED), Environmental Quality(EQ), Regional Development(RD), and Social Well-Being(SWB). The process of plan formulation must include structural and non-structural measures.

Within the planning framework specific criteria must be established relative to general policies, technical engineering, economic principles, social, and environmental values. These criteria are as follows:

General

a. The Federal responsibilities for mitigation measures be limited to that authorized under provisions of Section 111 of the River and Harbor Act of 1968 (P.L. 90-483) and be in accordance with guidance provided in Engineering Regulation (ER) 1105-2-50.

Technical Criteria

a. Engineering design and anticipated construction procedures should be based on present state of the art and knowledge applicable to the field of coastal engineering.

b. A coincident 200 year design frequency, using the 10 year recurrence significant deep water wave height in combination with the 20 year lake level, should be used for design of structures.

c. Moderate wave overtopping of groins is considered acceptable since the purpose of the groins is to compartment the fill.

d. Crest elevation of revetment be designed to permit no wave overtopping for the design storm conditions.

Economic Criteria

a. Tangible benefits should favorably compare with project economic costs.

b. Each formulated plan should provide the maximum net benefits within the formulation framework.

c. The benefits and costs should be in comparable economic terms.

d. A 50 year economic life and 7 1/8 percent interest rate are used for the economic evaluation.

e. The base case for comparison of alternative plans is the No Action plan.

f. Cost and benefit estimates are to be based on 1980 unit prices

Socio-economic and Environmental Criteria

For water resource planning, the criteria for socio-economic/environmental considerations are set forth by the National Environmental Policy Act of 1969 (P.L. 91-190) and Section 122 of the River and Harbor Act of 1979 (P.L. 91-611) and the guidance criteria contained in ER 1105-2-105. These criteria require that all significant adverse and beneficial economic, social, and environmental effects of planned developments be considered and evaluated in the process of plan formulation.

ALTERNATIVES CONSIDERED

In formulating the plan of improvement, 7 alternatives were considered and evaluated in terms of applicable criteria to determine that plan which most favorably fulfills the planning objectives and constraints. The alternative plans considered were:

- I No Action
- II Land Acquisition
- III Feeder Beach
- IV Groin System with Fill
- V Revetment
- VI Offshore Segmented Breakwaters with Fill
- VII Single Long Groin with Shore Restoration

The following is a screening of the alternative plans in terms of meeting planning objectives and constraints:

ALT. PLAN I - No Action: This plan represents the base condition for evaluation of all other structural alternatives. This alternative avoids the monetary investments and potential adverse impacts associated with the other plans. There would be no tangible or intangible NED Benefits resulting from this plan and no EQ, RD, and SWB impacts. The problems of shore erosion would remain unchanged. The No Action plan is responsive to the planning objectives should a determination be made that proceeding with mitigation measures for shore damages would not be justified on the basis of equity and in the public interest.

ALT. PLAN II - Land Acquisition: The principal feature of this plan is to award complete monetary reimbursement to owners and dwellers in the damaged area for property which must be vacated due to threatened erosion. This plan is responsive to planning objectives. Because adequate replacement housing is assured elsewhere in Lorain, these people suffer the loss of lakefront sites for their dwellings but are compensated by the realization that they need never be concerned again about the threat of loss due to bluff erosion. Federal policy (see public Law P.L. 91-646 Section 206) prohibits any type of relocation (except physical movement of the structure) when these types of purchase options are available to homeowners who receive fair compensation for evacuating their property. The possibility of physically relocating the houses is precluded by lack of available land and, often, the age and condition of the structures. In addition, alterations of aquatic and nearshore habitats would not occur under this plan and an opportunity for a significant public benefit would occur if the vacated land is converted into an upland recreational area by local interests.

ALT. PLAN III - Feeder Beach: This plan involves the initial placement of sand in the eroded shore sector (Station 8 + 00 to 24 + 00) equal to that which has been calculated to have been impounded by the Dike Disposal Structure which is 18,500 cubic yards to cover the period 1977 to 1980, thence the periodic placement of sand (equal to 5400 cubic yards per year) in the same area for the life of the project. This plan is only partially responsive to planning objectives as it does not provide a solution for the total erosion problem. Although the plan provides for replacement of an amount of sand back in the littoral zone equal to that calculated to be impounded by the Dike Disposal Structure, the predicted effectiveness of the plan is judged to be marginal because of the relatively small quantities of sand involved in the placement operation.

ALT. PLAN IV - Groin System with Fill: This plan involves the construction of four groins equally spaced within the eroded shore sector with concurrent filling of the compartments between the groins and annual nourishment thereafter for the life of the project. The plan fulfills planning objectives. The plan provides for partial treatment of the total erosion problem within the study limits. Its engineering certainty is judged to be greater than the Feeder Beach Plan for treatment of that portion of the erosion problem attributable to the Dike Disposal structure. However, the Groin and Fill Plan is judged to be of a lessor engineering certainity as compared to the Revetment Plan (Alternative Plan V).

ALT. PLAN V - Revetment: This plan involves the construction of a revetment throughout the length of the eroded sector. This plan fulfills planning objectives. The plan provides protection of the shore against natural erosion as well as any aggravated erosion caused by the Dike Disposal Structure. The engineering certainty of this plan is judged to be very positive and considered to be higher than any of the other structural alternatives considered in this study.

ALT. PLAN VI - Offshore Segmented Preakwaters with Fill: This plan involves the construction of a series of offshore breakwaters which would serve to protect the eroded sector of the study area. Initial and periodic placement of sand fill along the shore would be required. The plan fulfills planning objectives. It would provide protection of the shore against all causes. The engineering certainty of this plan is judged to be very high and comparable to the Revetment Plan (Alternative V). However, this alternative Plan VI was rejected for further consideration on the basis of excessive costs incurred to duplicate the effectiveness of protection that could be accomplished from other structural alternatives.

ALT. PLAN VII - Single Long Groin with Shore Restoration: This plan involves the construction of one long groin positioned along the shore such that the prefilled beach and foreshore zone to the east of the groin protects shores to the easterly limit of the study area. This groin would also compartment the shore segment westerly to the Dike Disposal Revetment to retain placed sand fill and thus protect that shore segment. This plan fulfills planning objectives. The engineering certainty of this plan is less than the Revetment Plan and the Offshore Segmented Breakwater Plan. There is also an engineering uncertainty of the amount of fill that would be needed periodically on the easterly side of the groin to meet requirements of maintaining the geometry and stability of the initially placed and adjusted fill. Because of this uncertainty, this plan was rejected for further study.

ALTERNATIVES CONSIDERED FURTHER

In reference to the seven alternatives considered, alternatives rejected were: Offshore Segmented Breakwaters with Fill(No. VI), and Single Long Groin with Shore Restoration(NO. VII). The No-Action Plan, Alternative I, is considered to be the base condition for comparison to all alternatives and consideration of this plan is implicit within the evaluation of the four remaining plans. The four alternatives considered for further evaluation are: Land Acquisition (No. II), Feeder Beach (No. III), Groin System with Fill (No. IV), and Revetment (No. V). Figure 3 is a layout for the Feeder Beach Plan, Figure 4 shows the Groin System with Fill Plan, and Figure 5 is a layout of the Revetment Plan.

The following summary tabulation presents an estimate of the cost and benefit analysis of the four alternatives:

Alternative Plans

	Land Acquisition	Feeder Beach	Groins & Fill	Revetment
First Costs	($X1000)	($X1000)	($X1000)	($X1000)
Federal	1022*	288	288	288
Non-Fed.	1152	0	1956	1508
Total	2174	288	2244	1796
Annualized Costs				
Federal	75	75	75	75
Non-Fed.	85	0	153	87
Total	160	75	228	162
Annualized Benefits	18	22	30	33
Benefit/Cost Ratio	0.11	0.30	0.13	0.20

*First cost amounts exceeding one million dollars require Congressional authorization.

SUMMARY & SYSTEM OF ACCOUNTS

A tabulation of summary and systems of accounts(S&A) for this Section 111 study of the shores east of the Lorain Harbor Diked Disposal Area structure follows.

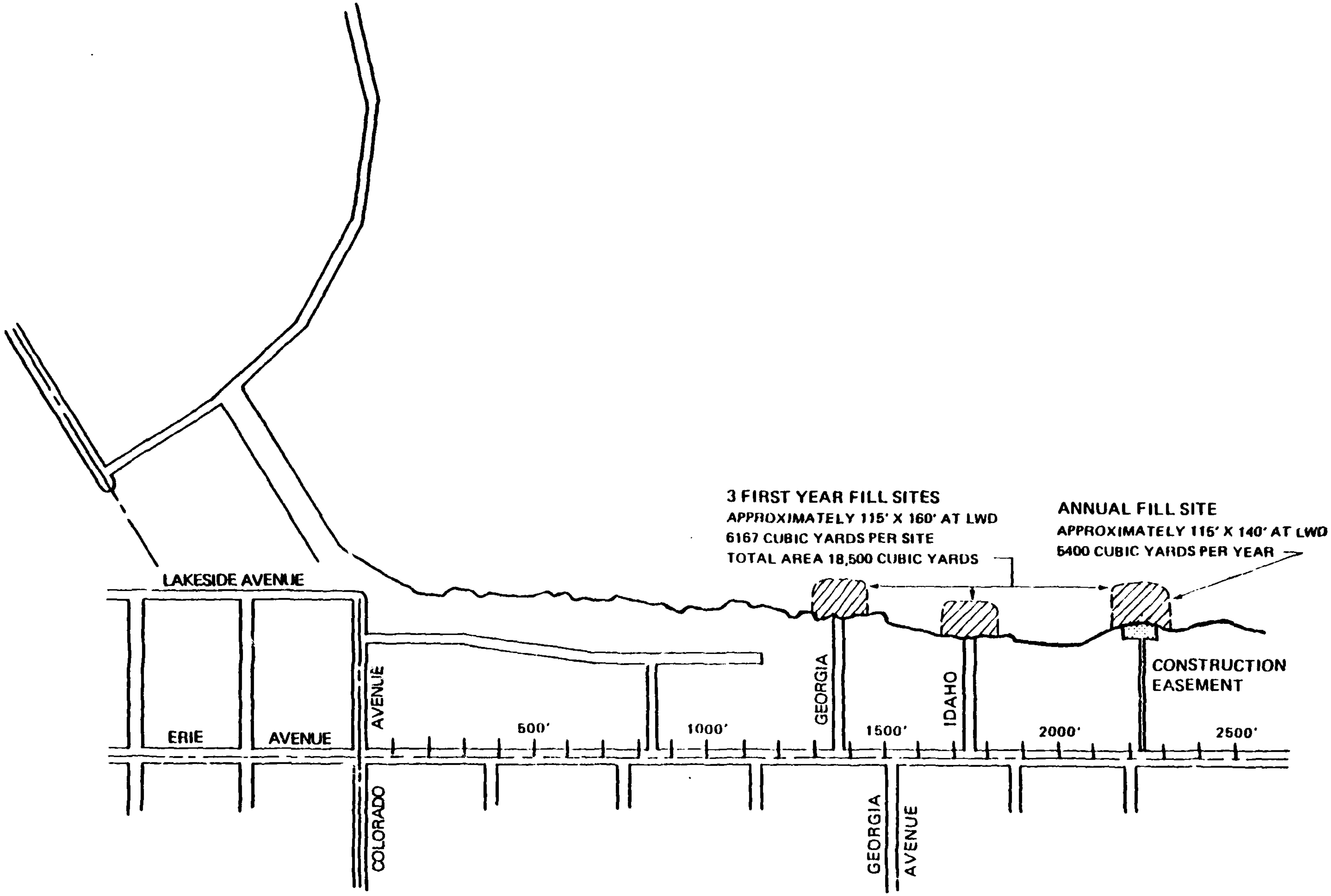


FIGURE 3 ALTERNATIVE III FEEDER BEACH PLAN

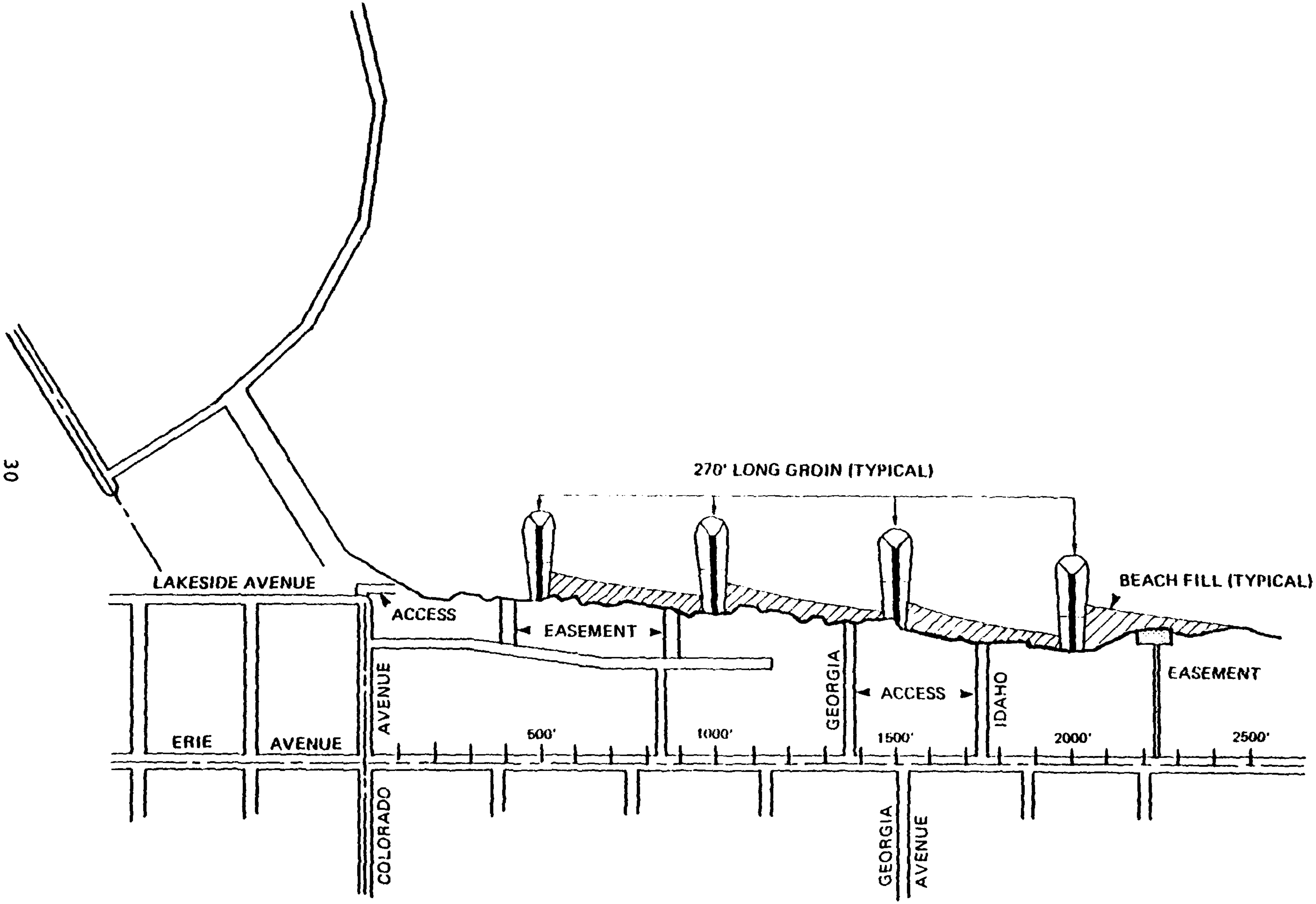


FIGURE 4 ALTERNATIVE IV GROIN SYSTEM WITH FILL PLAN

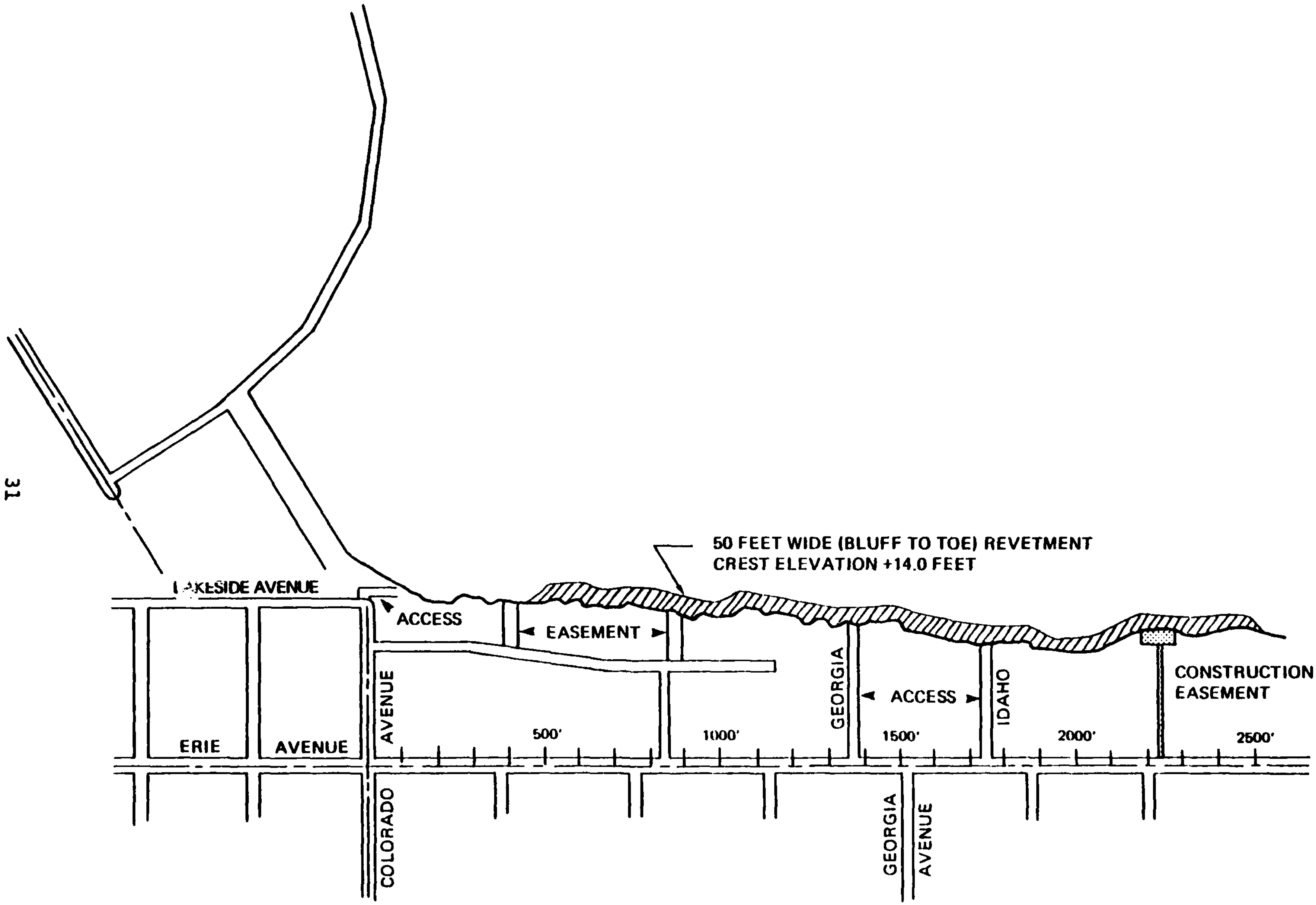


FIGURE 5 ALTERNATIVE V REVETMENT PLAN

TABLE 1
SUMMARY & SYSTEMS OF ACCOUNTS
SECTION 111, DIKED DISPOSAL AREA, LORAIN HARBOR, OHIO

	ALT I NO ACTION	ALT II LAND ACQUISITION	ALT III FEEDER BEACH	ALT IV GROINS & FILL	ALT V REVETMENT
A. Plan Description					
1. Affected Shoreline	Sta 00+00 to 25+00(2500ft)	Sta. 8+00 to 24+00(1600ft)	Sta. 00+00 to 25+00(2500ft)	Sta. 5+00 to 25+00(2000ft)	Sta. 5+00 to 25+00(2000ft)
2. Nature of Plan	No Change	Acquire land & remove all structures in affected area adjacent to bluff total 26 parcels & 27 families	Place 18,500 yd^3 sand in first year at 3 sites followed by periodic placements (averaging 5400 yd^3 annually)	Construct groin field of (4) 270 ft long groins spaced 500ft apart and fill in each compartment with 9630 yd^3 sand. Periodic nourishment averaging 2700 yd^3 annually.	Construct 14' high rubble mound revetment along 2000ft of shore backing up to bluff & incorporating existing private structures
3. Easements Needed	None	None	1 via private property 2 via public street end	3 via private property 3 via public street ends	3 via private property 3 via public street ends
B. Impact Assessment					
1. National Economic Development (NED)					
a. Benefits					
1. Reduced damages to private land lost, private structures lost, private shore protective works built	Adverse $22,500 annual damage above natural erosion	Beneficial $17,900 annual savings in private protective structures not needed	Beneficial $22,500 annual savings to land, homes, & protective structures	Beneficial $29,850 annual savings to land, homes, & protective structures	Beneficial $33,000 annual savings to land, homes, & protective structures

TABLE 1 (cont.)
SUMMARY & SYSTEMS OF ACCOUNTS
SECTION 111, DIKED DISPOSAL AREA, LORAIN HARBOR, OHIO

	ALT I NO ACTION	ALT II LAND ACQUISITION	ALT III FEEDER BEACH	ALT IV GROINS & FILL	ALT V REVETMENT
2. Recreational	No Benefit	Possible future benefit if cleared land is converted to parkland by local interests	No benefit due to short lived nature and low elevation of fill for bathing use	No benefit for beach due to low elevation of fill & access difficulty. Possible benefit of groins as fishing piers	Possible benefit as fishing facility
3. Intangible	No Benefit	Alleviation of concern of residents in damaged area	Beach aesthetics improved. Possible future use of accreting fillet as bathing beach	Alleviation of concern in protected area. Enhanced property values due to stabilized bluff line. Beach aesthetics improved	Alleviation of concern in protected area. Enhanced property values due to stabilized bluffline. Aesthetic enhancement of bluff as viewed from lake.
b. Increased Employment	No Change	Temporary during moving households and removal of structures.	Temporary and periodic. Approx. 1 month per year	Temporary during construction period. Periodic for nourishment thereafter	Temporary during construction period only.
c. Increased Safety	Adverse: Bluff eroding at accelerated rate	Structures in damaged area removed before hazard exists	Limited: Bluff continues to erode but at pre dike rate	Partial: Bluff may erode at much reduced rate	Structures fully protected

TABLE 1 (cont.)
SUMMARY & SYSTEMS OF ACCOUNTS

SECTION 111, DIKED DISPOSAL AREA, LORAIN HARBOR, OHIO

	ALT I NO ACTION	ALT II LAND ACQUISITION	ALT III FEEDER BEACH	ALT IV GROINS & FILL	ALT V REVETMENT
2. Environmental Quality (EQ)					
a. Water Quality *	No Impact	No Impact	Periodic, short-term turbidity	Periodic, short-term turbidity	Short-term turbidity
b. Wetlands	No Impact	No Impact	No Impact	No Impact	No Impact
c. Biota	No Impact	No Impact	Minor, periodic burial of benthic organisms	Burial of benthic organisms, creates rocky habitat	Some burial of benthic organisms, creates rocky habitat
d. Threatened, Endangered Species	No Impact	No Impact	No Impact	No Impact	No Impact
3. Regional Development (RD)					
a. Business & Industrial Activity*	No Impact	Very minor short-term increase	Very minor increase	Minor increase short-term	Minor increase short-term
b. Taxes, Government*	Gradual tax revenue losses due to declining property values	Loss of tax revenues	Gradual tax revenue losses due to declining property values	Increased tax revenues due to higher property values	Increased tax revenues due to higher property values

*Items specifically mentioned in Section 122 of the River and Harbor Flood Control Act of 1970. Public Law 91-611.

TABLE 1 (cont.)
SUMMARY & SYSTEMS OF ACCOUNTS
SECTION 111, DIKED DISPOSAL AREA, LORAIN HARBOR, OHIO

	ALT I NO ACTION	ALT II LAND ACQUISITION	ALT III FEEDER BEACH	ALT IV GROINS & FILL	ALT V REVETMENT
4. Social Well-Being (SWB)					
a. Employment*	No Impact	No Impact	Very minor, periodic increase	Minor temporary increase. Periodic thereafter	Minor temporary increase
b. Noise*	No Impact	Temporary as structures are removed	Minor, periodic annoyance, localized	Constr. annoyance localized. Periodic after	Construction annoyance localized
c. Aesthetic Values*	No Impact	Open view of lake created for public	No Impact	Wide beach created	Unsightly protection structures are covered
d. Archaeological/ Historical	No Impact	No Impact	No Impact	No Impact	No Impact
e. Housing	Gradual loss of homes	27 homes are razed	Gradual loss of homes	Houses are perserved from erosion damages	Houses are perserved from erosion damages
f. Public Facilities*	No Impact	Potential Park land created	No Impact	Potential fishing & bathing opportunities	Potential fishing opportunities

*Items specifically mentioned in Section 122 of the River and Harbor and Flood Control Act of 1970. Public Law 91-611.

TABLE 1 (cont.)
SUMMARY & SYSTEMS OF ACCOUNTS
SECTION 111, DIKED DISPOSAL AREA, LORAIN HARBOR, OHIO

	ALT I NO ACTION	ALT II LAND ACQUISITION	ALT III FEEDER BEACH	ALT IV GROINS & FILL	ALT V REVETMENT
C. Plan Evaluation					
1. Contribution to Planning Objectives					
a. Percent of shoreline protected against aggravated erosion	0%	0%	100%	100%	100%
b. Percent of shoreline protected against natural erosion	0%	0%	0%	70%	100%
c. Percent of parcels protected against aggravated erosion	0%	0%	100%	100%	100%
2. Relationships to Four Accounts					
a. NED Account					
1. NED Benefits (annualized)		$17,900	$22,500	$29,850	$33,000
2. NED Costs (annualized)	*	$160,000	$75,200	$228,400	$161,900
3. Benefit to Cost Ratio		0.11	0.30	0.13	0.20
b. EQ Account					
1. Marine Habitat destroyed	None	None	½ to 2 acres periodically but temporarily buried	2 acres buried under groins. 10 acres buried under beach fill	2.5 acres buried under revetment

*No Action results in $22,500 annual damages

TABLE 1 (cont.)
SUMMARY & SYSTEMS OF ACCOUNTS
SECTION 111, DIKED DISPOSAL AREA, LORAIN HARBOR, OHIO

	ALT I NO ACTION	ALT II LAND ACQUISITION	ALT III FEEDER BEACH	ALT IV GROINS & FILL	ALT V REVETMENT
2. Marine Habitat Altered	None further	None further	None-wave distribution of fill is natural process	Groins create sheltered area for fish and create hard bottom habitat	Creates some hard bottom habitat.
3. Terrestrial Habitat Altered	Continual loss of bluff at average rate of 1.1 ft/yr (over entire 2500ft)	Structures removed and vacant land created for 1600ft. of bluff. Continual loss of bluff at aver. rate of 1.1ft/yr (over 2500 ft)	Continual loss of bluff at average rate of 0.8ft/yr. (over entire 2500 ft)	No bluff lost. Groins may be used by gulls & shorebirds	No bluff lost Revetment may be used by gulls
4. Life forms Affected	None further	None further	Benthic fauna spawning fish (localized)	Spawning fish, Benthic fauna, Migratory waterfowl & Shorebirds	Spawning fish, Benthic fauna, Migratory waterfowl & Shorebirds
5. Archeological Values Destroyed	None	None	None	None	None
6. Overall Biological Productivity of Site	None	None	Low, bottom dwellers affected characteristic of moderately polluted bottom.	Low, bottom dwellers affected characteristic of moderately polluted bottom	Low, bottom dwellers affected characteristic of moderately polluted bottom

TABLE 1(cont.)
SUMMARY & SYSTEMS OF ACCOUNTS
SECTION 111, DIKED DISPOSAL AREA, LORAIN HARBOR, OHIO

	ALT I NO ACTION	ALT II LAND ACQUISITION	ALT III FEEDER BEACH	ALT IV GROINS & FILL	ALT V REVETMENT
c. SWB Account					
1. Housing Lost	Estimated 16 homes and 3.1 acres private property lost over 50 yr period in the damaged area	26 parcels purchased and 27 structures removed in first year	Estimated 13 homes and 1.4 acres private property lost over 50 yr period in the damaged area	After project completion, minimal property or structural loss in protected area is anticipated	After project completion, no property or structural loss in protected area is anticipated
2. Public Facilities Created	None	Potential park land on cleared parcels	None	Potential fishing and bathing areas created	Potential fishing area created
d. RD Account					
1. Tax Revenue	Gradual loss due to lost or vacated structures	Tax revenues lost on 27 structures removed	Pre dike losses continue as structures are lost or vacated	Increased tax revenue due to potential higher property value	Increased tax revenue due to potential higher property value
3. Plan Response to Associated Evaluation Criteria					
a. Acceptability	Unacceptable to local interests	Acceptable to federal interests	Acceptable to local interests	Acceptable to federal & local interests	Acceptable to federal & local interests
b. Certainty	N/A	Can be implemented. Uncertainty exists as to # of parcels to purchase and whether some structures need to be razed	Can be implemented. Slight uncertainty exists on efficiency of wave action in distributing fill	Can be implemented. Uncertainty exists on quantity of fill needed in compartment to fully protect bluff	Can be implemented. Uncertainty exists on whether to extend revetment to meet with spending beach

TABLE 1 (cont.)
SUMMARY & SYSTEMS OF ACCOUNTS
SECTION 111, DIKED DISPOSAL AREA, LORAIN HARBOR, OHIO

	ALT I NO ACTION	ALT II LAND/ ACQUISITION	ALT III FEEDER BEACH	ALT IV GROINS & FILL	ALT V REVETMENT
c. Completeness	Does not meet objective of erosion mitigation	Exceeds objective for mitigation of aggravated erosion	Meets objective for mitigation of aggravated erosion	Exceeds objective for mitigation of aggravated erosion	Exceeds objective for mitigation of aggravated erosion
d. Effectiveness	Ineffective	100% by removal of residents from endangered area	30 to 50% in protecting endangered property against natural & aggravated erosion	70% in protecting endangered property against natural erosion. 100% against aggravated erosion	100% in protecting endangered property against natural & aggravated erosion
4. Ranking of Plan	Recommended plan	Preliminary selection LED Plan	Preliminary selected NED Plan		Selected Plan
D. Implementation Responsibility					
1. Financial					
First Cost	No Cost				
Federal		$1,021,600	$287,800	$287,800	$287,800
Non Federal		$1,151,900	0	$1,956,100	$1,508,200
Total		$2,173,500	$287,800	$2,243,900	$1,796,000
Annualized Costs*					
Federal		$75,200	$75,200	$75,200	$ 75,200
Non Federal		$84,800	0	$153,200	$ 86,700
Total		$160,000	$75,200	$228,400	$161,900

*Includes interest and amortization of first cost

NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

From the preceeding evaluation, it is concluded that the Feeder Beach Plan, Alternative III, best accomplishes objectives of maximizing national economic development(NED) at least cost locally and nationally. The estimated first and annualized costs are respectively, $287,800 and $75,200. All costs for this plan would be Federal responsibility. The estimated annual benefits are $22,500, resulting in a benefit/cost ratio of 0.30.

ENVIRONMENTAL QUALITY(EQ) PLAN

An Environmental Quality(EQ) Plan addresses the planning objectives in the way which emphasizes aesthetic, ecological, and cultural net positive contributions to the components of the EQ account. An EQ plan is not developed in this study because commercial and residential uses within the study area would preclude implementable opportunities to enhance the environment. Creation of social, physical, or biological benefits of significant proportion would require large expenditures and usually would not comply with various study goals and constraints. Since the criteria for an EQ plan cannot be met, a Least Environmentally Damaging(LED) Plan is selected.

The Land Acquisition Plan, Alternative II, has been designated as the LED Plan. The principal impact of this alternative is the removal of residents and structures from the designated eroding area. Some property owners and dwellers may regard this impact as adverse, but full monetary compensation would be received for all tangible losses. Similar properties are available within Lorain for dislocated residents, although they would probably lose their lakeside proximity. From a general public perspective, negative impacts would be limited to annual property tax losses. Positive aspects of the acquisition plan include the elimination of expenditures for treating erosional damages to residential structures. A significant beneficial impact would also accrue if local interests converted the land into a park or similar recreational facility. The LED Plan accomplishes the study goal of preventing uncompensated damages from erosion, but does not alter or affect the natural aquatic and shore condition. Nearshore biological habitats and populations would not be disturbed on either a short-term or a long-term basis.

SELECTED PLAN

The Feeder Beach Plan will mitigate only that portion of the shoreline damages attributable to the Dike Disposal structure. An evaluation of its engineering certainty, combined with the judgement that this plan would not protect shore property and land which would be continually lost in the future due to natural erosion, resulted in the selection of a plan which would provide total protection against all erosion. The selected plan which would best satisfy planning objectives and would provide total protection is the Revetment Plan or Alternative V.

The Revetment Plan provides protection against natural erosion as well as the aggravated erosion caused by the Dike Disposal structures. The plan provides for 2000 lineal feet of rubblemound revetment extending along the shore easterly of Colorado Avenue. Where possible, the revetment will incorporate existing structures as a part of its core, however, the existing structures will be covered or integrated with appropriately graded stone such that the geometry and protective efficiency will be consistent throughout the length of the Revetment.

The estimated total first costs for the Revetment Plan are $1,796,000. Annualized costs, including amortization of the first cost are estimated to be $161,900. The annualized tangible benefits for preventing damage to shore properties is estimated to be $33,000. Intangible benefits which accrue as a result of implementation of this plan are alleviation of concern against property or structural loss for residents in the protected area, enhancement of property values due to a stabilized bluffline, and aesthetic improvement of the bluff face as compared to present conditions. The resulting benefit to cost ratio is 0.20 to 1.

The Federal financial responsibility for the Revetment Plan is limited to the maximum responsibility as defined in the Feeder Beach Plan (Alternative Plan No. III) as the Feeder Beach Plan mitigates against only those damages attributable to the Diked Disposal structure. Accordingly, the Federal responsibility for participation in the estimated first cost of the Revetment Plan is limited to

$287,800 and limited to $75,200 for annualized costs.

The historical shoreline and bluffline change data indicates that the shores easterly of Lorain Harbor have been eroding for many years prior to construction of the Diked Disposal structure. The quantified data applicable to this study indicates that the Diked Disposal structure does, and will continue to, impound westerly moving littoral drift. The adverse influence on the shore of this impoundment of littoral drift was determined to extend 2500 feet easterly of Colorado Avenue, thus, the Revetment Plan will completely mitigate the effect of the Dike Disposal structure and the plan will provide total shore protection from natural erosion.

THE SELECTED PLAN

The following describes the selected plan of improvement and presents summarized information on design, construction, and environmental impacts.

PLAN DESCRIPTION AND ACCOMPLISHMENTS

The Revetment Plan fulfills the objective of mitigating shore erosion attributable to the Diked Disposal structure and shore erosion attributable to natural causes.

The principal feature of this plan is a 2000-foot long rubble mound revetment extending from station 5+00 easterly to station 25+00. The revetment is of standard three layer design. Its crest is 6 ft. wide at an elevation of +14.0 ft. above L.W.D. which will protect the bluff face from wave runup and overtopping. A synthetic filter cloth is provided between the bluff face and revetment to prevent bluff sediments from eroding through the revetment voids. The revetment, where possible, will incorporate existing structures with a uniform structural protection extending from the defined accretion zone through and past the eroding zone of shoreline. The toe of the revetment extends approximately 50 feet offshore to about the 3-foot depth contour with respect to low water datum.

During the construction phase, access ramps down to the shoreline from the bluff will be necessary at Colorado Avenue and at station 22+40. Four other sites between station 5+00 and 25+00 will be used to deliver construction materials but not for access or egress of equipment. The area from station 00+00 to 5+00 is assumed to be protected sufficiently by the accretion fillet so as not to require the extension of the revetment to the dike disposal spending beach.

Since this alternative protects the shoreline against any future erosion, the full benefit of all damages prevented at the post dike recession rate can be assumed. This benefit was estimated to be $33,000 annually in losses prevented to property, structures, and private protective structures.

Intangible benefits which accrue as a result of the implementation of this plan are: alleviation of concern against property or structural loss for residents in the protected area; possible enhancement of property values due to a stabilized bluffline, and aesthetic improvement of the bluff face as viewed from the lake. A possible recreational benefit may be realized if the revetment is used as a fishing pier by the local residents. Another economic benefit would be the temporary creation of employment opportunities during the construction phase of the plan.

EFFECT ON THE ENVIRONMENT

The environmental effects of plan implementation are that 2.5 acres of marine habitat will be buried under the revetment. This may be partially offset by the rocky habitat created by the existence of the revetment. The terrestrial habitat is preserved because the bluff is permanently armored against retreat. The revetment may provide a habitat suitable for use by gulls and shorebirds.

The effects of the plan on social well-being of the area are to temporarily increase employment during the construction phase which will be offset by the noise and nuisance of construction activity in the area. Housing is preserved in the area which will also mean increased tax revenues due to the higher property value of the protected property.

OTHER EFFECTS

The plan is technically feasible and can be implemented with a very high degree of certainty that it will fulfill planning objectives and perform as predicted.

Financial responsibility for implementation of this plan is both Federal and non-Federal. The maximum Federal financial responsibility is limited to expenditures which will fulfill objectives of providing shore protection to mitigate damages attributable to the Diked Disposal structure. Accordingly, the estimated costs for implementation of the Feeder Beach Plan (Alternative Plan III) becomes the maximum Federal responsibility for cost sharing purposes for the Revetment Plan

ECONOMICS OF SELECTED PLAN

METHODOLOGY

Economic analysis of the proposed improvement can be determined by comparison of estimated average annual costs (amortization of initial investment plus annual operation and maintenance costs) with estimated average annual benefits to be realized over the life of the project. Costs and benefits at their time of accrual are made comparable by conversion to present value at an appropriate discount rate published by the Water Resource Council.

PROJECT COSTS

Estimated first costs and annualized charges of the selected plan of improvement based on August 1980 prices are summarized as:

	FIRST COST ITEMS	
A	12,100 Tons Bedding Stone @$25.00/Ton	302,500
B	5,060 Tons Underlayer Stone @$45.00/Ton	227,700
C	17,250 Tons Armor Stone @$35.00/Ton	603,750
D	32,000 Square Feet Filter Cloth @$0.80/SF	25,600
E	Easements for Access	17,750
F	Construction Roads & Areas	20,000
G	Subtotal A thru F	1,197,300
H	Contingencies @20% of G	239,500
I	Subtotal G + H	1,436,800
J	Engineering & Design @12% of I	172,400
K	Supervision & Administration	
L	Supervision & Inspection @5% of I	71,800
M	Overhead on J @20%	34,500
N	Overhead on L @27%	19,400
O	Indirect Labor @25% of J&L	61,100
P	Total First Costs I+J thru O	1,796,000
	ANNUALIZED COSTS	
1.	Amortization of Total First Costs (i = 7 1/8, n = 50 yrs) Total First Costs x CRF (.07361)	132,200
2.	Annual Maintenance of Structure 2% of First Cost + Contingencies (2% of I)	28,700
3.	Annual Inspection Cost	1,000
	Total Annualized Costs	161,900

PROJECT BENEFITS

Benefits to be derived from the plan of improvement are limited to the elimination of shore damages in the eroded sector. Based on shore recession rates since Dike construction, the average annual damages were estimated to be $33,000 for the eroded shore sector, and this is the estimated average annual benefit that will result from the Revetment Plan.

PROJECT JUSTIFICATION

The following summary is a comparison of average annualized benefits and costs. Only direct tangible values for each are represented.

ITEM	AMOUNT
Average Annualized Benefits	$33,000
Average Annualized Costs	$161,900
Benefit-to-Cost-Ratio	0.20

DIVISION OF PLAN RESPONSIBILITIES

GENERAL

The purpose of this section is to present the division of responsibilities between the Federal and Non-Federal interests in connection with mitigation of the erosion problem east of the Diked Disposal Area structure. Under the Section 111 authority, the Federal responsibility for mitigation of shore damages is limited to that portion of the damage attributable to the navigation works. If an ambient shore erosion problem exists in the study area, the responsibility for mitigation of that portion of damage or the providing of shore protective measures to treat the ambient problem is Non-Federal.

SUMMARY OF COST APPORTIONMENT

A tabulation of Federal and Non-Federal costs for each alternative evaluated in detail is presented in Table 1 Systems and Accounts and in this Main Report under the section "Alternatives Considered Further", page 27. Alternative Plan III, Feeder Beach would be 100% Federal responsibility and funded. Alternative Plan II, Land Acquisition, Alternative Plan IV, Groins and Fill, and

Alternative Plan V, Revetment, would be cost apportioned as per the tabulation.

VIEWS OF NON-FEDERAL INTERESTS

The study has been coordinated with non-Federal interests as described on page 4 in the Section entitled, "Study Participants and Coordination". Although few written responses have been received, circulation of the draft study report should increase letter response.

Conversations and comments from City of Lorain officials expressed concern for resolution of the erosion problems east of the dike disposal area. Concomitantly, the importance of the diked disposal area to the commercial interests of the port have been recognized.

In a September 15, 1980 letter to the Buffalo District from present Mayor William E. Parker, the City of Lorain has pledged to cooperate and assist in combating the shore erosion problem. However, the city would not pledge support in any cost sharing alternatives with the Federal government as, due to the private ownership of the eroded sector, this would be an illegal use of public funds to protect private property.

The Lorain County Regional Planning Commission was not concerned that project planning would result in actions contrary to their responsibilities.

The Ohio Environmental Protection Agency recommends that any structural work within the waters of Lake Erie involve only materials from clean, approved sources. Asphaltic materials generally would not be approved.

REVIEW BY FEDERAL AGENCIES

Official review by Federal agencies remains largely uncompleted until after draft report distribution. Preliminary coordination has revealed that agency concerns generally will be limited. The U.S. Fish and Wildlife Service recognizes the highly disturbed nature of the project area and expects no significant impacts upon biota.

SUMMARY

Based on this detailed study it is concluded that the Diked Disposal Area has not caused the total erosion problem experienced by the shore east of the Diked structure. The structure has, however, contributed to some degree, an impact which has accelerated this natural condition.

Four alternatives were evaluated in terms of the problems and needs for mitigating the shore damages attributable to the Federally constructed Diked Disposal Area and for treatment of the total erosion problem. The "No-Action" Alternative is also included in the planning process and utilized as the base condition for comparative purposes.

An evaluation was made of the impact on the environment that each alternative would have.

Of the alternative plans studied, the Revetment Plan was selected as the most favorable plan to fulfill planning objectives and mitigate damages attributal to the Diked Disposal structure and mitigation of the total erosion problem. The total project first costs are estimated to be $1,796,000. Annualized costs are estimated to be $161,900. Average annualized benefits are estimated to be $33,000. The benefit cost ratio is 0.20 to 1.

The Federal responsibility for participation in the first and annual costs of the Revetment Plan is limited to that portion of the erosion attributal to the navigation structures. Of the four alternatives identified for further study, only the Feeder Beach Plan (Alternative III) satisfies the objective of mitigating only the possible Dike Disposal structure induced effects, and the costs to implement that plan was determined to be the maximum limit of Federal financing responsibility toward other plans. Accordingly, the Federal financial responsibility in the Revetment Plan is as follows:

REVETMENT PLAN (ALTERNATIVE V)

	Federal	Non-Federal	Total
First Cost	$287,800	$1,508,200	$1,796,000
Annualized Costs	75,200	86,700	161,900

In the response of views of Non-Federal interests, the City of Lorain pledged to cooperate and assist in combating the shore erosion problem. However, the City would not pledge support in any cost sharing alternative with the Federal government as, due to the private ownership of the eroded sector, this would be an illegal use of public funds to protect private property.

RECOMMENDATIONS

The findings in this study are that:

(a) Although the impoundment of littoral material by the Diked Disposal structure may have some effect on the shores, the existing data does not clearly show quantification or definition of an increase in shore erosion due to the Diked Disposal structure;

(b) Even though quantification for predicting damages in the future was based on very limited data, the Feeder Beach Plan developed to mitigate damages attributable to the Dike structure was uncertain from an engineering standpoint as the plan would not protect homes and land which would be continually lost at some point in the future due to natural erosion;

(c) Although the selected Revetment Plan provides total shore protection and satisfied the technical objective of the Section 111 Authority, the computed economic justification is extremely low; and,

(d) Non-Federal participation in the financial support of the selected Revetment Plan will be required and the views expressed by the City of Lorain and the State indicate a local sponsor would not be forthcoming.

Based on the above findings, in this study, the recommendation is that no Federal action be taken as there is no solution to the problem within the scope of current Congressional authorization and in the overall public interest.

Environmental Assessment

for

SECTION 111

Detailed Project Report

on

Shores East of Diked Disposal Area

Lorain Harbor, Ohio

The responsible lead agency is the U. S. Army Corps of Engineers, Buffalo District.

ABSTRACT

The District's tentative recommendation is that no action should be taken to mitigate erosion attributable to the construction of the Lorain Harbor diked disposal area. The attributable erosion is only a small percentage of the total erosion problem. The selected plan of revetting the shoreline would require substantial non-federal cost sharing which apparently is not available. Other alternatives considered include breakwaters, groins, feeder-beach, and acquisition/evacuation. No significant impacts are expected from either of the alternatives; however, public concern for erosion protection is very pronounced.

Note: Information, displays, maps, etc. discussed in the Lorain Section 111 Main Report are incorporated by reference in the EA.

LIST OF PREPARERS

The following people were primarily responsible for preparing this Environmental Impact Statement

NAME	EXPERTISE	EXPERIENCE	PROFESSIONAL DISCIPLINE
Phil Berkeley (EIS Coordinator)	Aquatic Biology	5 yrs. EIS Studies Buffalo District	Biologist
Richard H. Lewis	Archaeology & History	3 yrs. Cultural & Environmental Resource, Buffalo, and Rock Island District	Archaeologist
R. Craig Holland, P.E.	Planning/Engineering	9 yrs. Environmental Planning, Engineering, Consultant	Civil Engineer
Lawrence Watson, Ph.D	Resource Planning	12 yrs. Environmental Assessment, Planning Consultant	Geographer & Remote Sensor
Ted Turk, Ph.D	Ecology/Marine Biology	Education & Environmental Analysis, Consultant	Biologist
Steven P. Giannino, P.E.	Coastal Engineering	7 yrs. Coastal Engineering, Consultant	Civil Engineer
Raymond Rodrigue, Ph.D	Civil Engineering	12 yrs. Engineering & Environmental Studies, Consultant	Civil Engineer

ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

TABLE OF CONTENTS (cont)

List of Tables

1. SUMMARY

<u>Major Conclusions and Findings</u> - Alternative No. III, The Feeder Beach Plan, was designated as the National Economic Development(NED) plan because its Benefit/Cost (B/C) ratio of 0.30 was the highest among the plans considered, while still satisfying the requirements for mitigation under Section 111. The NED Benefits calculated for this plan amount to $22,500 annually versus annualized costs of $75,200.

The Land Acquisition Plan, Alternative II was designated as the Least Environmentally Damaging(LED) Plan because it results in the minimum environmental disturbance. The principal feature of this plan is to award complete monetary reimbursement to owners and dwellers in the damaged area for property which must be vacated due to threatened erosion. Because adequate replacement housing is assured elsewhere in Lorain, these people suffer the loss of lakefront sites for their dwellings but are compensated by the realization that they need never be concerned again about the threat of loss due to bluff erosion. In addition, alterations of aquatic and nearshore habitats would not occur under this plan and an opportunity for a significant public benefit would occur if the vacated land is converted into an upland recreational area by local interests.

The Selected Plan is the Revetment Alternative No. V. This plan is the most cost-effective means of providing complete protection to the eroding shoreline. No objectionable impacts would occur to the natural or human environment as a result of project implementation. A major portion of construction costs would be incurred by non-Federal interests since the project does more than compensate for erosion atrributable to the diked disposal area structure.

The study recommends that no Federal action be taken to mitigate shoreline erosion east of the dike disposal structure. The Federally attributable erosion is only a minor portion of total erosion in the study area. Non-Federal interests are unable or unwilling to cost share the selected plan or any alternative which would effectively stop the shoreline erosion.

<u>Controversies and Unresolved Issues of Public Concern</u> - Unresolved issues identified in this study pertain to engineering objectives rather than environmental impacts. The residential users within the study area will continue

to experience erosion problems along their shoreline because no action is expected from governmental agencies to convert this condition. This is very disturbing to property owners who will continue to face alternatives of high individual expenditures for erosion protection or the rapid loss of property usefulness. No action can be taken by the Corps of Engineers which would effectively improve this situation unless cost-sharing agreements can be attained with non-Federal interests. Non-Federal interests do not intend to cooperate in any plan requiring significant outlays of capital. Besides budgetary constraints, these interests site procedural regulations which forbid expenditures for protection of private, rather than public, concerns.

Another unresolved issue is the exact level of impact that the dike disposal structure has had on the adjacent shoreline. A "worst case" approach has been adopted in this study because post-dike bluff recession data is inadequate at this time to exactly define damages attributable to the federal navigation works.

Relationship to Environmental Requirements - Each of the alternatives considered in detail would comply with identified environmental requirements at all levels of government. In particular, these requirements include Federal policies relative to wetlands, water quality, rare and endangered species, archaeological and historical preservation, coastal zone management, and clean air. No significant adverse impacts would occur to these resources from implementation of any alternative. See Table 1.1.

TABLE 1.1

Relationship of Plans to Environmental Requirements, Protection Statutes, and other Environmental Requirements (Tentatively Selected Plan - Revetment)

Federal Statutes	Acquisition/ Evacuation	Feeder Beach	Groin & Fill	Revetment
Archaeological and Historical Preservation Act, as amended, 16 U.S.C. 469 et seq.	Partial	Partial	Partial	Partial
Clean Air Act, as amended, 42 U.S.C. 7401 et seq.	Partial	Partial	Partial	Partial
Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. 1251 et seq.	Partial	Partial	Partial	Partial
Coastal Zone Management Act, as amended, 16 U.S.C. 1451, et seq.	Full	Full	Full	Full
Endangered Species Act, as amended, 16 U.S.C. 1531 et seq.	Full	Full	Full	Full
Estuary Protection Act, 16 U.S.C. 1221, et seq.	N/A	N/A	N/A	N/A
Federal Water Project Recreation Act, as amended, 16 U.S.C. 460-1 (12), et seq.	Full	Full	Full	Full
Fish and Wildlife Coordination Act, as amended, U.S.C. 661, et seq.	Partial	Partial	Partial	Partial
Land and Water Conservation Fund Act, as amended, 16 U.S.C. 4601-4601-11 et seq.	N/A	N/A	N/A	N/A
Marine Protection, Research, and Sanctuaries Act 22 U.S.C. 1401 et seq.	N/A	N/A	N/A	N/A

	Acquisition/ Evacuation	Feeder Beach	Groin & Fill	Revetment
Federal Statutes				
National Historical Preservation Act, as amended, 16 U.S.C. 470a, et seq.	Partial	Partial	Partial	Partial
National Environmental Policy Act, as amended, 42 U.S.C. 4321, et seq.	Partial	Partial	Partial	Partial
Rivers and Harbors Act, 33 U.S.C. 401 et seq.	Full	Full	Full	Full
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et. seq.	N/A	N/A	N/A	N/A
Wild and Senic Rivers Act, as amended, 16 U.S.C. 1271, et seq.	N/A	N/A	N/A	N/A
Executive Orders, Memoranda, Etc.				
Floodplain Management (E.O. 11988)	N/A	N/A	N/A	N/A
Protection of Wetlands (E.O. 11990)	Partial	Partial	Partial	Partial
Environmental Effects Abroad of Major Federal Actions (E.O. 12114)	N/A	N/A	N/A	N/A
Analysis of Impacts on Prime and Unique Farmlands (CEQ Memorandum, 30 Aug. 76)	N/A	N/A	N/A	N/A
State and Local Policies				
Ohio Coastal Zone Management	Full	Full	Full	Full
Lorain County Regional Planning	Full	Full	Full	Full

Notes: The compliance categories used in Table 1.1 were assigned based on the following definitions:

a. Full compliance - all requirements of the statute, E.O. or other policy and related regulations have been met.

b. Partial compliance - some requirements of the statute, E.O. or other policy and related regulations remain to be met.(This often includes distribution and filing of the EIS)

c. Noncompliance - none of the requirements of the statute, E.O. or other policy and related regulations have been met.

d. Not applicable(N/A) - statute, E.O., or other policy not applicable.

2. NEED FOR AND OBJECTIVES OF ACTION

2.01 Study Authority - The authority for mitigation of shore damages attributable to navigation projects is contained within Section 111, River and Harbor Act of 1968 (P.L. 90-483). This study was approved on the basis of findings reported in the Reconnaissance Report completed in February 1980.

2.02 Public Concern - During the period August 1976 to September 1977, the Lorain Harbor Diked Disposal Area was constructed to contain the polluted sediments from harbor dredging operations. The Spending Beach Revetment which extends from the Dike to the shore was constructed during the period June-November 1977. Subsequent to the Dike Disposal Area construction, shore residents east of the harbor complained that this structure was causing significant shoreline erosion and failure of privately built shore protection structures. In a letter dated 19 July 1979 the Mayor of the City of Lorain officially requested that the Federal government investigate the severity of the erosion problem attributable to the Disposal Dike. In response to this request, the Buffalo District Corps of Engineers completed a Reconnaissance study in February 1980 to determine whether the Dike Disposal structure had caused an increase in erosion of the shore to the east of the structures and, if so, develop preliminary alternative plans for mitigating the increased erosion. The Reconnaissance study concluded, based upon available engineering, economic, environmental, and social information that the Diked Disposal area contributed to the erosion and therefore warranted the preparation of a detailed project report(DPR). The DPR would formulate a basis for selection of the optimum plan for mitigation of damages attributable to the Dike Disposal structure provided the plan is socially acceptable, technically practical and economically feasible.

2.03 Study Objectives - The purposes of this study are to determine the extent of shore erosion damage to the east of Lorain Harbor, Ohio due to the Dike Disposal area structure and due to natural processes, and develop designs, cost estimates, and cost sharing responsibilities of appropriate alternatives to provide shore erosion protection or mitigation of damages due to the Dike Disposal structures and natural processes. More specific planning objectives are contained in the Main Report and appendicies of the Detailed Project Report. In summary, the objectives pertinent to assessing impacts include a desire to mitigate and protect the shoreline without damaging environmental quality or social well-being within the study area. Study goals include efforts to minimize disruption to residential users and, when possible, to enhance the human, physical, and biological uses in a manner conducive to increased quality of life.

3. ALTERNATIVES

3.01 Plans Eliminated From Further Study - Of the seven preliminary alternatives, including no-action, only two were eliminated from further study. These two were the offshore segmented breakwater with fill and the single long groin with shore restoration.

3.02 The offshore segmented breakwater plan was excluded largely on the basis of excession costs incurred to duplicate the effectiveness of protection available from other structural alternatives. The revetment plan, for instance, would be equally as effective in protecting the bluff against erosion as an offshore segmented breakwater and fill plan.

3.03 The single groin with shore restoration concept was rejected because its effect would be to reinstate conditions similar to those when only the east breakwater shorearm was influencing the shoreline to the east. This, of course, would not solve the erosion problem and it would be a much more costly alternative than the non structural feeder beach plan which accomplishes the same purpose of mitigating only dike attributable erosion.

3.04 Without Conditions - If a shore protection plan is not instituted to mitigate erosion attributable to the federally constructed containment dike, privately owned lands and structures will be damaged or destroyed within an accelerated time frame. A second possibility would include future increased costs born by homeowners for private shore protection measures.

3.05 Plans Considered in Detail - Five plans were considered in detail. They include measures to completely mitigate all erosion, a plan to correct only the erosion attributable to the federally constructed dike impoundment and a no-action plan. To completely mitigate all erosion, a groin field with fill plan and a revetment plan were studied. To provide an alternative of mitigating for all erosion without using structural means, an acquisition plan was studied. A feeder beach plan was studied for purposes of correcting only Federally caused damages due to increased erosion rates.

Comparative Impacts

3.06 Socio-Economic - The feeder beach plan would create only slight improvements to existing property characteristics in the study area as compared to no-action. The acquisition plan would provide monetary compensation to property owners for full market value of properties and for other tangible losses incurred in moving. However, it is unlikely that anyone would be able to relocate to a lakefront site. Land acquisition would create an opportunity for public recreational development, but would reduce city property tax revenues. The revetment and groin field plans would probably increase property values and homeowner security by eliminating erosional damages. The revetment plan would also create visual amenities by replacing the many failing and unsightly protection structures with a uniform protected bluff profile.

3.07 Biological - The land acquisition alternative would have the least biological impact of all alternatives except no-action. Of the other alternatives, a feeder beach would have the least impact, periodically causing temporary burial of the benthic community and possible disruption of fish spawning in a small area (½ to 2 acres). Moderate alteration of beach and very nearshore sediments and benthic fauna would occur. The revetment alternative would cover approximately 2.5 acres of existing benthic community and possible fish feeding and spawning area with rock rubble (suitable for vegetation and invertebrate growth, and for some fish spawning and feeding). The groin field alternative would cover approximately 2 acres of existing benthic community with rock rubble, with above side effects, but it would also create approximately 2.5 acres of sand fill. The coarser sediments of the beach would cause slightly altered benthic fauna in approximately 10 acres of nearshore habitat. Both the revetment and groin field should attract fish and possibly improve fishing very locally. No alternative is expected to impact commercial fishing. Table 3.1 presents a more detailed comparison of biological impacts.

TABLE 3.1

COMPARATIVE BIOLOGICAL IMPACTS

Resource or Issue	No Action	Feeder Beach	Groins & Fill	Revetment	Land Acquisition
Wetlands	No Impact	No Impact	No Impact	No Impact	No Impact
Endangered Species	No Impact	No Impact	No Impact	No Impact	No Impact
Benthic Community	No Impact	½ to 2 acres of benthic community will be periodically but temporarily buried. Slight alteration of very nearshore sediments and fauna	Loss of 2 acres of benthic community to groins(colonizable by plants and invertebrates) and 2.5 acres to beach. Slightly altered benthic sediments and fauna in 10 acres	Loss of 2.5 acres of benthic community to revetment(colonizable by plants and invertebrates)	No Impact
Fish	No Impact	Temporary and periodic disruption of feeding in small(½ to 2 acres) area. Disruption of spawning in spring only. Slightly altered very nearshore food source(benthic fauna)	Loss of 12 acres of existing feeding and possible spawning area. Provision of feeding area and increased spawning habitat for some species, on groins. Shelter of groins will attract fish and possibly improve fishing in their vicinity. Approx. 10 acres altered very nearshore food source(benthic fauna)	Loss of 2.5 acres of existing feeding and possibly spawning area. Provision of feeding area and increased spawning habitat for some species, on revetment. Shelter of groins will attract fish and possibly improve fishing in their vicinity.	No Impact
Commercial Fishing	No Impact	No Impact	No Impact	No Impact	No Impact
Waterfowl and Shorebirds	No Impact	Possible increase in use of beach by shorebirds.	Use of groins by gulls. Possible increase in use of beach by shorebirds.	Use of revetment by gulls.	No Impact

4. AFFECTED ENVIRONMENT

4.01 Environmental Conditions - The city of Lorain is located along the south shore of Lake Erie in North Central Ohio. The Black River flows through the city and empties into Lake Erie at the sight of the Port of Lorain. The city is within Lorain County and is 27 mi west of Cleveland.

4.02 Local terrain is typical glacial lake plan and is relatively level. Surficial materials are primarily unconsolidated Pleistocene glacial deposits. Low relief fossil beaches and ridges can be found inland of present beaches and represent earlier stages in Lark Erie geological history.

4.03 The Lorain area was originally covered by midlatitude temperate forest. Dominant trees included such broadleaf deciduous species as beech and maple on the uplands, and ash, willow, and cottonwood along lowland stream banks. With extensive land development and disturbance, most of the former cover has been removed in favor of agriculture and urban development.

4.04 The Black River is a meandering, slow stream with a high sediment load due to extensive agricultural activitity within the drainage basin. The river affects the type of wildlife found in the study area.

4.05 Within the lake, the benthic community is dominated by sludge worms and midge larvae and is characteristic of a moderately polluted bottom. The phytoplankton is typical of similar areas, with blue-green, green, dinoflagellate, and diatom species present. The zooplankton consists of calanoid and cyclopoid copepods, cladocerans, miscellaneous crustacean nauplius larvae, and rotifers.(9) (26)

4.06 The lake supports a considerable sport fishery and a modest commercial fishery in the Lorain area. Yellow perch is the dominant species in both fisheries.

4.07 Lorain is located in a major bird migration area and has abundant and diverse waterfowl fauna.

4.08 Lorain is a commercial and industrial center located within 500 miles of half of the population of the U.S. Over 50 manufacturing plants, employing more than one third of the county labor force, are located here. Annual payrolls average in excess of $250 million. Major employers include a "big three" auto maker, a large steel fabricator and a large ship building firm.

4.09 The present city population is approximately 82,000, with Lorain County having 276,000. A rich mix of ethnic groups, including persons from northern and eastern Europe, hispanic cultures and of Afro-american origin, reside in the area.

4.10 Significant Resources and Issues - A number of resources and issues have been designated as significant following an evaluation of physical biological and socio-economic factors in the study area. Included in the latter group are quality of life factors such as condition and value of housing and recreation. These significant resources and issues are discussed in the following sections.

4.11 Property Values - 1970 census data indicated that an average property in the study area, house and lot, was valued between $10,000 and $12,750. Present values for study area housing are estimated to range between $40,000-$70,000. Data from the City of Lorain indicates that approximately 45 lakefront parcels are occupied within the study area. Using average figures, the total value of these occupied properties is about $2,000,000.

4.12 Business-Industrial Activity/Employment - Lorain due to its location at a juncture between lake, rail and highway systems and other lesser factors, had developed a diverse business-industrial base. On the average, plants in the city employ over 24,000 workers with an annual payroll in excess of $250 million.

4.13 The city has been a major port for a considerable period. It has facilities for shipping and receiving bulk cargo such as iron ore, coal, and gypsum. A nearly complete multi-million dollar pelletized iron ore terminal is now operating in the port. Vessels up to 1,000 feet in length can be handled at this facility. A major ship building firm is located on the Black River, just upstream of the main commercial docks. Repair and winter shelter for lake carriers is provided at several points along the river as well. The economic dependance of the city upon the port is evident in that an average of over 7 million tons of iron ore are moved through Lorain each year. Upwards of 15,000 persons, both in and surrounding Lorain are dependent upon this vital commerce.

4.14 Industrial activity includes the manufacturing of steel pipe, ships, automative components and vehicles, chemicals, building materials and electronic equipment. Lorain has a diversified employment base due to the existence of over 55 manufacturing plants. The largest single employer in the area is a major auto maker with 8,000 to 9,000 employees, in two plants. A major steel plant is second with 7,500 to 8,000 employees. A third firm, a builder of bulk cargo ships, also employees a large number of Lorain residents.

4.15 Both primary metals and transportation manufacturing, employing over one third of the total county work force, are not anticipated to gain in absolute employment over the next 20 to 30 years, according to <u>Northeast Ohio Demographic and Economic Projections 1970-2020</u>. Employment in Lorain County has expanded at a moderate rate and is estimated to reach 91,350 by the end of 1980. Manufacturing is expected to continue as a dominant factor in local employment beyond the turn of the century.

4.16 <u>Archaeological and Historical Resources</u> - In order to assess the impacts of the proposed plans on significant cultural resources, the 18 March 1980 edition of the National Register of Historic Places and all subsequent revisions were consulted. While several properties were listed for the city of Lorain, only one, the Lorain Lighthouse, is located in close proximity to the Environmental Impact Area of this study. This structure will sustain no direct impacts as a result of this study, but may be subjected to visual impacts resulting from nearby construction. Based on a cultural resources report completed for the area in 1975 entitled: <u>Inventory of Cultural Resources: Diked Disposal Site No. 7, Lorain,</u>

Harbor, Ohio, by Dr. Don Dragoo, there are no potentially significant sites which would be impacted by any of the project alternatives. This report is contained in the Cultural Resources Appendix No. 6. In addition, the Regional Archaeological Preservation Officer, in Cleveland, has stated that no known archaeological sites exist in or adjacent to the study area.

4.17 Residential Environment - The predominant type of housing in the area is single family, multi-level, frame dwellings. Much of it dates from the period of World War I through the mid 1920's. Property values generally increase from west to east in the study area. The condition of structures varies widely.

4.18 About 25-50 percent of the housing is renter occupied. Rents range from about $175/month to over $250/month. About 11% of the residents were reported to be below the poverty level in 1976. Median 1970 income was reported at $8116. The majority of residents are between 18 and 65 years old; about 10 percent are classified as senior citizens.

4.19 Recreation - Lorain area recreational and open space availability is generally lower than standards proposed by the National Recreation and Park Association for a city of the size of Lorain. Mid 1970's figures indicate that the region lacks over 200 acres of leisure and open space. Therefore, lakeshore areas can be expected to have considerable value as places for present or potential recreational activity.

4.20 Lake related leisure time activities are an important element in the Lorain recreational picture. Pleasure boating, fishing, swimming, walking, and running activities are commonly observed on or near the lakeshore. A shortage of public fishing piers exists in the area. As a result, a number of structures such as the dike disposal area, east shore arm, and groins located in Century Park are utilized by the general public. Residents also use privately owned and built seawall structures for fishing. These structures are used to observe harbor and lake activities as well.

4.21 Approximately 3,000 small boats were registered in Lorain during the mid 1970's. The port authorities have indicated that the needs of such crafts and their operators are of concern. Marina development plans have been formulated and additional planning activity is taking place at present.

4.22 City parks and recreation officials have indicated that recreational swimming activities have shifted from the study area. A swimming facility located at Longfellow Park is heavily used by local swimmers. The pool has taken the place of the local beaches as a focus for swimming and sunning activities. The presence of lifeguards at the pool and the absence of them on the beach may be factors in the shift. Greatly improved water quality at the pool is undoubtedly another major consideration in the move from lake to pool swimming activity.

4.23 Access to much of the shoreline, in the study area, is limited by residents who have posted the beaches behind their property.

4.24 Wetlands and Water Quality - No wetland areas are located in the study area. The water quality of Lake Erie is generally regarded as degraded.

4.25 Endangered Species - No species on the U.S. Fish and Wildlife Service's list of endangered and threatened wildlife and plants(28), or on the Ohio Department of Natural Resources' list of endangered wild animals(19) occurs in or near the study area.

4.26 Benthic Community - In the shallow waters near the study area, the bottom sediments are composed of a mixture of clays, organic silts, sand and rock fragments, with fine material (clays and silts) predominant (9)(26).

4.27 The benthic fauna is dominated by sludgeworms of the genus Limnodrilus (Oligochaeta: Tubificidae) and by fly larvae and pupae of the genera. (Chironomus and Procladius (Chironomidae). Also present are the fingernail clams Sphaerium and Pisidium (Heterodonta: Sphaeridae), the flatworms Dugesia (Turbellaria: Planariidae), the amphipods Crangonyx and Gammarus (Gammaridae), the Oligochaete Branchiura, and the leech Helobdella (Hirudrinea: Glossiphoniidae)(9)(26).

4.28 The abundance of benthic fauna is moderately high, with total organism density on the order of several thousand per square meter, but not as high as in Lorain Harbor, where density is on the order of several tens of thousands per square meter(9). The bottom sediments near the study area are less polluted than those in the harbor, and are rated as moderately polluted by the classification of Wright(9).

4.29 These benthic organisms are the principal food source for most of the fish species that are common in the shallow waters of the area(6).

4.30 Fish - Table 4.1 is a list of the fishes occurring in the nearshore Lorain area. There is evidence(3) that most of these species also spawn in the vicinity. The most important species (by virtue of their abundance and/or their importance in the local commercial or sport fishery) likely to spawn in shallow water around Lorain are yellow perch, rainbow smelt, gizzard shad, freshwater drum, white bass, emerald and spottail shiner, and walleye. Most of these species also inhabit the deeper, offshore waters(30). This is particularly true of yellow perch, gizzard shad, freshwater drum, rainbow smelt, and walleye; the yellow perch is the major component of the commercial fishery there.

4.31 Commercial Fishery - Two commercial fishing boats operate out of Lorain Harbor on a permanent basis. This number increases to as many as seven during peak fishing periods (late spring and early fall(7). These boats take primarily yellow perch, by gill net, but other species are taken (Table 4.2). The Lorain commercial fishery is a moderately important one, comprising, for example, approximately 13.1% (by dollar value) of the Ohio, and 2.3% of the total Lake Erie commercial yellow perch catch (Table 4.2). The portion of Lake Erie offshore from Lorain and vicinity is one of the principal commercial yellow perch areas (20). The high rank in the commercial list of more valuable species, such as yellow perch and white bass, and the low rank of less valuable species, such as carp and catfish, make the Lorain catch (Table 4.2) more valuable, pound-for-pound, than the Lake Erie fishery in general.

4.32 Sport Fishery - The Lorain nearshore sport fishery consists primarily of yellow perch, freshwater drum, white bass, largemouth bass, and walleye. The best sport-fishing periods are in late spring (May-June) and early fall (September-October). Most of the fishing is done from boats from one-half to five miles offshore, although some fish are caught from the breakwaters around the harbor. Fishing is one of the main recreations in Lorain. In 1979 approximately 25,000 fishing licenses were sold in Lorain County.(22)

Table 4.1 Nearshore Fishes of the Lorain Area

Common Name	Scientific Name
Alewife°	*Pomolobus pseudoharengus*
Carp°*	*Cyprinus carpio*
Channel Catfish°*	*Ictalurus punctatus*
Coho Salmon	*Oncorhynchus kisutch*
Emerald Shiner°	*Notropis atherinoides*
Freshwater Drum°*+	*Aplodinotus grunniens*
Gizzard Shad°*	*Dorosoma cepedianum*
Goldfish°*	*Carassius auratus*
Largemouth Bass°+	*Micropterus salmoides*
Quillback°*	*Carpiodes cyprinus*
Rainbow Smelt°*	*Osmerus mordax*
Spottail Shiner°	*Notropis hudsonius*
Troutperch°	*Percopsis omiscomaycus*
Walleye°*+	*Stizostedion vitreum vitreum*
White Bass°*+	*Morone chrysops*
White Sucker°*	*Catostomus commersoni*
Yellow Perch°*+	*Perca flavescens*

°Spawns near study area
*Commercial in Lake Erie
+Sport at Lorain

Table 4.2 Commercial Fish Landings, Lorain, Ohio 1973 (26)
(More recent information is not available)

Species	Pounds	Dollars	% of L. Erie	% of Ohio
Yellow Perch	304,575	114,249	2.3	13.1
Drum(Sheepshead)	23,774	1,343	1.5	1.9
White Bass	8,534	2,114	0.2	0.5
Suckers	3,258	177	3.4	9.6
Quillback	1,705	137	2.1	2.1
Carp	619	31	small	small
Catfish	69	27	small	small

4.33 Waterfowl and Shorebirds - Lorain is located in a major bird migration area. Waterfowl (including both diving and dabbling ducks) and shorebirds are moderately abundant and diverse in the area. Present for at least a portion of the year are ring-billed gulls, herring gulls, Bonaparte's gulls, black ducks, mallards, teals, canvas-backs, mergansers, buffleheads, goldeneyes, scaups, old-squaws, common loons, horned grebes, great blue herons, spotted sandpipers and killdeer(16)(17). The vicinity of the Black River is the prime bird area in Lorain (8), but rafts of ducks are common in the offshore waters, particularly in the fall. Duck rafts are also seen near the Diked Disposal Area and offshore of the study area(8). As the weather gets colder in the early winter, many of these birds move to the Ohio Edison warm water discharge just west of Lorain Harbor.

4.34 Gulls are common in the harbor area, resting and feeding on the breakwaters and nearby waters. Due to the lack of suitable beach or marsh habitat, the study area is seldom used by shorebirds, but an occassional gull, spotted sandpiper, or killdeer may be found there(8).

4.35 The area supports considerable recreational water-fowl hunting in the fall, mostly from the breakwaters near the harbor, but also from offshore boats.

5. ENVIRONMENTAL EFFECTS

5.01 Impacts of the various structural and nonstructural alternatives on significant resources and issues, as described in Section 4 are presented here.

5.02 Property Values and Taxes - Structural alternatives which prevent erosion can be expected to increase both the value of lakeshore property and that of tax revenues. The more extensive and costly alternatives would have the greatest impact. Those associated with less ambitious and less effective solutions, such as the feeder beach plan would have the least impact. Such variation is a product of the preception by individuals of the value of mitigation measures in offering protection to their property and thus increaseing their property values.

5.03 The acquisition alternative would compensate owners for the full market value of their property. However, tax revenues, would be eliminated.

5.04 The no-action alternative would cause property values to decline in direct proportion to erosional damages. Property owners are not likely to and are probably not financially able to invest in permanent protection measures.

5.05 Business-Industrial Activity/Employment - The structural alternatives would utilize locally-available, commercial building materials such as sand, rock, and stone. The construction process would involve some local labor, equipment, and fuel supplies. Generally, the more costly projects (groin field and revetment) would have the most beneficial effects. However, the feeder beach plan would cause recurring effects due to periodic sand placement.

5.06 The acquisition/evacuation and the no-action alternatives would cause negligable impacts upon this resource area.

5.07 Archaeological and Historical Resources - None of the alternatives would cause effects since no resource exists close enough to the study area.

5.08 Residential Environment - Should the non-structural alternative be selected, evacuation of parcels fronting the bluff from approximately 800 to 2400 feet east of Colorado Avenue would be necessary.

5.09 The Director of Community Development, City of Lorain, has indicated that finding replacement housing would not be a difficult process. He stated that with two exceptions, where high population densities exist, much of the city would be suitable for relocation of persons presently residing along the lakefront. Possible hostile reaction to moving from the lakeshore or from family homes of long standing is likely. It is reasonable to speculate that some individuals would not readily agree to relocation to an area away from the lake or from a place with emotional ties to the past.

5.10 As relatively abundant replacement housing appears to be available, the acquisition/evacuation alternative seems feasible. It would be up to those persons being displaced to locate replacement housing. This would allow persons to select locations within the city or elsewhere. With a wider choice, it's possible to spread the effects of evacuation over a potentially broader region and to reduce the effect on any one particular area.

5.11 Some low level, long term evacuation should result if the "no-action" alternative is selected. Erosion has been responsible for evacuations of lakeshore residents and subsequent building demolition in the past. It is reasonable to expect that this will continue should the area remain as is. Evacuation actions would be sporadic, leaving empty lots next to occupied houses.

5.12 Construction activities associated with the groin plan, the revetment plan, and the feeder beach plan would cause temporary disturbance to people dwelling near the project site. Most disturbances would be related to vehicular noise and dust generation. Reactions generally should be tolerant since direct gains will accrue to property owners from the project activity. This is especially likely for the two comprehensive protection measures. The feeder beach plan would require a considerably shorter construction period (about a month), but would recur every year or so. Also, this plan does not afford the level of protection necessary to completely eliminate erosion damages.

5.13 Avoidance of early morning and late evening construction and of weekend construction would reduce the potential of complaints. Construction vehicles should be properly muffled.

5.14 The asthetics of the shoreline would be improved by the revetment plan because the structure would replace many failing and unsightly protection structures which had been constructed by private property owners over many years with a uniform structure. A narrow beach created by fill operations in the groin plan would increase the asthetics of the shoreline but to a much smaller degree.

5.15 Recreation - The alternatives which call for the construction of groins or revetments have the potential for inducing an increase in water related recreation in the study area where the use of structures as fishing piers is made possible.

5.16 The acquisition/evacuation alternative would create opportunities for development of a public park. However, swimming would be hazardous due to the limited beach area and the danger of access from the bluff.

5.17 The alternative of periodic filling or no-action would not change the area with respect to recreation. A possible exception would be usage of the feeder beach as a temporary bathing area.

5.18 Wetlands and Water Quality - There will be no effect upon wetlands since this resource is nonexistant within the study area. Potential pollution of Lake Erie waters will be averted by using only clean, approved, sources of building materials for any structural alternatives. Short term turbidity would be caused during periods of construction at the waters' edge.

5.19 Endangered Species - There will be no effects upon endangered species since none are found in or near the study area.

5.20 Benthic Community - Effects of Feeder Beach Plan in the localized areas where sand would be added to the littoral zone,one half to two acres of existing benthic community will be covered periodically, but temporarily. Repopulation should take no more than a few months, since most of the affected organisms can either burrow up through the new sediment or recolonize from surrounding areas(23). Areas downdrift from the fill sites will experience progressively less severe burial as the sand is distributed in a natural fashion.

5.21 The feeder beach plan should result in the replacement of existing littoral sediment with more sandy sediments, Most of this replacement will be below the water line, but some sandy beach above the water line should be created. Here, the existing benthic community will probably be largely eliminated. Below the water line, the coarser sediments should cause the benthic community to show some decrease in the now-dominant oligochaetes, and some increase in amphiopods, sphaeriid clams, and chironomids is possible. These changes would result in a community generally considered characteristic of a less polluted bottom than currently exists. It should be noted, however, that such changes will probably not be profound and will be limited to the very nearshore area.

5.22 Effect of Groin System with Fill Plan - The construction of four groins, 270 feet long and averaging 90 feet wide, will cover approximately two acres of existing benthic areas with rock rubble, and most of the associated benthic community will probably be lost. Counteracting this is the fact that the hard surfaces of the rock rubble will provide an area for attachment and growth by aquatic vegetation (cladophora) and invertebrates such as amphipods and dragonfly, mayfly and damselfly nymphs.

5.23 This alternative should create approximately 2.5 acres of sandy beach which will mostly eliminate the benthic community in that area. Approximately 10 acres below the water line will become sand-dominated, with the potential benthic community changes mentioned in paragraph 5.21, Effects of Feeder Beach.

5.24 Effect of the Revetment Plan - The construction of a 2000-foot revetment will cover approximately 2.5 acres of existing very shallow water benthic community. As with the groin field alternative the associated loss of benthic community will be at least partially offset by the provision of new aquatic vegetation and invertebrate habitat on the underwater part of the revetment.

5.25 This alternative is expected to create little, if any, new beach area and would not have much effect on shallow water sediments or organisms.

5.26 Effect of the Land Acquisition Plan - Little impact should occur except that continued erosion would create more shallow water habitat.

Fish

5.27 Effect of The Feeder Beach Plan - Fish that are present in the immediate area will be driven away temporarily by the dumping of sand. They should return within a few hours(23).

5.28 The potential is greater for an impact on fish spawning in the localized area of sand dumping. Most of the nearshore fishes of the Lorain area spawn in shallow water (Table 5.1), although it is not known which of these spawn in the study area. Sudden deposition of large amounts of sand would disruptspawning activity. In addition, most of the local fish species lay their eggs on the bottom (Table 5.1), and eggs buried by sand would probably suffer very high mortality(23). Although reproductive activity by some of these fish species occurs at most times of spring and summer, almost all the abundant or important species, including yellow perch, spawn in the spring (April-May) (Table 5.1). Confining beach nourishment to other times of the year would greatly reduce the potential for impacts on spawning. Even if this is not feasible, the impact on fish populations would probably be slight as long as sand is dumped in a small area.

5.29 Since most of the fish found in the study area feed on benthic invertebrates during at least part of their lives(6)(23), any effect of beach nourishment on the benthic community could have an indirect effect on fish populations. The most important potentially affected fish, the yellow perch, has been shown to be very flexible in its feeding (23) and would probably simply continue feeding on an altered benthic community. It seems reasonable that many of the other fish species have a similar flexibility of diet, thus reducing the impact of changes in benthic fauna on fish populations.

5.30 Effect of Groin System with Fill Plan - During the construction period, increased turbidity, noise, and general disturbance will temporarily drive most, but probably not all, fish from the construction area. Fish would be expected to reinhabit the area after construction ceases.

5.31 The groins would cover approximately 2 acres of bottom that are probably now used by fish for feeding and spawning. However, the rock rubble of the groins and the associated aquatic vegetation and invertebrate fauna will provide new food and, perhaps more important, shelter for fish.

Table 5.1 - Spawning and Feeding Ecology of Common Nearshore Lorain Fishes
From (2)(3)(6)(23)(24)

	Spawning			
Species	Habitat	Substrate	Season	Adult Feeding Niche
Alewife	Shallow beaches	Sand or gravel bars	June	Zooplankton
Carp	Weedy or grassy shallows	Nearly any substrate	May-June	Benthic omnivore
Channel Catfish	Nearshore and rivers, turbid	Holes, log jams, crevices	Late June	Bottom feeder
Coho Salmon	Stocked			Fish predator
Emerald Shiner	Offshore, open water	Pelagic eggs	June-July	Zooplankton
Freshwater Drum	Rivers, nearshore, or offshore	Pelagic eggs	June-August	Bottom feeder, some fish
Gizzard Shad	Shoreline, marshes	Many substrates, sand, gravel	May	Phytoplankton
Goldfish	Weedy lake and river shallows	Nearly any substrate	May-June	Benthic omnivore
Largemouth Bass	Streams, harbors, bays	Sand, rock, gravel, mud	May	Fish predator
Quillback	Quiet shallows of lakes and rivers	Sand, mud, vegetation	April-May	Benthic omnivore
Rainbow Smelt	Offshore, beaches and streams	Gravel or sand	May	Small fish, invertebrates
Spottail Shiner	Lake shallows and river mouths	Sand, gravel, vegetation	June	Zooplankton
Troutperch	Nearshore, beaches	Bedrock, sand, gravel, stones	April-June	Bottom feeder
Walleye	Rivers and nearshore	Rocky shoals, gravel bars	April	Fish predator
White Bass	Shallows of lakes and river	Rocky, gravel, sand, vegetation	May	Fish predator
White Sucker	Shallows of lakes and river	Gravel or stones	April	Benthic omnivore
Yellow Perch	Rivers, bays, nearshore, offshore	Sand, gravel, vegetation	April-May	Fish and bottom feeder

5.32 It is well known that artificial reefs in marine habitats attract large numbers of fish and enhance fishing (1). Few such reefs have been built in the Great Lakes, but the effect on fish is expected to be similar(21). In fact, a concrete and rock rubble diked disposal area in Maumee Bay, Lake Erie, has been shown to attract significant numbers of white bass, gizzard shad, freshwater drum, channel catfish, and carp(2). Yellow perch and largemouth bass also have a strong affinity for cover and would be expected to be attracted by such structures(21).

5.33 In regard to the effect of a groin field on fish spawning, the groins would increase the amount of suitable spawning area for species that lay their eggs on hard substrates. This includes walleye, which were shown to use the Maumee Bay dike for spawning(2), and other hard-bottom spawners (white bass, black bass, trout-perch, white sucker) might be expected to respond similarly. Species that do not spawn on hard substrates (Table 5.1) would experience a loss of spawning area, but the remaining soft-bottom area would probably be sufficient as spawning space seems unlikely to be limiting for these species.

5.34 Groin field construction, with the resulting noise, high water turbidity, and general disturbance, would drive fish out of the area and could potentially disrupt local spawning. If construction were confined to months other than April and May, the potential for such as impact would be substantially reduced.

5.35 Again, any indirect effects of changes in shallow water sediments, through effects on the benthic community on fish populations would probably be largely mitigated by flexibility in fish feeding.

5.36 In summary, the building of rock rubble groins would probably attract a variety of fish species and result in improved sport fishing, at least in the vicinity of the groins. In the unlikely occurrence that building the groins had a negative impact on fish populations, this impact would probably be very local and not important to fish in the Lorain area in general.

5.37 <u>Effect of Revetment Plan</u> - The construction of a revetment would put rock rubble over approximately 2.5 acres of existing bottom in very shallow water, some of which is probably used by fish for feeding or spawning.

The counteracting provision of shelter and spawning and feeding area by the rock rubble that was mentioned above in discussing the effect of the groin field alternative would also apply to the revetment alternative. In addition, a revetment would have less effect than a groin field on the nature of the shallow water sediments in the area. Therefore, the net impact of a revetment on fish populations should be negligible or slightly positive, with the possibility of improved fishing very locally.

5.38 Again, to minimize the disruption of fish spawning construction should not occur during the spring.

5.39 Effect of Land Acquisition Plan - No noticeable impacts upon fish are expected from this alternative.

5.40 Summary of Commercial Fishery Impacts - None of the alternatives is likely to impact the local commerical fishery. The commercial fishery is located almost completely offshore. Any effect on fish populations will occur only in the shallowest nearshore water and will be restricted to the near vicinity of the study area. Wider effects, such as that of increased spawning habitat on local populations of some species, are likely to be insignificant. A revetment or groin field probably could not attract enough fish from offshore to affect commercial fishing.

Waterfowl and Shorebirds

5.41 Effect of the Feeder Beach Plan - The development of a more suitable beach habitat in the area should increase use of the area by shorebirds such as gulls, sandpipers and killdeer.

5.42 Effect of Groin System with Fill Plan - Since herring gulls and ring-bill gulls now use existing breakwaters at Lorain for resting and feeding, it is likely that the same species, and possibly other shorebirds, will make similar use of any groins that are constructed. The slight improvement of the beach habitat expected to result from this alternative should increase use of the area by shorebirds.

5.43 Effect of Revetment Plan - Gulls will probably use the revetment for resting and feeding.

5.44 Effect of Acquisition Plan - Some increase in use of the evacuated land by terrestrial birds may result from implementation of this plan.

6. PUBLIC INVOLVEMENT

6.01 The public involvement program has included a public workshop, a public meeting, and continued informational exchanges with principal governmental and private organizations. The public involvement program was designed to coordinate study efforts with organizations having regulatory or administrative interest in the study, and with individuals being directly affected by study decisions.

6.02 Coordination by letter or telephone has included governmental agencies at the Federal, state, regional, county, and city levels. A complete listing is located in Appendix 3.

6.03 The public workshop was held in March of 1980, to inform the public of the study initiation. The public meeting held in September of 1980 was to divulge tentative study results to the public and incorporate their input into the study planning.

6.04 The public involvement program, public views and responses, and pertinent correspondence are contained in Appendix 3. Written responses have been few, and agencies generally have expressed preliminary opinions that little adverse environmental impacts would occur from implementation of study alternatives. After report distribution, expected written responses probably will confirm preliminary views.

7. INDEX REFERENCES AND APPENDIXES

7.01 An index, list of references and appendixes is shown in Table 7.1. The purpose of the table is to provide the reader with an alphabetized subject index with references to the EA, Main Report, and Report Appendixes for each subject. Specific significant resources are alphabetized by subject under that heading.

TABLE 7.1

INDEX, REFERENCES AND APPENDIXES
(Tentatively Selected Plan - Revetment)

SUBJECTS	STUDY DOCUMENTATION Environmental Assessment	 Main Report (References Incorporated)	 Report Appendixes (References Incorporated)
Alternatives	ppEA-12 Section 3.0	pp 23-28	App 4 pp 4-1-4-31
Areas of Controversy	ppEA-5 Section 6.0		App #3 pp. 3-2
Bibliography			App #7 pp. 7-1 to 7-3
Comparative Impacts of Alternatives	ppEA-12 para. 3.06 & 3.07		
Environmental Conditions	ppEA-15 Section 4.0	pp 6-8	
Environmental Effects	ppEA-24 Section 5.0	pp 25-27	App #2 pp 2-3,5,8,12,15
List of Preparers	ppEA-2		
Major Conclusions & Findings	ppEA-5	pp 48-50	
Need for and Objectives of Action	ppEA-10 Section 2.0	pp 20-22	
Planning Objectives	ppEA-10 para. 2.03	pp 21-22	
Plans Considered in Detail	ppEA-12 para. 3.05	pp 25-27	App #4 pp 4-1-4-31
Plans Eliminated from Further Study	ppEA-12 para. 3.01-3.04	pp 26	App #2 pp 2-1
Public Concerns		pp 20	App #3 pp. 3-2, 3-4

AD-A120 366 CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT F/G 13/2
DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT. SECTION 1--ETC(U)
NOV 81

UNCLASSIFIED NL

2 OF 4
AD A
120366

TABLE 7.1 Continued

SUBJECTS	STUDY DOCUMENTATION Environmental Assessment	Main Report (References Incorporated)	Report Appendixes (References Incorporated)
Public Involvement Program	ppEA-32 Section 6.0	pp 47	App #3 pp 3-1
Public Views and Responses	ppEA-32 para. 6.04	pp 47	App #3 pp. ALL
Relationship to Environmental Requirements	ppEA-7		
Required Coordination	ppEA-32 Section 6.0		App. #3 pp 3-1
Siginficant Resources	ppEA-16	pp 13-14	App. #6 pp. ALL
Archaeological/ Historical	ppEA-17 para. 4.17-5.07	pp 8	
Benthic Biota	ppEA-18 para. 4.17-4.30 5.20-5.26	pp 8	
Business/Industrial	ppEA-19 para. 4.13-4.16 5.05-5.06	pp 13	
Endangered Species	ppEA-19 para 4.26-5.19	pp 13	
Fish	ppEA-20 para. 4.31-4.33 5.27-5.40		
Property Values & Taxes	ppEA-16 para. 4.11-4.12 5.02-5.04	pp 14	
Recreational	ppEA-18 para. 4.20-4.24 5.15-5.17	pp 14	
Residential Environment	ppEA-18 para. 4.18-4.19 5.08-5.14	pp 14	

TABLE 7.1 Continued

SUBJECTS	STUDY DOCUMENTATION Environmental Assessment	Main Report (References Incorporated)	Report Appendixes (References Incorporated)
Waterfowl and Shorebirds	ppEA-23 para. 4.34-4.36 5.41-5.44		
Wetlands and Water Quality	ppEA-19 para. 4.25 5.18	pp 13	
Study Recipients	ppEA-32 para. 6.02		App #3 pp. 3-1
Study Authority	ppEA-10 para. 2.01	pp 2	
Summary	ppEA-5 Section 1.0	pp 48	
Table of Contents	ppEA-3	pp i-iv	
Unresolved Issues	ppEA-5		App. #3 pp. 3-3
Without Conditions	ppEA-12 para. 3.04	pp 25	App. #2 pp. 2-2

APPENDIX 1

PROBLEM IDENTIFICATION

APPENDIX 1

PROBLEM IDENTIFICATION

TABLE OF CONTENTS

PROBLEM IDENTIFICATION

INTRODUCTION

The physical features of Lorain Harbor, Ohio are presented in figure 1-1. The Corps of Engineers' Diked Disposal Area shown was constructed between August, 1976 and September, 1977. Construction on the Spending Beach Revetment was started in June, 1977 and completed in November, 1977.

Subsequent to the completion of the dike structure and the spending beach, local residents east of these structures began noticing "excessive" erosion of the shoreline fronting their properties and attributed this erosion to the presence of the dike structure. On July 19, 1979, then mayor Joseph Zahorec wrote a letter to the Corps of Engineers, Buffalo District requesting a "study to determine the direct cause of this... severe erosion condition."

Section 111 proceedings were instituted with a Reconnaissance report on October 26, 1979 to determine the culpability of the diked structure in the erosion occurring along the shoreline east of Colorado Avenue. The findings of that report released on February 13, 1980 was that the Federally constructed Dike Disposal structure had not instituted erosion on the shores to the east, but had contributed to the acceleration of a natural condition of erosion and bluff recession.

The objective of this Section 111 report is to determine the exact nature and magnitude of this contribution to erosion and develop alternatives for mitigation of the portion of erosion attributable to the Federal Navigation Works - Diked Disposal Structure.

PRIOR STUDIES

Prior reports pertinent to this Section 111 study are summarized below.

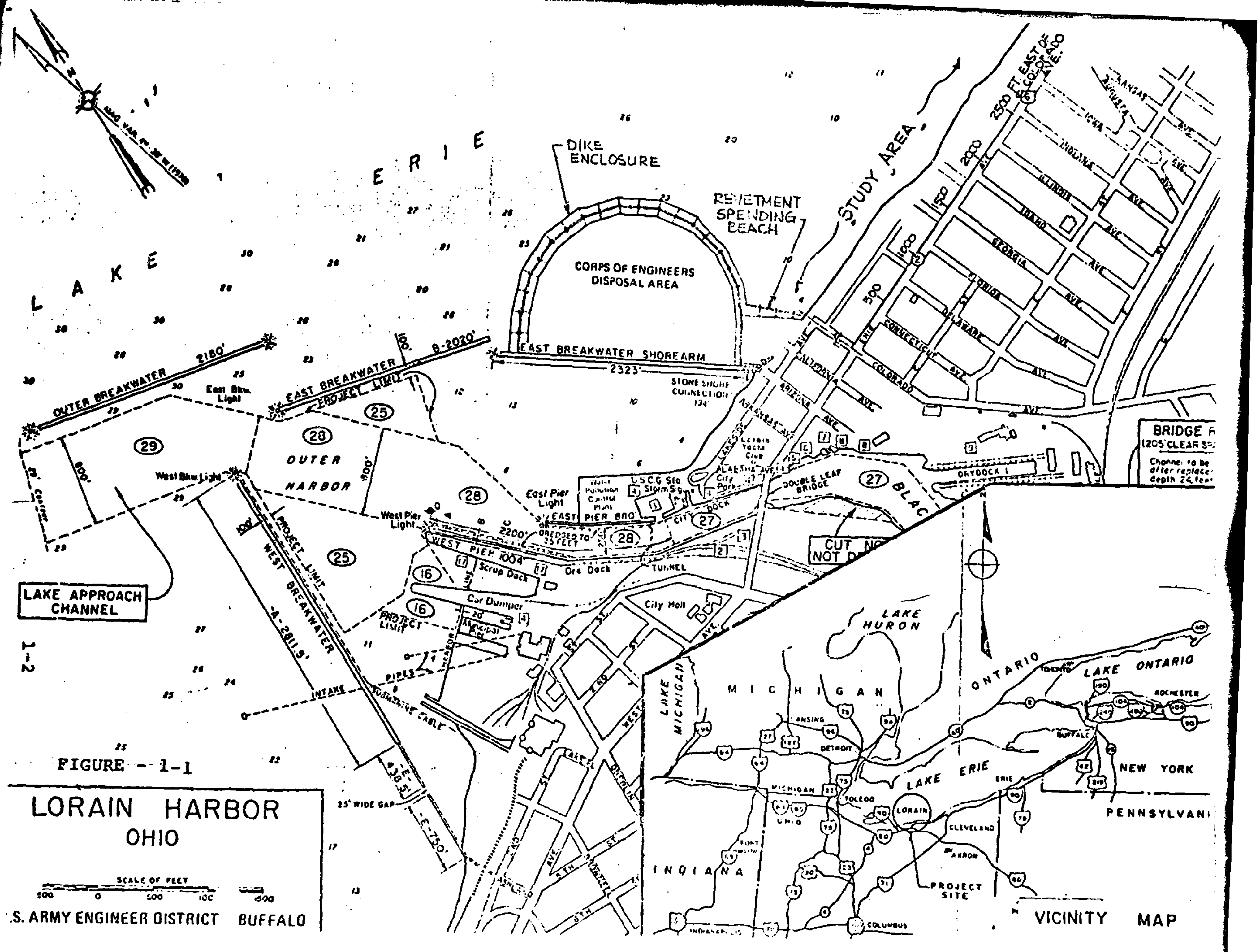

LAKE ERIE
DIKE ENCLOSURE
CORPS OF ENGINEERS DISPOSAL AREA
REVETMENT SPENDING BEACH
STUDY AREA
EAST BREAKWATER SHOREARM
2323'
STONE SHORE CONNECTION
OUTER BREAKWATER
2180'
EAST BREAKWATER
B-2020'
PROJECT LIMIT
OUTER HARBOR
East Bkw. Light
West Bkw. Light
East Pier Light
West Pier Light
EAST PIER 880'
WEST PIER 1004'
DREDGED TO 25 FEET
2200'
WEST BREAKWATER
-A-2811.5'
-E-438.5'
-E-750'
25' WIDE GAP
Scrap Dock
Ore Dock
Car Dumper
City Dock
City Hall
TUNNEL
DOUBLE LEAF BRIDGE
DRYDOCK
INTAKE
PIPES
SUBMARINE CABLE
LAKE APPROACH CHANNEL
29' Contour
BRIDGE
Channel to be after replaced depth 24 feet
MAG. VAR.
LORAIN HARBOR
OHIO
SCALE OF FEET
U.S. ARMY ENGINEER DISTRICT BUFFALO
VICINITY MAP
LAKE HURON
LAKE MICHIGAN
LAKE ONTARIO
LAKE ERIE
MICHIGAN
INDIANA
OHIO
ONTARIO
NEW YORK
PENNSYLVANIA
LORAIN
PROJECT SITE
TOLEDO
DETROIT
CLEVELAND
AKRON
COLUMBUS
BUFFALO
ROCHESTER
TORONTO

FIGURE - 1-1

1. House Document No. 229, 83rd Congress, "Appendix VIII, Ohio Shoreline of Lake Erie Between Vermilion and Sheffield Lake Village, Beach Erosion Control Study." This August 1949 report was prepared by the U.S. Army Corps of Engineers, Buffalo District, submitted through higher authority for review, and printed as above indicated U.S. Congressional House Document. Table 1 of that report lists the printed documents relating to improvements of Lorain Harbor from 1897 to 1949. Since these are not related to the Construction of the Dike Structure they are not included here. The following quotes, Paragraph 84, of the report regarding shore erosion east of Lorain Harbor:

"Immediately east of the east pier at Lorain Harbor, erosion has been active over the entire period of record. In 1907 the Federal Government placed a stone and brush mattress at the inner end of the east pier to prevent a breach from the lake into the river. The city of Lorain received a permit in 1912 to dump all maintenance dredging material from the Black River close to shore in the area east of the pier, and continued this up to 1917. In 1931-32, 400,000 cubic yards were pumped onto shore between the pier and Colorado Avenue during deepening operations in the outer harbor. Many shore protection structures have been built in the area, and private property owners and the city have dumped an unknown amount of material over the bank in an attempt to halt erosion. In 1943 the city, in an attempt to halt erosion just west of Arkansas Avenue, dumped broken concrete paving and bricks into a cove where it remained for 3 years. A northeast storm removed it from the cove and distributed it in this area for the present and the city intends to continue dumping material at this point."

2. January 22, 1970, Section 111 Report by U.S. Army Corps of Engineers, Buffalo District, entitled "Investigation of Effects of East Breakwater

Shorearm at Lorain Harbor, Ohio on Adjacent Shore." This January 1970 report was instituted because of claims from residents east of the Shorearm that it was causing increased erosion in that area. The following quotes Paragraph 16 of the report regarding the findings and conclusion of the study:

"In view of the facts and evidence presented herein it is apparent that the U.S. East Breakwater Shorearm is not responsible for, and its construction has not increased, the erosion of the shore along Lakeside Avenue. Although the rate of erosion may be accelerated beyond that which was occurring immediately prior to the construction of the shorearm the increased erosion is a natural result of the near-record lake levels that have been experienced. Further study of the problem with a view to adoption of a Federal project for prevention or mitigation of damages due to the effect of the breakwater is not recommended."

3. "Design Analysis for Spending Beach Section of Dike Disposal Area, Lorain Harbor, Ohio", a report prepared in June 1975 by Parsons, Brinckerhoff, Quade & Douglas, Inc. for the U.S. Army Corps of Engineers, Buffalo District. Page 33 of this report discusses the effect of the dike disposal structure on shoreline to the east:

"Additionally, the construction of the proposed Spoil Disposal Facilities containment structure should induce a quiet longshore (pocket) water body, consequently increasing deposition of suspended materials and or debris on the beach and between the containment structure and the beach. To protect the entire privately owned shoreline or any part thereof from natural storm attack, during this period of high lake stages and consequential unstable beach profile condition, is unwarranted. Moreover since it has been previously discussed and will be further demonstrated in the following section, the proposed Spoil Disposal Facility will offer substantial protection to the shoreline from storm waves arising out of the northwest and north."

4. Section 111 Reconnaissance Report on Shores East of Diked Disposal Area, Lorain Harbor, Ohio prepared in February 1980 by Tetra Tech, Inc. for the U.S. Army Corps of Engineers, Buffalo District. The conclusion from that report is as follows:

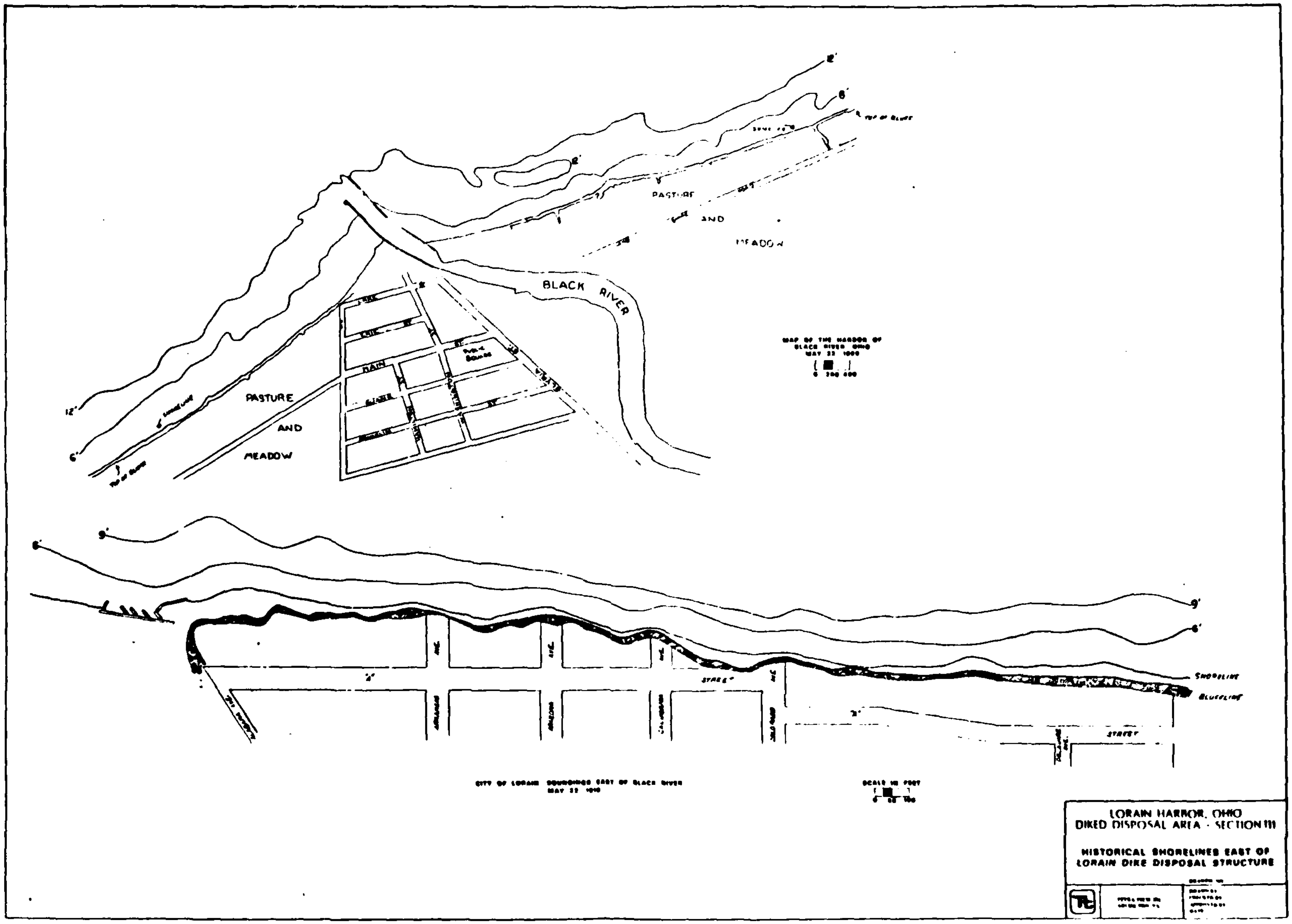
"Based on this preliminary study, it is concluded that the Dike Disposal Area has not caused the erosion problem experienced by the shore east of Lorain. Natural erosion and bluff recession has been the historical condition of this shore. The Dike Disposal structure has, however, contributed to some degree, an impact which may accelerate this natural condition."

DATA AND ALALYSIS

The following sections present the data which was assembled, updated and analyzed to determine:

1. the possible cause of erosion along the study shoreline;
2. the impact of the dike disposal structure on shoreline erosion; and
3. the extent of erosion attributable to the dike disposal structure and natural forces.

For historical perspective, Figures 1-2 and 1-3 present the shoreline east Lorain Harbor for the years 1865, 1918, 1921, 1934 and 1944.



BLACK RIVER
PASTURE
AND
MEADOW
PASTURE
AND
MEADOW
12'
6'
2'
9'
6'
SHORELINE
BLUFFLINE
STREET
LORAIN HARBOR, OHIO
DIKED DISPOSAL AREA · SECTION 111
HISTORICAL SHORELINES EAST OF
LORAIN DIKE DISPOSAL STRUCTURE

Figure 1-2

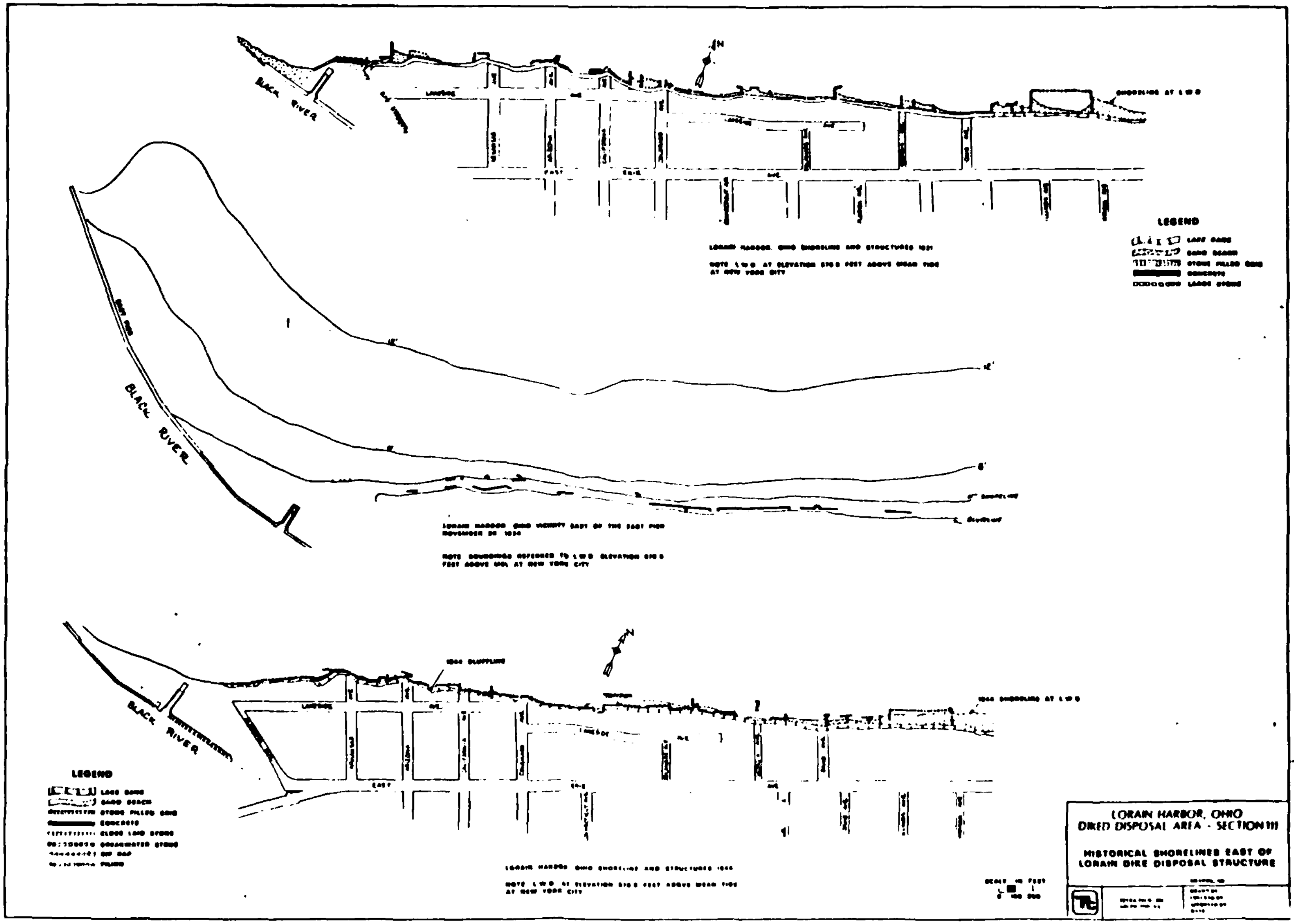

LORAIN HARBOR, OHIO
DIKED DISPOSAL AREA - SECTION 111
HISTORICAL SHORELINES EAST OF LORAIN DIKE DISPOSAL STRUCTURE
LEGEND
BLACK RIVER

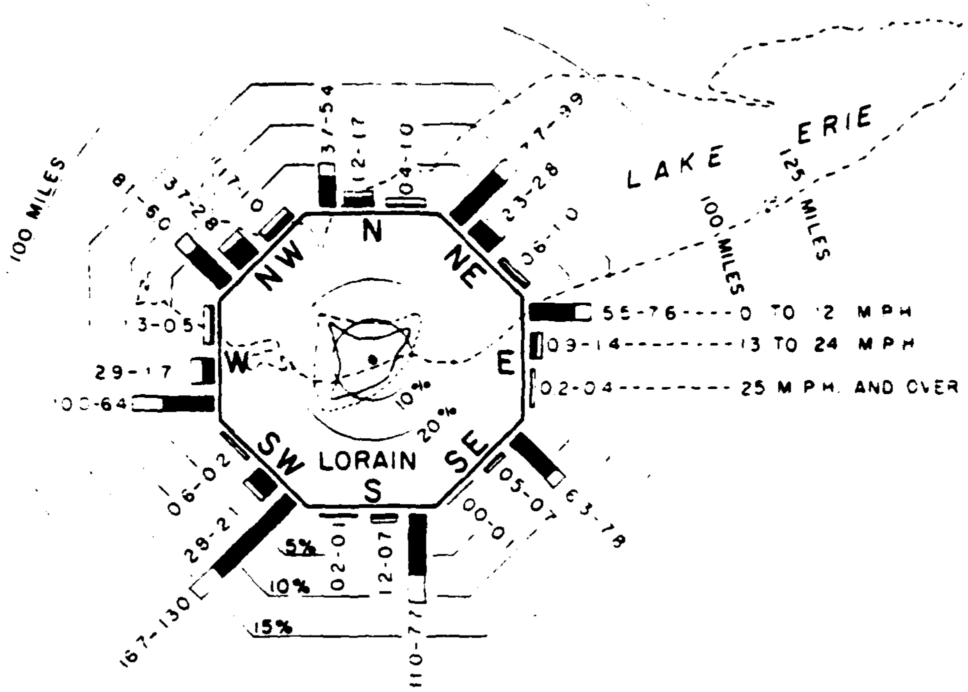
Figure 1-3

Wind

The wind affects the project site only by exerting its influence on the surface of Lake Erie to create waves which are the prime erosive force on the shoreline.

Wind data for the study area was obtained from U.S. Coast Guard data at Lorain Harbor, Ohio for the period 1938 thru 1971. This data shows no predominance of wind from any particular direction, although there is a slight favor of winds from the West vs. winds from the East. There is also a slight favor of the higher wind speeds (25 mph and over) from the Northwest and West directions over those from the Northeast. These factors, are enough to overcome the inconsistency of fetch lengths (approx. 70 miles to the Northwest vs. approx. 200 miles to the Northeast) to produce the highest deep water wave heights from Western approach quadrants.

Nearshore waves from the Northwest thru West approach angles are shielded (see page 1-64) from reaching portions of the study shoreline by the dike disposal structure. It is this inequality of wave incidence on the study shoreline which produces an inbalance of littoral forces and eventually contributes to natural erosion along the study shoreline.



WIND DIAGRAM FOR LORAIN HARBOR, OHIO

NOTES

▬ INDICATES DURATION FOR ICE-FREE PERIOD (MAR. TO DEC. INCL.) IN PERCENT OF TOTAL DURATION.

▭ INDICATES DURATION FOR ICE PERIOD (JAN. TO FEB. INCL.) IN PERCENT OF TOTAL DURATION.

∼ INDICATES PERCENT OF TOTAL WIND MOVEMENT OCCURRING DURING ICE-FREE PERIOD.

---- INDICATES PERCENT OF TOTAL WIND MOVEMENT OCCURRING DURING COMBINED ICE AND ICE-FREE PERIODS.

FIGURES AT ENDS OF BARS INDICATE PERCENT OF TOTAL WIND DURATION FOR ICE-FREE PERIOD AND COMBINED ICE-FREE AND ICE PERIODS, RESPECTIVELY.

WIND DATA BASED ON RECORDS OF THE U.S. COAST GUARD AT LORAIN HARBOR, OHIO FOR PERIOD 1 JAN. 1938-31 DEC. 1971

Figure 1-4 WIND DIAGRAM
(FROM: U.S.A.E.D, Buffalo
Drawing No. 76-LOD-1/1
dated 3-30-76)

Waves

Design wave criteria for the areas east of the dike disposal structure were calculated using "Design Wave Information for the Great Lakes" to estimate extreme waves in deep water off Lorain. To determine what changes occur in these waves as they approach shore, the irregular wave theory developed by Goda and reported in two CERC papers was utilized.

The calculations are presented in the following pages. A 10 year return interval deep water wave height of 9.8 ft. is considered to be the extreme estimate used for design purposed in this study.

DESIGN WAVE CONDITIONS FOR AREAS EAST OF
LORAIN HARBOR DIKE DISPOSAL STRUCTURE

EXTREME ESTIMATES FOR DESIGN WAVE CONDITIONS IN DEEP WATER OFF LORAIN, OHIO WERE OBTAINED FROM: RESIO & VINCENT, "DESIGN WAVE INFORMATION FOR THE GREAT LAKES" REPORT 1, LAKE ERIE, JANUARY 1976.

A 10 YEAR RETURN PERIOD WAVE HEIGHT WAS CHOSEN TO BE COMBINED WITH A 20 YEAR RETURN PERIOD LAKE LEVEL TO OBTAIN DESIGN CONDITIONS.

FOR GRID POINT 8, LORAIN, OHIO 10 YEAR R.I. ESTIMATES

SEASON	APPROACH CLASS 1		APPROACH CLASS 2		APPROACH CLASS 3	
	Ho	To	Ho	To	Ho	To
WINTER	8.5	7.0	9.8	7.2	9.8	7.8
SPRING	3.9	5.2	4.6	5.5	6.9	6.7
SUMMER	4.9	5.8	4.3	5.4	7.2	6.8
FALL	8.5	7.0	8.5	6.8	9.5	7.7
DIRECTION	ENE to N		N to NW		NW to WNW	

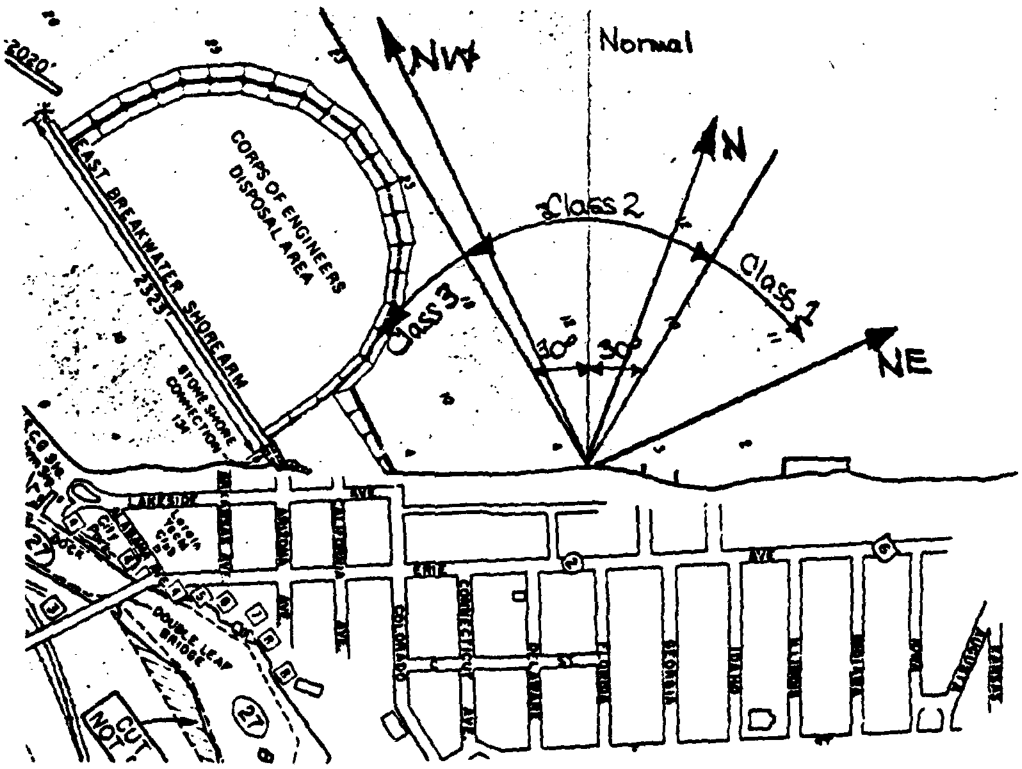


TABLE OF EXTREMES ESTIMATES
GRID LOCATION 11, 8 LAT=41.57 LON=82.12 LORAIN OH
SHORELINE GRID POINT 8

WINTER

	ANGLE CLASSES 1	2	3	ALL
5	7.2(0.6)	8.9(0.4)	9.5(0.2)	10.3(0.6)
10	8.5(0.7)	9.8(0.5)	9.8(0.2)	10.9(0.8)
20	9.8(0.9)	10.8(0.7)	10.5(0.3)	11.7(1.0)
50	11.8(1.1)	12.1(0.8)	10.8(0.3)	13.2(1.2)
100	13.1(1.3)	13.1(0.9)	11.2(0.4)	14.3(1.4)

SPRING

	ANGLE CLASSES 1	2	3	ALL
5	3.6(0.3)	3.6(0.5)	5.9(0.4)	6.1(0.5)
10	3.9(0.4)	4.6(0.7)	6.9(0.5)	7.2(0.7)
20	4.6(0.6)	5.9(0.8)	7.5(0.6)	8.2(0.9)
50	5.9(0.7)	7.5(1.0)	8.9(0.8)	9.6(1.1)
100	6.6(0.8)	8.9(1.2)	9.8(0.9)	10.7(1.2)

SUMMER

	ANGLE CLASSES 1	2	3	ALL
5	3.6(1.3)	3.6(0.7)	5.9(1.2)	6.3(1.3)
10	4.9(1.7)	4.3(1.0)	7.2(1.6)	7.6(1.8)
20	6.2(2.1)	4.6(1.2)	8.2(1.9)	8.9(2.2)
50	8.2(2.6)	5.6(1.5)	9.8(2.4)	10.6(2.8)
100	9.5(3.0)	6.2(1.8)	11.2(2.8)	11.9(3.2)

FALL

	ANGLE CLASSES 1	2	3	ALL
5	7.9(0.3)	7.5(0.4)	8.9(0.2)	9.4(0.4)
10	8.5(0.4)	8.5(0.5)	9.5(0.3)	10.0(0.6)
20	9.2(0.5)	9.5(0.7)	9.8(0.4)	10.8(0.7)
50	10.2(0.6)	10.8(0.8)	10.8(0.5)	11.8(0.9)
100	10.8(0.7)	11.8(0.9)	11.2(0.5)	12.5(1.0)

(Continued)

(Sheet 8 of 24)

GRID LOCATION 11, 8 LAT=41.57 LON=82.12   LORAIN OH

GRID POINT NUMBER 8

SIGNIFICANT PERIOD BY ANGLE CLASS AND WAVE HEIGHT

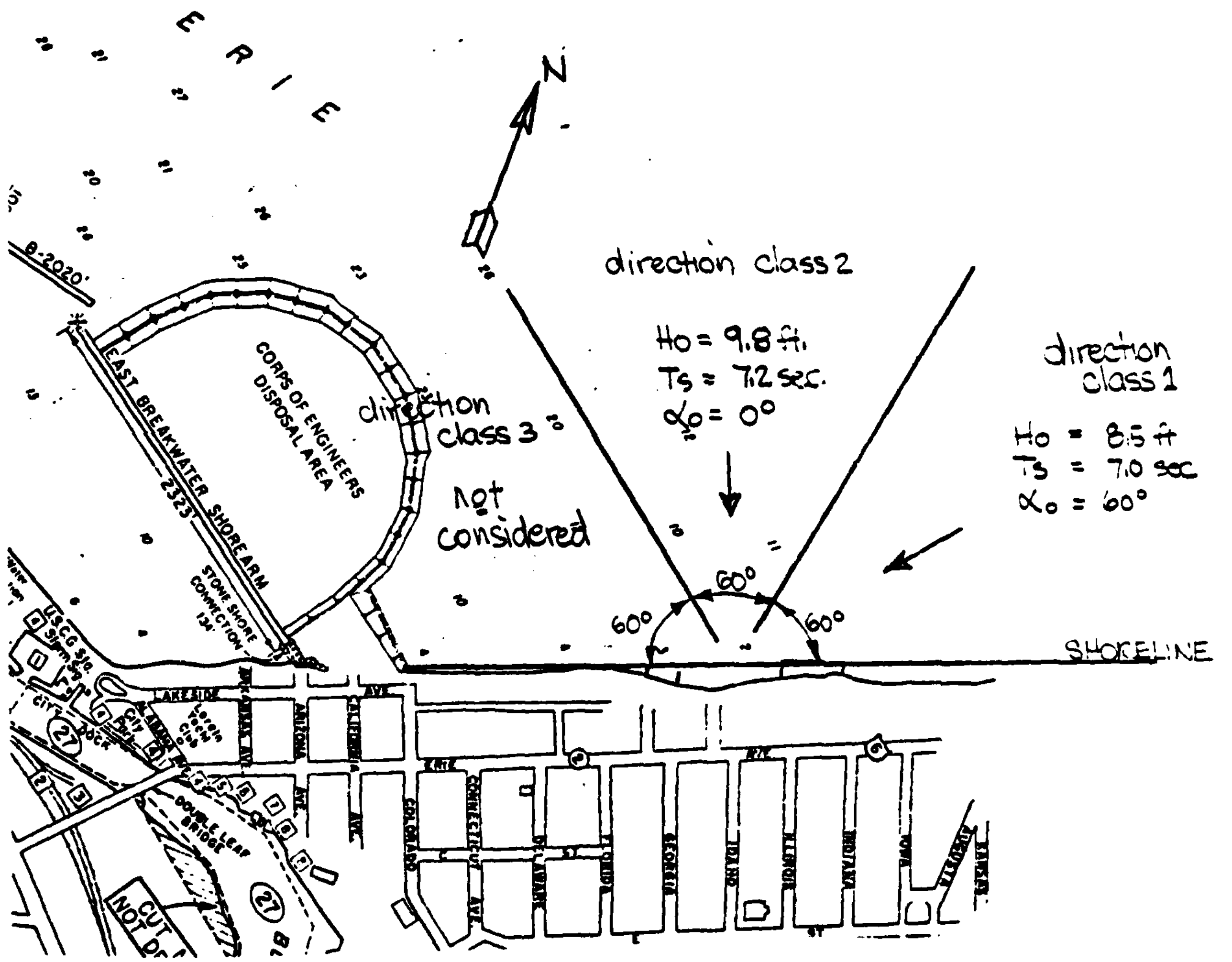
WAVE HEIGHT (FT)	ANGLE CLASS 1	2	3
1	2.3	2.3	2.4
2	3.6	3.5	3.7
3	4.5	4.5	4.7
4	5.3	5.2	5.4
5	5.8	5.7	6.0
6	6.1	6.0	6.4
7	6.5	6.3	6.7
8	6.8	6.6	7.1
9	7.1	6.9	7.5
10	7.5	7.3	7.9
11	7.8	7.6	8.2
12	8.1	7.9	8.6
13	8.4	8.2	9.0
14	8.8	8.5	9.3
15	9.1	8.8	9.7
16	9.4	9.1	10.1
17	9.8	9.4	10.4
18	10.1	9.7	10.8
19	10.4	10.0	11.2
20	10.8	10.3	11.6
21	11.1	10.7	11.9
22	11.4	11.0	12.3
23	11.7	11.3	12.7
24	12.1	11.6	13.0
25	12.4	11.9	13.4

(Continued)

(Sheet 8 of 24)

ESTIMATING NEARSHORE CONDITIONS FOR IRREGULAR WAVES

USING THE EXTREME ESTIMATES FROM RESIO & VINCENT "DESIGN WAVE INFORMATION FOR THE GREAT LAKES" AND THE METHODS DEVELOPED BY GODA AS REPORTED IN CETA 79-5, SEELIG, WILLIAM N., "ESTIMATING NEARSHORE SIGNIFICANT WAVE HEIGHT FOR IRREGULAR WAVES", CERC OCTOBER 1979; AND
SEELIG, WILLIAM N. AND AHRENS, JOHN P. "ESTIMATING NEARSHORE CONDITIONS FOR IRREGULAR WAVES", CERC DRAFT REPORT JULY 1979;
DEVELOPE TABLES OF NEARSHORE CONDITIONS FOR INCOMING WAVE DATA PER DEEPWATER CONDITIONS SHOWN ON SKETCH BELOW



PREDICTED NEARSHORE SIGNIFICANT WAVE HEIGHTS

DIRECTION 1 : $H_0 = 8.5$ ft, $T_s = 7.0$ sec, $\alpha_0 = 60°$, $S^* = 4$ assuming wind waves

d_{SWL} (ft)	d/gT_s^2	K_R	α	H_0'	H_0'/L_0	d_{SWL}/H_0'	H_s (ft)
18	0.0114	0.74	23°	6.29	0.025	2.86	6.23
15	0.0095	0.73	20°	6.21	0.025	2.42	6.27
12	0.0076	0.72	18°	6.12	0.024	1.96	6.24
9	0.0057	0.71	16°	6.04	0.024	1.49	5.50
6	0.0038	0.70	13°	5.95	0.024	1.01	4.22
3	0.0019	0.69	9°	5.87	0.023	0.51	2.47

DIRECTION 2 : $H_0 = 9.8$ ft, $T_s = 7.2$ sec, $\alpha_0 = 0°$, $S^* = 4$

d_{SWL} (ft)	d/gT_s^2	K_R	α	H_0'	H_0'/L_0	d_{SWL}/H_0'	H_s (FT)
18	0.0108	0.94	0°-1°	9.21	0.035	1.95	3.93
15	0.0090	0.918	0°-1°	9.00	0.034	1.67	8.19
12	0.0072	0.916	0°-1°	8.98	0.034	1.34	7.36
9	0.0054	0.912	0°-1°	8.94	0.034	0.99	5.63
6	0.0036	0.907	0°-1°	8.89	0.033	0.67	4.18
3	0.0018	0.90	0°-1°	8.82	0.033	0.34	2.65

DIRECTION 3 : WILL NOT BE CONSIDERED DUE TO THE SHADOWING EFFECT OF THE LORAIN HARBOR NAVIGATION STRUCTURES ON INCOMING WAVES WEST OF NORTH-WEST ON THE LENGTH OF SHORELINE UNDER CONSIDERATION.

NOTES:
1) S^* = DIRECTIONAL SPREADING COEFFICIENT = 4 FOR WIND DRIVEN WAVES
2) THIS METHOD NEGLECTS BOTTOM FRICTION
3) BOTTOM SLOPE $m = 1/100$ for $d > 6$ ft. $m = 1/50$ for $d > 3 < 9$ ft
4) $H_0' = K_R H_0$; $H_0'/L_0 = H_0'/5.12 T_s^2$

Lake Levels

Fluctuations in lake level may alter shoreline conditions extensively. The International Great Lake Datum (IGLD) for low water for Lake Erie has been established as 568.6 feet. The mean elevation of the lake surface for the period 1860 to 1977 has been 570.36 feet or 1.76 feet above low water datum. In addition to annual and seasonal fluctuations, cycles of high and low stages (as related to either the IGLD or the average lake level for the past 117 years), extend over periods of several years with no historically consistent pattern.

Currently, the lake stage appears to be declining from the highest lake stages ever recorded in 1973. The pre-dike period 1973-1978, which was marked by the highest lake levels on record, was excluded from bluff recession analysis because of its presumed unfair bias toward excessive erosion rates caused by high lake levels. (see page 1-33) Instead, the period 1937 to 1973 was used as representative of long term pre-dike conditions because it covered periods of high and low lake stages. In the two years (1978-1980) since dike construction, the post dike bluff recession rates were found to be slightly higher than the long term average rate over the period 1937-1973. Without a comparable post dike period of low lake stage it is impossible to tell how much of the post dike bluff recession is related to lake stage and how much is attributable to the dike disposal structure.

Two tables on the following pages provide:

1. Monthly and annual average elevations of the lake at Cleveland, Ohio based upon 30 years of U.S. Department of Commerce NOAA data.
2. A summary of the above data in terms of annual averages and variance from the IGLD.

U. S. DEPARTMENT OF COMMERCE
NOAA - NOS ROCKVILLE, MARYLAND
GREAT LAKES WATER LEVELS, C3314

MONTHLY AND ANNUAL AVERAGE ELEVATIONS
WATER LEVELS IN FEET, IGLD (1955)

Station 3063 : Cleveland, Ohio on Lake Erie

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL AVG
1950	569.84	570.47	570.46	571.26	571.38	571.24	571.04	570.74	570.61	570.34	570.16	570.53	570.67
1951	570.54	570.58	571.26	571.80	572.05	572.03	571.92	571.62	571.22	570.90	570.77	570.86	571.30
1952	571.39	572.06	572.28	572.67	572.76	572.73	572.51	572.22	571.95	571.32	570.87	570.87	571.97
1953	571.05	571.04	571.27	571.52	571.82	572.11	571.99	571.85	571.40	571.01	570.65	570.37	571.34
1954	570.34	570.19	570.69	571.54	571.83	571.74	571.61	571.41	571.08	571.24	571.29	571.23	571.18
1955	571.44	571.23	571.77	572.10	572.11	571.99	571.76	571.61	571.18	570.84	570.42	570.29	571.40
1956	570.01	569.45	570.04	570.56	571.35	571.56	571.54	571.45	571.13	570.58	570.09	569.97	570.64
1957	569.80	569.78	570.00	570.63	571.02	571.07	571.30	570.92	570.54	570.12	569.64	569.77	570.38
1958	569.86	569.34	569.42	569.62	569.74	569.85	570.11	570.11	569.90	569.48	569.08	568.86	569.61
1959	568.70	569.14	569.58	570.14	570.57	570.53	570.25	570.02	569.67	569.54	569.29	569.53	569.75
1960	569.85	569.98	570.00	570.55	570.95	571.23	571.34	571.29	571.03	570.54	570.02	569.72	[illegible]
1961	569.58	569.60	570.29	570.84	571.57	571.50	571.31	571.22	570.92	570.37	569.97	569.71	570.57
1962	569.42	569.56	569.87	570.22	570.31	570.43	570.36	570.23	569.98	569.80	569.72	569.48	569.95
1963	569.15	568.92	569.22	569.85	570.05	570.01	569.76	569.61	569.35	569.02	568.76	568.51	569.35
1964	568.43	568.54	568.87	569.42	569.72	569.65	569.51	569.29	569.03	568.53	568.26	568.24	568.96
1965	568.47	568.63	569.19	569.58	569.88	569.87	569.72	569.58	569.46	569.19	569.07	569.14	569.32
1966	569.44	569.50	569.80	570.15	570.49	570.57	570.50	570.29	570.00	569.36	569.38	569.87	569.95
1967	569.80	569.86	569.99	570.55	570.93	570.94	571.03	570.88	570.53	570.27	570.19	570.41	570.45
1968	570.56	570.85	570.84	571.13	571.19	571.40	571.46	571.32	570.97	570.56	570.36	570.46	570.92
1969	570.49	571.05	570.92	571.56	572.07	572.30	572.53	572.34	571.82	571.29	571.00	571.09	571.54
1970	570.53	570.51	570.65	571.19	571.47	571.62	571.63	571.48	571.22	571.00	570.88	570.96	571.10
1971	570.75	570.71	571.30	571.53	571.70	571.84	571.70	571.51	571.40	571.16	570.79	570.81	571.27
1972	570.86	570.92	571.35	571.81	572.26	572.30	572.40	572.22	572.11	571.95	572.17	572.35	571.89
1973	572.39	572.53	572.88	573.30	573.25	573.51	573.34	573.03	572.51	572.14	571.77	571.83	572.71
1974	571.99	572.38	572.79	573.20	573.18	573.24	573.07	572.72	572.31	571.80	571.67	571.87	572.52
1975	571.88	572.04	572.51	572.58	572.59	572.73	572.58	572.38	572.45	572.08	571.68	571.69	572.27
1976	571.61	571.67	572.79	572.88	572.90	572.79	572.77	572.57	572.11	571.68	571.06	570.70	572.13
1977	570.40	570.22	570.85	571.55	571.94	571.70	571.70	571.53	571.52	571.36	571.03	571.11	571.24
1978	571.26	571.18	571.33	572.26	572.38	572.25	571.98	571.67	571.31	570.98	570.74	570.47	571.43
1979	570.46	570.43	570.90	571.82	572.12	572.20	572.17	572.06	572.01	571.68	571.33	571.45	571.55
1980	571.70	571.51	571.71	572.40									

MEAN AND VARIANCE LAKE LEVEL DATA
1968 to 1979

DATE	MEAN ELEVATION IGLD* Feet	VARIANCE FROM IGLD* Feet
Annual		
1968	570.92	+2.32
1969	571.54	+2.94
1970	571.10	+2.50
1971	571.27	+2.67
1972	571.89	+3.29
1973	572.71	+4.11
1974	572.52	+3.92
1975	572.27	+3.67
1976	572.13	+2.53
1977	571.24	+2.50
1978	571.48	+2.88
1979	571.55	+2.95
Longterm 1860-1977	570.36	+1.76
Highest Monthly Mean = June, 1973	573.51	+4.91
Lowest Monthly Mean = Feb., 1936	567.49	-1.11

*IGLD = International Great Lakes Datum (1955) = 568.6 feet

Figure 1-5 is a graph of the tabulated NOAA data for the period 1960 thru 1980. Noted on this graph are the lake levels at the times of Corps of Engineers Surveys in the area east of the dike. Also noted are the lake levels which occurred at the time aerial photographs were taken of the project area. These notations on lake levels are used later in this appendix when aerial photographic evidence of beach widths fronting the bluff are compared from year to year to develop trends of accretion or erosion.

A design Lake Level for the project area was developed from information contained in "Standardized Frequency Curves for Design Water Levels Determination on the Great Lakes", U.S. Army Corps of Engineers, Detroit, Michigan, December and May 1979.

The method used was to determine the 20 year return interval annual mean lake level for Lake Erie from the curve reproduced here and add to this annual mean the 1 year annual peak rise in lake level at Lorain Ohio. Since only curves for Marblehead and Cleveland, Ohio are presented, these values are averaged assuming Lorain is approximately midway between them. This yields:

20 year annual mean Lake Erie level	573.05
1 year annual peak rise (1.2 + 0.9) ÷ 2 =	1.05
20 year design peak water level	574.10

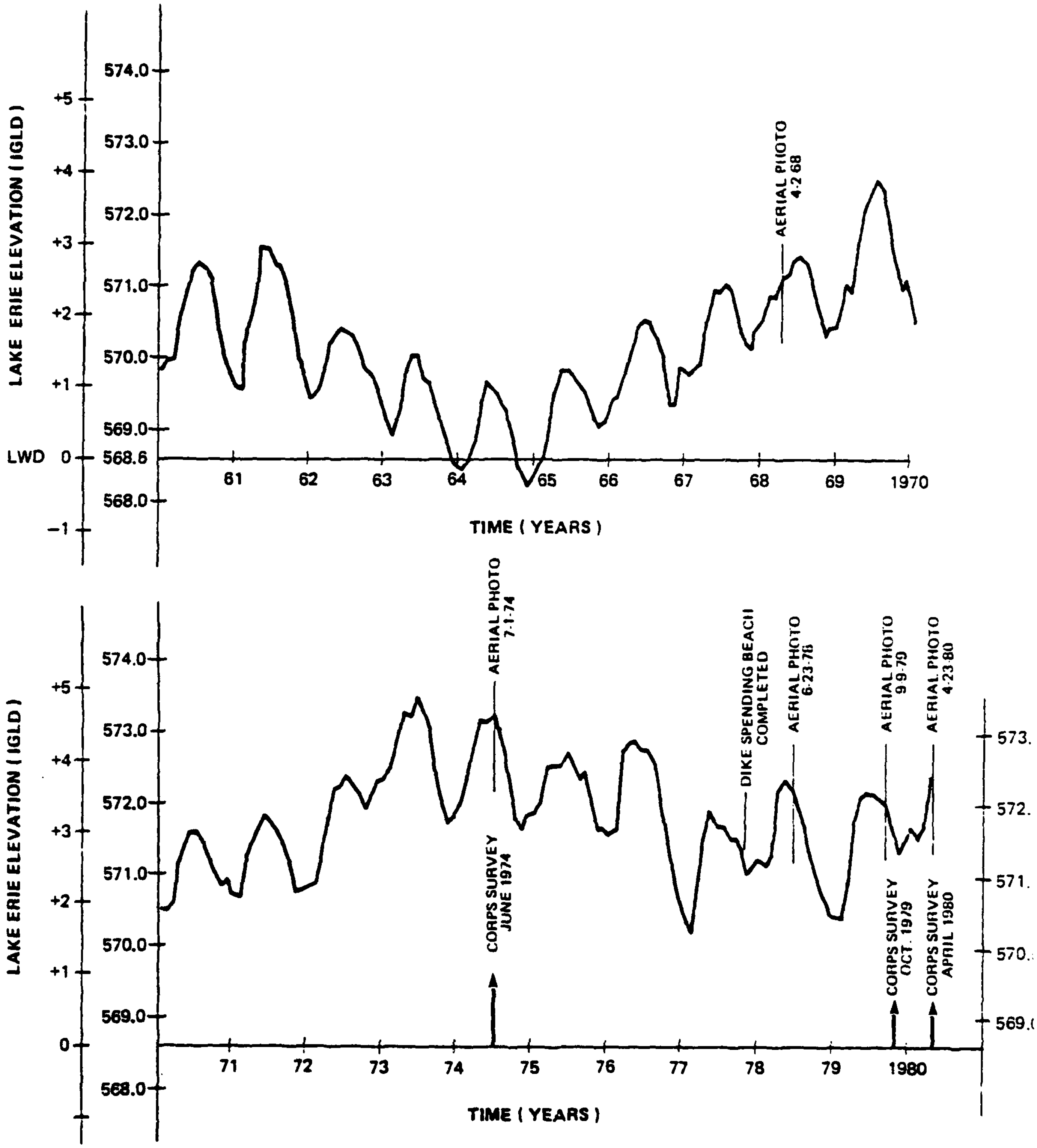
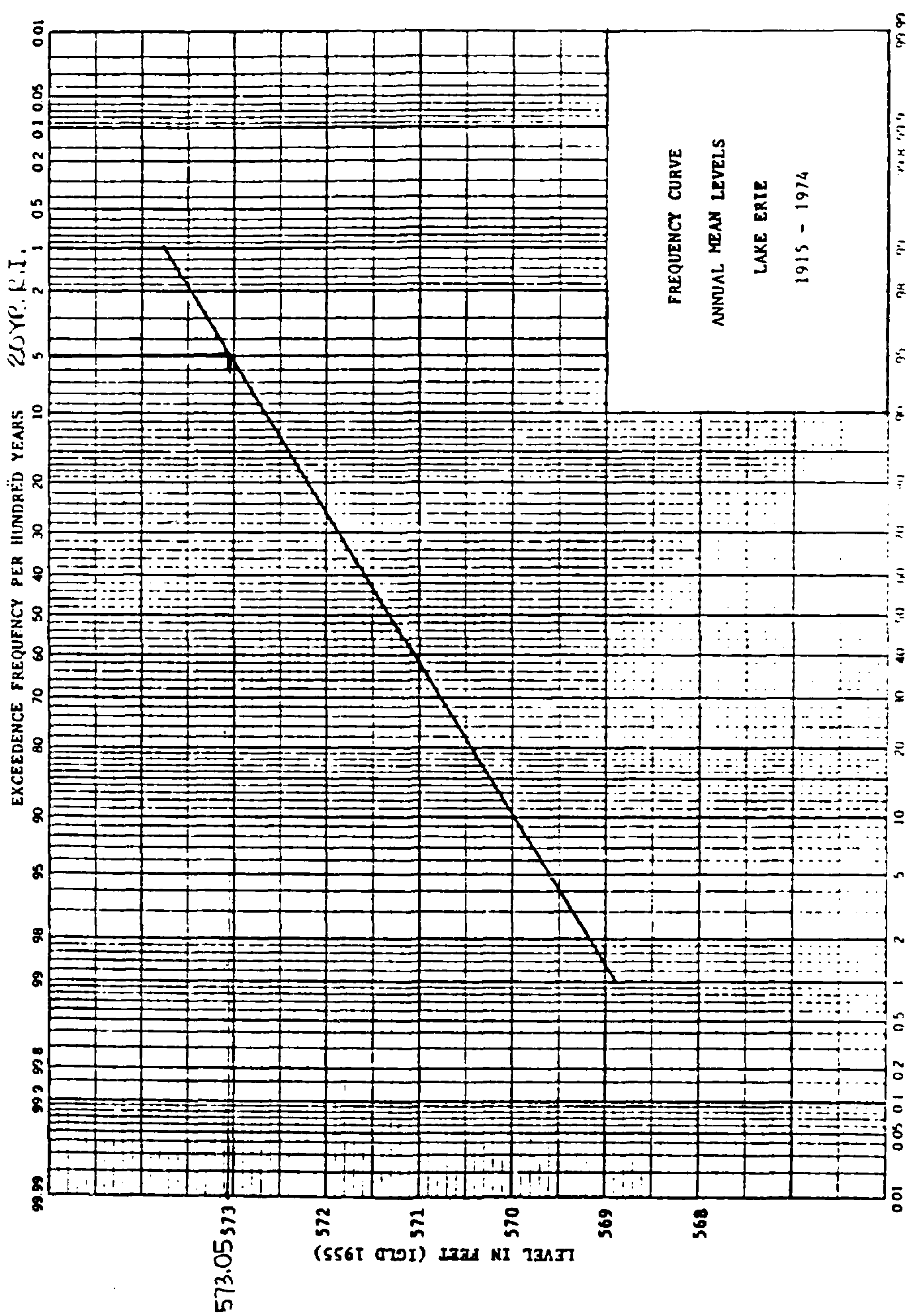
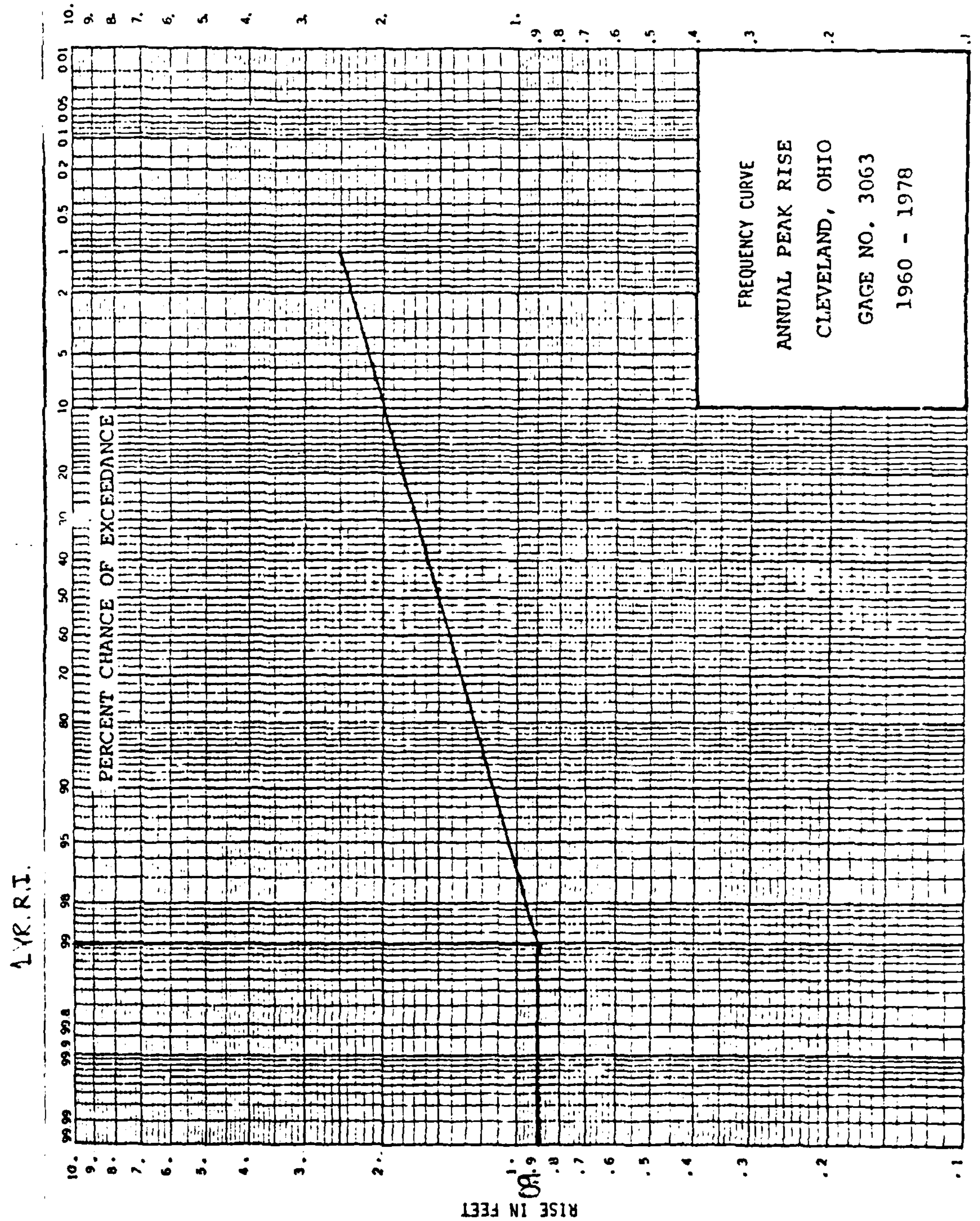
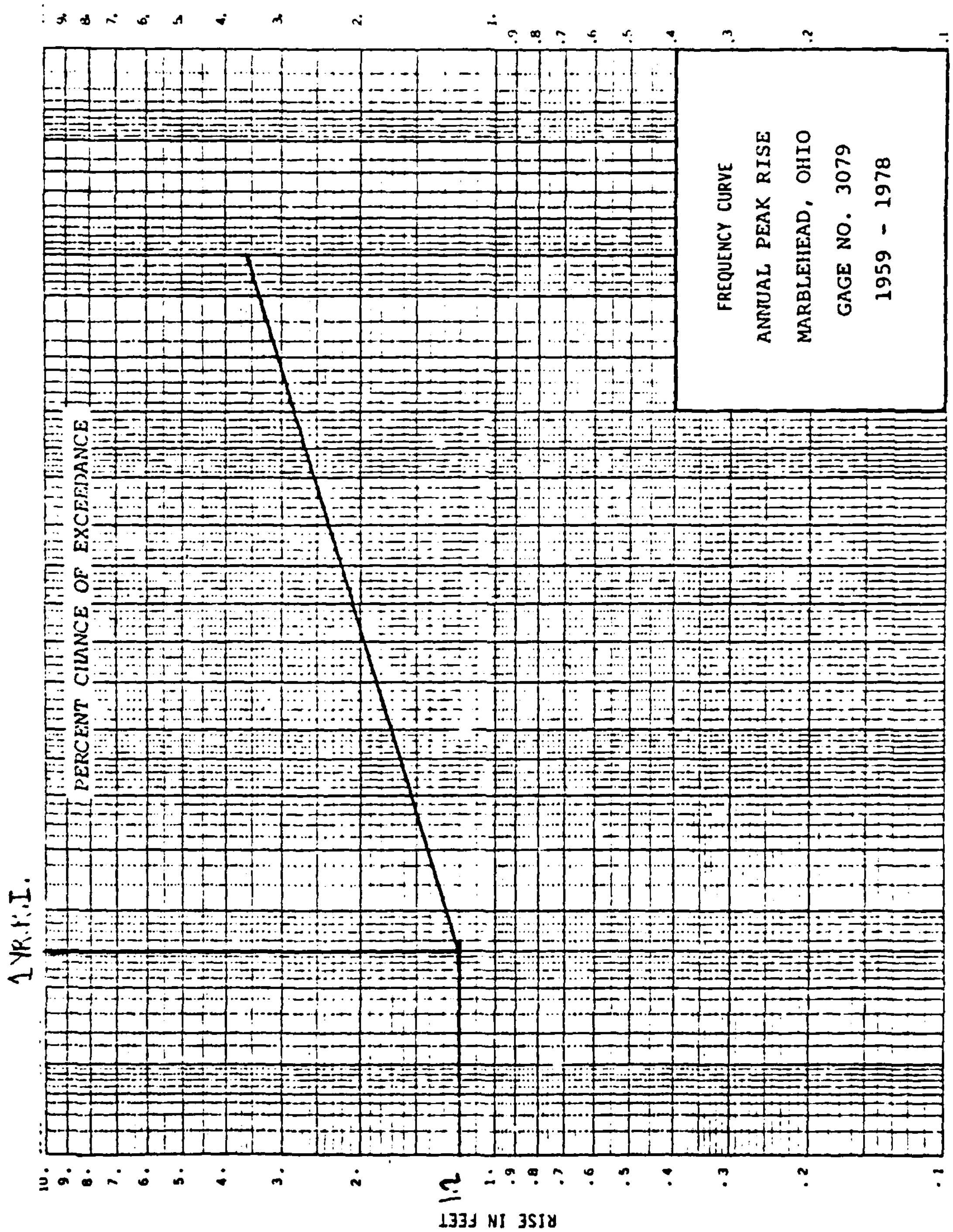


Figure 1-5 Lake Level Fluctuations
Lake Erie 1960 to 1980


FREQUENCY CURVE
ANNUAL MEAN LEVELS
LAKE ERIE
1915 - 1974
EXCEEDENCE FREQUENCY PER HUNDRED YEARS
LEVEL IN FEET (IGLD 1955)
573
572
571
570
569
568
573.05
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99



FREQUENCY CURVE
ANNUAL PEAK RISE
CLEVELAND, OHIO
GAGE NO. 3063
1960 - 1978
PERCENT CHANCE OF EXCEEDANCE
RISE IN FEET
1 YR. R.I.


FREQUENCY CURVE
ANNUAL PEAK RISE
MARBLEHEAD, OHIO
GAGE NO. 3079
1959 - 1978
PERCENT CHANCE OF EXCEEDANCE
RISE IN FEET
1 YR.R.I.
1.2

Littoral Sediment Transport

Aerial photographs (1937, 1951, 1974, 1978, 1979, 1930) showing shore structures to the east of Lorain Harbor within the study limits indicate a slight predominance of east to west movement of littoral materials.

The possible sources of sediment supply to the littoral zone in the study area easterly of Lorain Harbor are from stream discharge, bluff erosion, and littoral material transported into the area from shores easterly of the study limits. The Lorain Harbor entrance structures are a complete barrier to longshore sediment transport and there is no sediment supply to the study area from the west, including sediment discharge from the Black River. There is no evidence (Carter, 1977) that streams located easterly of Lorain Harbor supply any significant quantity of sediments to the shore. There is considerable evidence and documentation that the sediment supply to the littoral zone along much of the Lake Erie shoreline, including the study area and shores easterly thereof, is derived from erosion of the bluff. Since the bluff composition contains a small amount of medium to coarse sand (approximately 20%), each cubic yard of sand composing the beach and foreshore zone represents many times that amount of eroded bluff material. There is little evidence that there is a large supply of littoral material transported into the study area from the east. This is due to the past and present construction of many structures to prevent shore erosion and littoral movement not only to the east but within the study area. These structures greatly reduce the supply of sediment moving in the littoral zone from bluff erosion.

Bluff Recession

The City of Lorain, Office of Engineering, provided a street layout drawing covering the shore sector from immediately east of the Black River to Roof Road whereon the position of the top of bluffline was shown for the years 1884, 1921, 1932 and 1944. A baseline was established on the drawing along the north side of Erie Avenue from which the distance to the bluffline for the four survey years was determined. To this map, the Corps of Engineers' 1980 survey bluffline was fitted as a comparison to the blufflines of previous years. Because of scale problems in transference, the exact location of this 1980 bluffline cannot be assured.

Average bluff recession rates for the 2500 feet of shoreline under study are presented in the table on the following page and the comparative blufflines chart is shown in figure 1-6.

The Geological Survey of the State of Ohio, Department of Natural Resources (ODNR), has plotted historical changes for the top of the bluffline along segments of the Lake Erie Shore on Open File Map #91 for the years 1876, 1937, 1968 and 1973. An arbitrary baseline was established from which distances to the bluffline for the four survey years were determined.

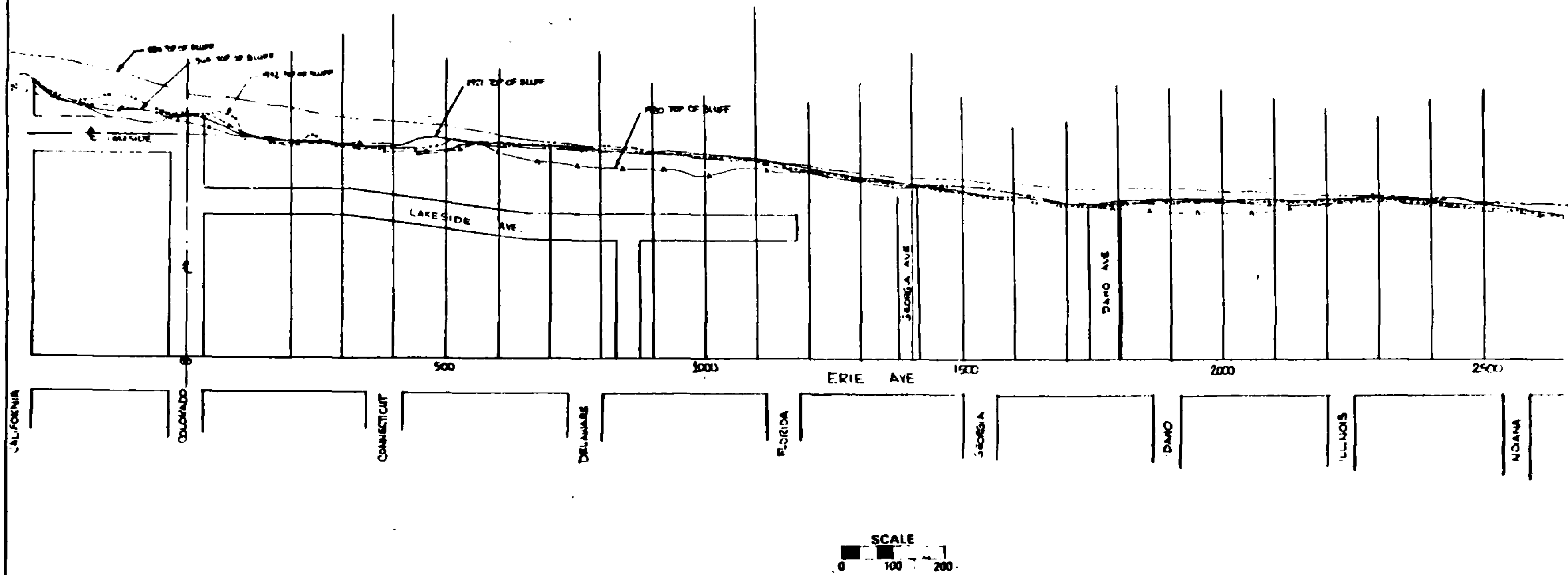
Average bluff recession rates for the 2500 feet of shoreline under study are presented in the table of ODNR bluff recession rates. Figure 1-7 shows these historical bluff lines for comparison.

This bluff recession data was developed in an effort to determine a pre dike period bluff recession rate to compare to post-dike conditions. The City of Lorain data is not recent enough (1944) to be helpful for pre-dike conditions. The ODNR data, on the other hand, covers the period up to 1973 which is just prior to the 1977 dike construction.

BLUFF RECESSION RATES - CITY OF LORAIN DATA

DISTANCE	1884	1921	Δ 1884	1932	Δ 1921	1944	Δ 1932	1980	Δ 1944	Δ 1884-1980
000	508	466	42	470	-4	468	2	452	16	56
100	498	430	68	440	-10	436	4	427	9	71
200	480	418	62	413	5	408	5	418	-10	62
300	466	413	53	408	5	412	-4	414	-2	52
400	458	410	48	404	6	399	5	406	-7	52
500	450	423	27	417	6	401	16	399	2	51
600	431	416	15	417	-1	410	7	398	12	33
700	419	411	8	412	-1	406	6	380	26	39
800	406	402	4	410	-8	400	10	369	31	37
900	397	397	0	397	0	397	0	365	32	32
1000	386	395	-9	390	5	395	-5	353	2	33
1100	382	387	-5	380	7	387	-7	368	19	14
1200	373	369	4	363	6	359	4	360	-1	13
1300	360	350	10	346	4	342	4	344	-2	16
1400	350	338	12	334	4	332	2	339	-7	11
1500	347	323	24	320	3	333	-13	320	13	27
1600	340	313	27	309	4	320	-11	309	11	31
1700	329	300	29	297	3	300	-3	297	3	32
1800	330	305	25	298	7	300	-2	290	10	40
1900	330	310	20	300	10	306	-6	284	22	46
2000	322	309	13	304	5	307	-3	283	24	39
2100	320	318	2	304	14	298	6	287	11	33
2200	316	310	6	305	5	300	5	299	1	17
2300	315	311	4	309	2	304	5	315	-11	0
2400	309	305	4	301	4	298	3	310	-12	-1
2500	303	299	4	291	8	287	4	300	-13	3
Average Δ			19.11		3.42		1.31		6.88	32.27
Rate ft/yr			0.52		0.31		0.11		0.19	0.34

Notes:
1) Distance is in feet east of the centerline of Colorado Avenue as shown on figure 1-6
2) Bluff location is measured from the baseline: north side of Erie Avenue on City of Lorain overlays, Figure 1-6
3) 1980 bluff localtion from Corps Survey of Feb. 1980
4) Recession is +Δ
   Accretion is -Δ



TOP OF BLUFF LINES

Line	Year
——— - - ———	1884
———————	1921
— — ○○ ——— ○○ —	1932
——○— ——○— —	1944
————△————	1980

Lorain Harbor, Ohio
Diked Disposal Area—Section 111

BLUFF RECESSION LINES
CITY OF LORAIN DATA

Tetra Tech, Inc.
Arlington, VA

Drawn by
Checked by
Approved by
Date

Figure 1-6

BLUFF RECESSION RATES - ODNR DATA

DISTANCE	1876	1937	Δ 1876	1968	Δ 1937	1973	Δ 1968	Δ 1876-1973	Δ 1937-1973
000	635	535	100	535	0	520	15	115	15
100	615	530	85	490	40	490	0	125	40
200	610	525	85	480	45	480	0	130	45
300	585	520	65	475	45	475	0	110	45
400	565	510	55	475	35	475	0	90	35
500	550	525	25	495	30	475	20	75	50
600	550	515	35	495	20	485	10	65	30
700	555	520	35	495	25	475	20	80	45
800	545	510	35	480	30	465	15	80	45
900	540	490	50	460	30	445	15	95	45
1000	530	480	50	450	30	450	0	80	30
1100	525	475	50	450	25	450	0	75	25
1200	515	470	45	440	30	440	0	75	30
1300	500	465	35	440	25	440	0	60	25
1400	495	460	35	435	25	435	0	60	25
1500	490	445	45	425	20	425	0	65	20
1600	485	440	45	415	25	415	0	70	25
1700	475	430	45	390	40	390	0	85	40
1800	470	430	40	395	35	395	0	75	35
1900	470	435	35	410	25	410	0	60	25
2000	465	440	25	440	0	415	25	50	25
2100	475	445	30	445	0	425	20	50	20
2200	480	450	30	450	0	405	45	75	45
2300	470	445	25	445	0	435	10	35	10
2400	475	445	30	445	0	445	0	30	0
2500	475	430	45	430	0	430	0	45	0
Average Δ Rate ft/yr			45.4 0.74		22.0 0.72		7.5 1.50	75.19 0.78	29.8 0.82

Notes: 1) Distance is in feet east of the centerline of Colorado Avenue as shown on Figure 1-7
2) Bluff location is measured from an arbitrary baseline approximately parallel to Erie Avenue
3) Recession is +Δ
Accretion is -Δ

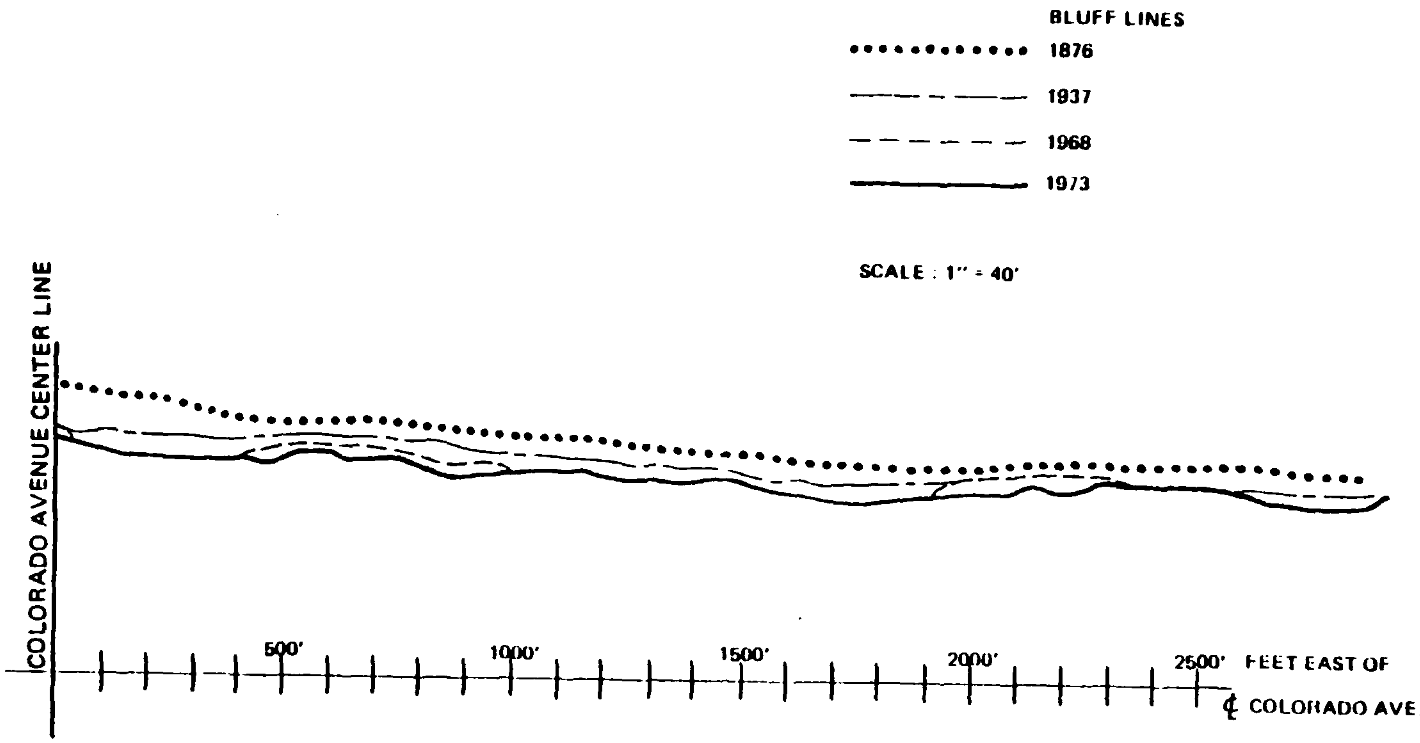


Figure 1-7

BLUFF RECESSION FROM OHIO DEPARTMENT OF NATURAL RESOURCES OPEN FILE MAP 91

The period 1876 to 1937 was not considered representative of shore protection conditions (number, type & effectiveness) as they exist today. Neglecting the period prior to 1937, a 1937 to 1973 bluffline recession rate was chosen as representative of the pre-dike condition. This bluff recession data represents 36 years of averaged recession for the shoreline similarly protected as it is today but at an average lake level lower than it is today.

The data suggests that the 2500 feet of shoreline under study has not historically receeded at a uniform rate throughout the reach. The shoreline has therefore been broken down into increments with similar recession history based upon Ohio Department of Natural Resources data. Recession rates from ODNR data have been calculated at section lines positioned every 100 feet along the reach and the rate thus obtained is assumed to be the average rate for 100 feet of shoreline extending 50 feet either side of the section line. Therefore, the recession rate calculated at section line 0 (ft) east of the Colorado Avenue centerline is assumed to be the average recession rate over the interval -50 to +50(ft) east of Colorado Avenue. The 50 west of the Colorado Avenue centerline will be dropped because it is outside of the shoreline area under study here. Likewise, the average recession rate for sections at 2400 and 2500 ft east of the Colorado Avenue centerline is assumed representative of the interval 2350 to 2550 ft with the last 50 ft dropped as outside the study shoreline. The average pre-dike recession rates per shoreline increment are shown in the following table.

Bluff Recession Rates - Aerial Photography Data

Time period covered July 1974 through April 1980

July 1974 / June 1978	June 1978 / April 1980	July 1974 / April 1980
48 MOS = 4yrs.	22 MOS = 1.8 yrs.	69 MOS = 5.75 yrs.

Year	Increment	BLUFF AREA(sq. ft)	Δ in BLUFF (ft)	Δ in BLUFF per year(ft/yr)
1974-1980	-50 to +50	400	4.0	.7
	+50 to 450	1000	2.5	.4
	450 to 950	2200	4.4	.8
	950 to 1950	7500	7.5	1.3
	1950 to 2350	9700	24.3	4.2
	2350 to 2550	3000	15.0	2.6
	-50 to 2550	23800	9.1	1.6
1974-1978	-50 to +50	400	4.0	1.0
	+50 to 450	1000	2.5	0.6
	450 to 950	2000	4.0	1.0
	950 to 1950	4800	4.8	1.2
	1950 to 2350	7600	19.0	4.8
	2350 to 2550	2600	13.0	3.3
	-50 to 2550	18400	7.1	1.8
1978-1980	-50 to +50	00	0.0	0.0
	+50 to 450	00	0.0	0.0
	450 to 950	200	0.4	0.2
	950 to 1950	2700	2.7	1.5
	1950 to 2350	2100	5.2	2.9
	2350 to 2550	400	2.0	1.1
	-50 to 2550	5400	2.1	1.1

Notes: 1) Measurements of bluff area lost are estimates from comparison of Corps of Engineers supplied aerial photograph taken
July 1, 1974
June 23, 1978
April 23, 1980
all at nominal scale of 1 inch = 400 feet

2) Average bluff recession Δ in feet is obtained by dividing the estimated loss in square feet by the coverage length.

3) Average bluff recession per year is obtained by dividing Δ by the time period between photos.

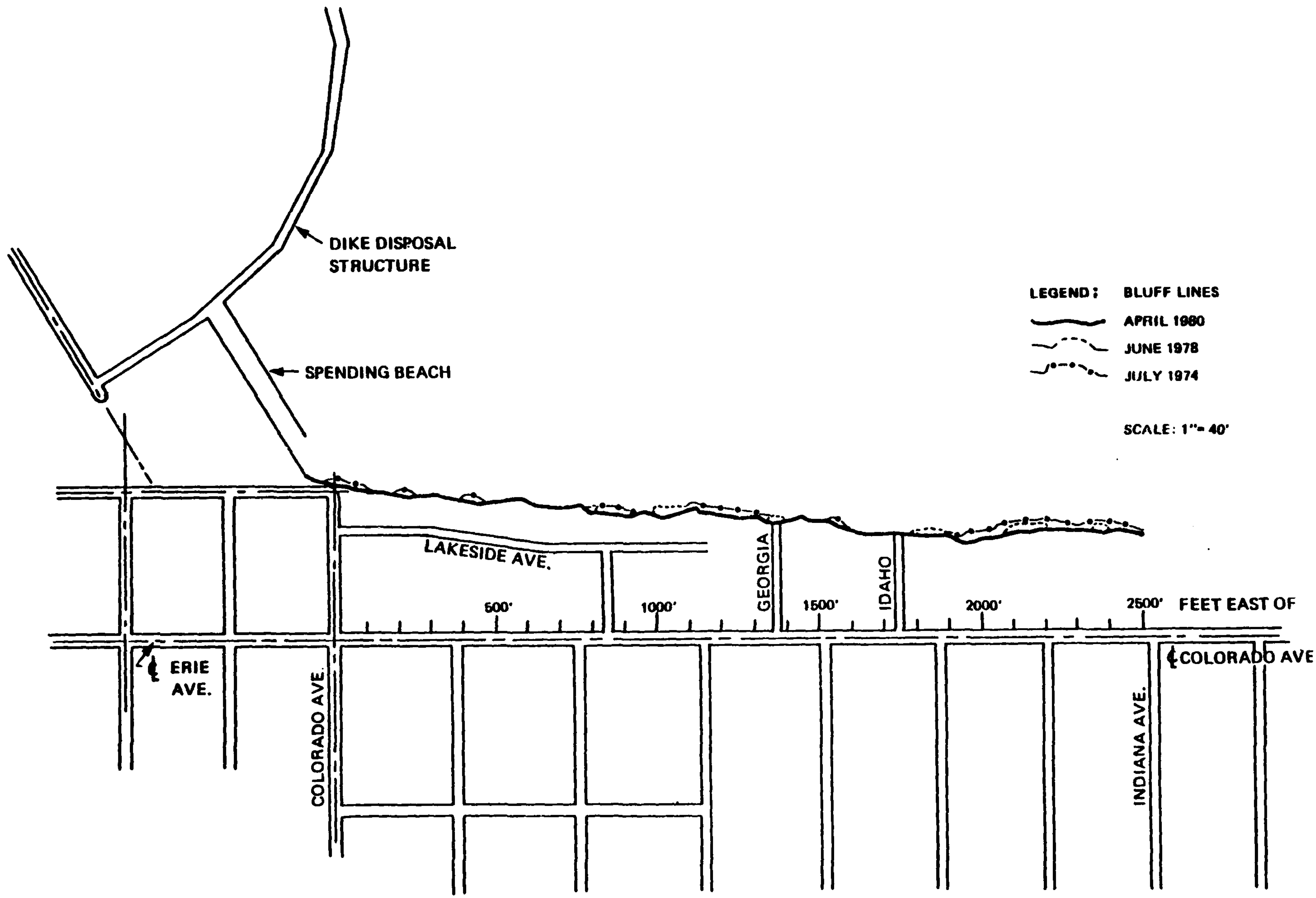


Figure 1-8 Bluff Recession From Aerial Photographs

Shoreline Increment*	Average Pre-Dike Rate	
0 to 50	0.4	ft/yr.
50 to 450	1.2	
450 to 950	1.2	
950 to 1950	0.8	
1950 to 2350	0.7	
2350 to 2500	0.0	
0 to 2500	0.8	ft/yr. (weighted)

*Refers to distance in feet east of the Colorado Ave. centerline.

In order to determine a post-dike recession rate for the bluff 2500 feet east of Colorado Avenue, aerial photographs taken during July 1974, June 1978, and April 1980 were compared (see table following page). A base map delineating the former bluff positons was assembled (figure 1-8). This base map was constructed on acetate from the April 1980 photographs. It was overlayed onto the 1974 and 1978 photos, which are of approximately the same scale. After matching common geographic features earlier blufflines were transferred to the base map where they differed from the 1980 photographs. The final product was a map showing the approximate position of the bluff during each of the 3 years considered. Where there is no measured change between the aerial photography, only the more recent bluffline is shown. Care was taken to minimize possible errors from distortion by using the center portion of each air photo.

The study shoreline was broken down into increments corresponding to those used in the pre-dike bluff recession analysis based upon ODNR data. This breakdown facilitates comparison of both sets of data on similar shoreline increments. Within each increment the recession rate is obtained by calculating the area of bluff lost divided by the shoreline length increment and further divided by the time interval between aerial photographs. As in the earlier analysis, average recession rates thus obtained are assumed representative of the entire increment even though portions of that increment may have receded at faster or slower rates. The 50 feet west and east of the 2500 feet of study shoreline (used only to obtain proper increment recession averages) are dropped from further consideration to avoid confusion as to the length of study shoreline.

Examination of the Bluff Recession Rates shows the following: The period 1974-1978, a pre-dike period for the most part, was characterized by a higher average recession rate for the entire 2500 feet of study area (1.8 ft/yr) than for the post-dike period, 1978-1980 (1.1 ft/yr).

The severity of the 1974-1978 recession rate is undoubtedly influenced by the post 1973 high lake levels in conjunction with private structural protection work failures due to increased wave attack. The absence of a balancing period of low lake levels makes these aerial photography recession rate estimates suspect. For this reason the 1974-1978 data is not used as representative of pre-dike conditions in favor of 1937 to 1973 ODNR data.

The post-dike period unfortunately has only 2 years of record and only aerial photography data is available for predicting the recession rates during those two years (1978-1980). Predicting present and future bluff recession based upon only 2 years of data obtained from aerial photograph comparisons is highly suspect because of the following reasons:

1. the shoreline recession in the 2 year span between aerial photographs is small and at a scale of 1:4800, a slight error in locating the bluffline is exaggerated when dividing by the small time interval to obtain recession rate in ft/yr.
2. transferring blufflines to a single map at the scale of 1:4800 can produce inaccuracies due to drafting errors

3. the recession rates observed over a 2 year period may be reflecting high lake level and accelerated structural failures caused by high lave levels instead of the effects of many cycles of lake levels as would a longer term record

4. any prediction for a 50 year period based upon only 2 years of data would be suspect

Taking these factors into account the 1978-1980 aerial photography data can be used as the post-dike bluff recession rates provided that it is recognized that this may be a "worst case" estimate of the influence of the dike on the study shoreline.

Shoreline Increment*	Average Post-Dike Rate
0 to 50	0.0 ft/yr
50 to 450	0.0
450 to 950	0.2
950 to 1950	1.5
1950 to 2350	2.9
2350 to 2500	1.1
0 to 2500	1.1 ft/yr (weighted)

*Refers to distance in feet east of the Colorado Avenue centerline.

A summary of all the bluff recession data generated for this study is presented in the following table.

BLUFF RECESSION RATES (FT/YR)

	SHORT RANGE										LONG RANGE	
SHORELINE INCREMENT[1]	ODNR[3] 1826-1937	C of L[4] 1884-1921	C of L 1921-1932	C of L 1932-1944	ODNR 1937-1968	ODNR 1968-1973	ODNR 1936-1973	AERIAL PHOTOS[6] 1974-1978	AERIAL PHOTOS[6] 1978-1980	AERIAL PHOTOS[6] 1974-1980	ODNR 1876-1973	C of L/ COE 1884-1980
-50 to 50	1.6	1.1	-0.4	0.2	0.0	3.0	0.4	1.0	0.0	0.7	1.2	0.6
50 to 450	1.2	1.6	0.1	0.2	1.3	0.0	1.2	0.6	0.0	0.4	1.2	0.6
450 to 950	0.6	0.3	-0.1	0.7	0.9	3.2	1.2	1.0	0.2	0.8	0.8	0.4
950 to 1950	0.7	0.4	0.5	-0.3	0.9	0.0	0.8	1.2	1.5	1.3	0.7	0.3
1950 to 2350	0.5	0.2	0.6	0.3	0.0	5.0	0.7	4.8	2.9	4.2	0.5	0.2
2350 to 2550	0.6	0.1	0.6	0.3	0.0	0.0	0.0	3.3	1.1	2.6	0.4	0.0
-50 to 2550	0.7	0.5	0.3	0.1	0.7	1.5	0.8	1.8	1.1	1.6	0.8	0.3
22000[2]	1.1				0.3	1.1					0.8	
							Pre-Dike Rates		Post-Dike Rates			

NOTES:

1) Shoreline increments refer to distance from center line Colorado Ave. measured along the north side of Erie Ave. Positive distances are measured east.

2) These recession rates have been estimated by the Ohio Department of Natural Resources for the entire Reach 1 of Lorain County. This is 22000 feet of shoreline which includes the 2500 feet of shore under study.

3) ODNR = Ohio Department of Natural Resources bluff line charts were used to estimate these recession rates.

4) C of L = City of Lorain bluff line charts were used to estimate these recession rates.

5) COE = Corps of Engineers 1980 Survey was used to estimate bluff recession rates.

6) Aerial Photos = Corps of Engineers aerial photos were used to compare bluff lines to obtain bluff recession estimates.

Beach Distribution

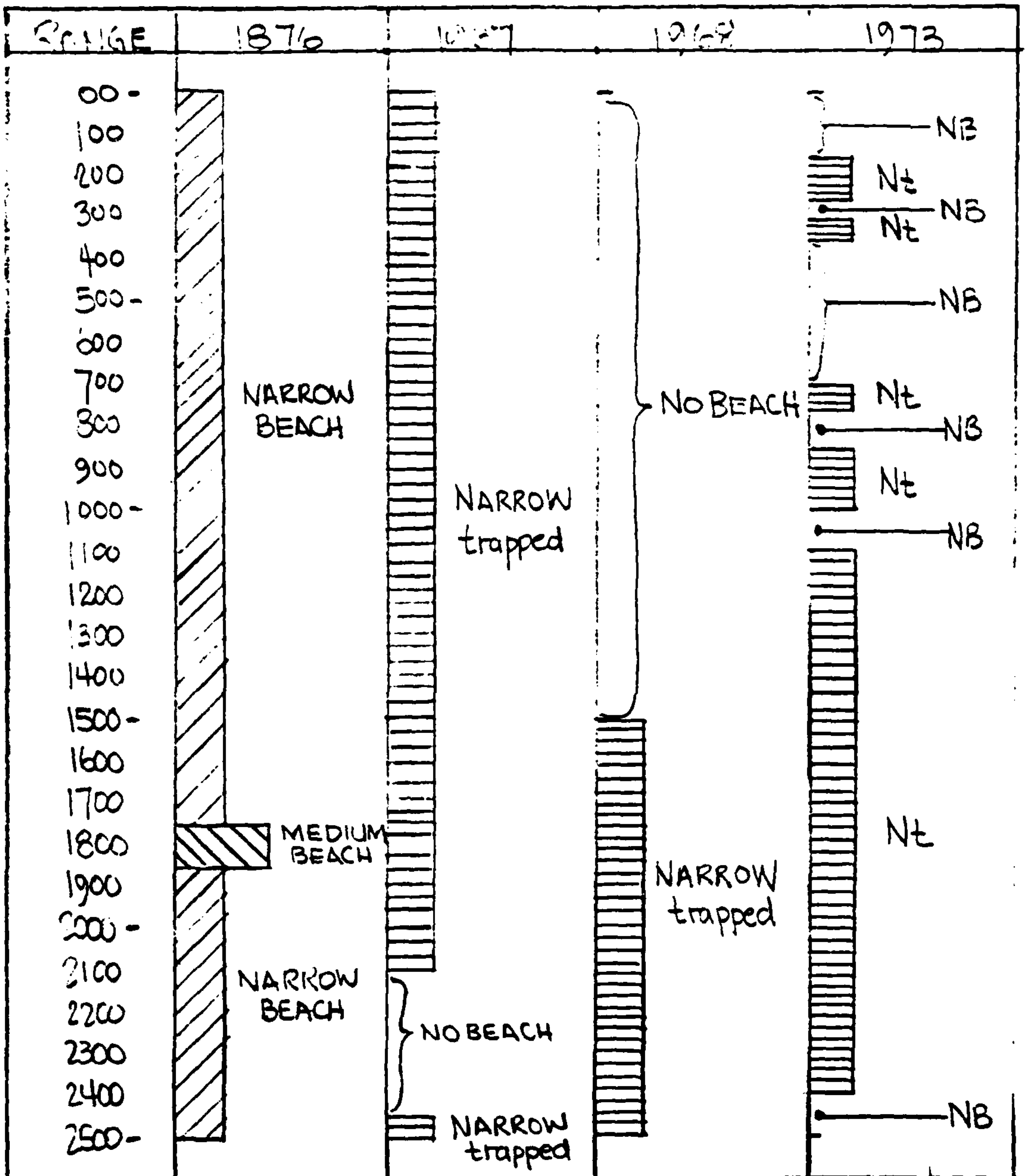
A survey of the location and extent of beaches along the shore was made by the Ohio Department of Natural Resources in 1974. It covered changes from 1876 through 1973 compiled from field survey, aerial photography, and historical maps/charts/surveys. In 1896, the entire 2500 feet of shoreline was fronted by natural beach material. In 1937, when private protection structures became numerous, instead of narrow or medium natural beaches, most of the 2500 feet of shore was fronted by small, trapped beaches (86%), and 14% had no beach front. In 1974 these figures changed significantly. Narrow beaches made up 3%, trapped beach area dropped to 56% and "No Beach" increased to 41%. These changes can be attributed to the poor design and construction of private protective structures and lack of material available in the littoral zone.

The ODNR survey of years 1876, 1937, 1968 and 1973 is shown graphically in the table on the following page. This survey was updated using 1974, 1978, 1979 and 1980 aerial photographs, and utilizing the same nomenclature and technique as ODNR. This data is presented in a table of beach distribution per aerial surveys on the following page.

The most noticable trend over these years was the establishment and maintenance of significant beach area within the first 200 feet east of Colorado Ave. whereas there is no beach found along the next several hundred feet of shoreline. The length of this "No Beach" varies with lake level, but has been at least 400 feet in extent. From 600 feet to about 1900 feet east of Colorado Ave. the shoreline has been variable; for the most part there is no beach and only a few small sections of trapped beach are found. From about 1900 feet to 2400 feet a continuous trapped beach is evident (and has persisted through time) from the air photos.

SHORE RECESSION RATES

BEACH DISTRIBUTION PER ODNR 1974 SURVEY



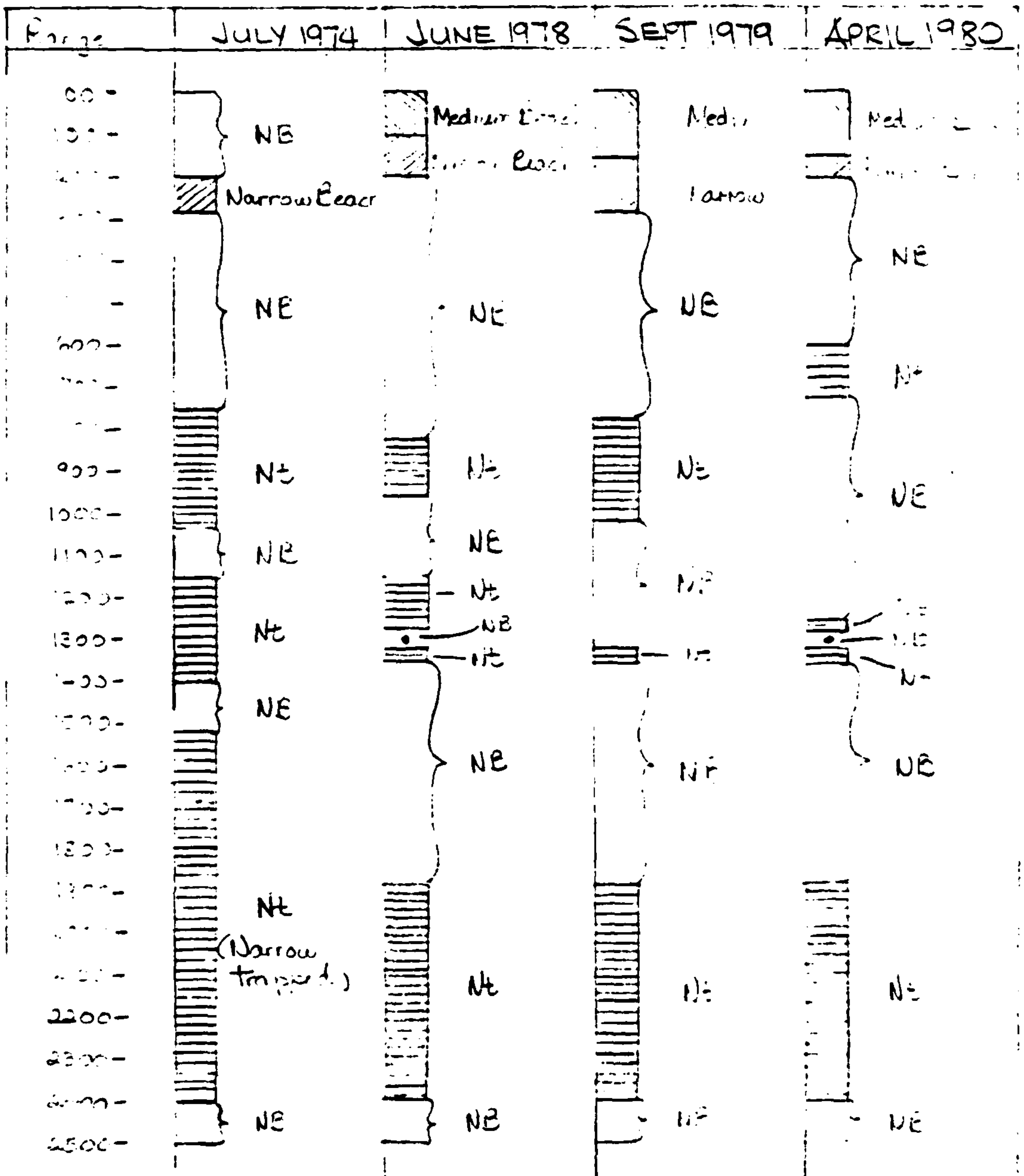
	1876		[illegible]		1968		1973	
% M	4	15	0	18	0	8	0	8
% N	96	74	0	0	0	0	0	1
% N (t)	0	0	86	57	40	43	66	32
% NB	0	4	14	24	60	44	34	59

(Second column of each year: compare percent for entire ODNR Reach 3, 25,500 ft.)

LEGEND: M = Medium Beach visible approx 50 to 100 ft wide
N = Narrow Beach visible approx 0 to 50 ft wide
N (t) = Narrow Beach (0 to 50 ft) trapped by structures
NB = No Beach Evident

SHORE RECESSION RATES

BEACH DISTRIBUTION PER AERIAL SURVEYS



	JULY 1974	JUNE 1978	SEPT 1979	APRIL 1980
% M	0	4	6	6
% N	3	4	5	2
% N(±)	56	32	32	[illegible]
% NE	41	60	57	[illegible]

The last 100 feet of the study shoreline is void of any beach (and has been since the 1973 photos).

When comparing the 1980 beach distribution (post-dike) to the 1974 beach distribution (pre-dike) and taking into account the respective lake levels at the time of the aerial photos (573.1 IGLD for July 1974 vs 572.4 IGLD for April 1980) one can say:

a. a definite fillet is being formed adjacent to the revetment spending beach in the post-dike era as evidenced by the growth of a medium beach
b. east of this fillet the percentage of no beach has increased and the percentage of trapped beach decreased between 1974 and 1980 even though the lake level was lower in 1980

These points suggest that there is accretion adjacent to the dike structure and erosion further to the east, but this evidence is inconclusive since the condition of private shore protective structures has not been taken into account.

Structural Survey

Shore structures become important in understanding the spatial variations in beach erosion and bluff recession. In 1974 a structural inventory was done by the Ohio Department of Natural Resources. Of the 24 structures still existing out of 34 structures identified along the 2500 feet east of Colorado Avenue, 71% (or 17 of 24) were in fair to poor condition.

An update of the shoreline structures was made using aerial photography dated April, 1980. Existing structures were checked against the locations of functional structures provided by the Corps of Engineers. However, unlike the 1974 inventory, no field check of the condition of these structures was made. As there have been no structural improvements, the structures found in 1980 have either remained the same, or deteriorated in their condition, and therefore lost some of their effectiveness as protection against wave attack.

Geographical Distribution of Shore Structures For 2500 feet East of Colorado Avenue

Shoreline Increment	1974	1980	Structure #'s
0 to 50	-	-	177
50 to 450	5	3	178-183
450 to 950	5	5	184-189
950 to 1950	11	10	190-205
1950 to 2350	1	1	206-208
2350 to 2500	2	-	209-210
0 to 2500	24	19	

By 1980, another 5 structures could not be found on the aerial photographs. Of the 19 remaining structures, 63% (or 12 of 19) were in fair to poor condition. The 5 structures lost between 1974 and 1980 were listed as being either in fair or poor condition in 1974. Recognizing that structures deteriorate through time, and given the poor design of these structures initially, their subsequent deterioriation and destruction are all contributing factors to bluff recession.

Of particular interest are structures 206 thru 209 which are located approximately 2000 to 2500 ft. east of Colorado Avenue. When comparing their locations to that of the most severe bluff recession in the period 1974 to 1978 and 1978 to 1980 it can be seen (page 1-31) that the loss or severe deterioration of this string of structures must have a strong influence on bluff recession.

When a structure is lost, rapid adjustments in shoreline position takes place which would account for the 1974-1978 recession rates being artifically high. With time, these perturbations die down as the decrease in recession rates from 1974 to 1978 vs 1978 to 1980 show and the shoreline thereafter retreats at a more steady rate. Of concern here is whether the 1978-1980 rates presented are still reflecting the structural loss or represent an average trend for the future.

Figure 1-9 is a location map of the structures along the shoreline between the dike disposal structure and 2500 feet east of Colorado Avenue. The tables which follow are a breakdown of the structures by approximate construction period and the condition of the structures in the 1974 ODNR and the 1980 aerial photograph surveys.

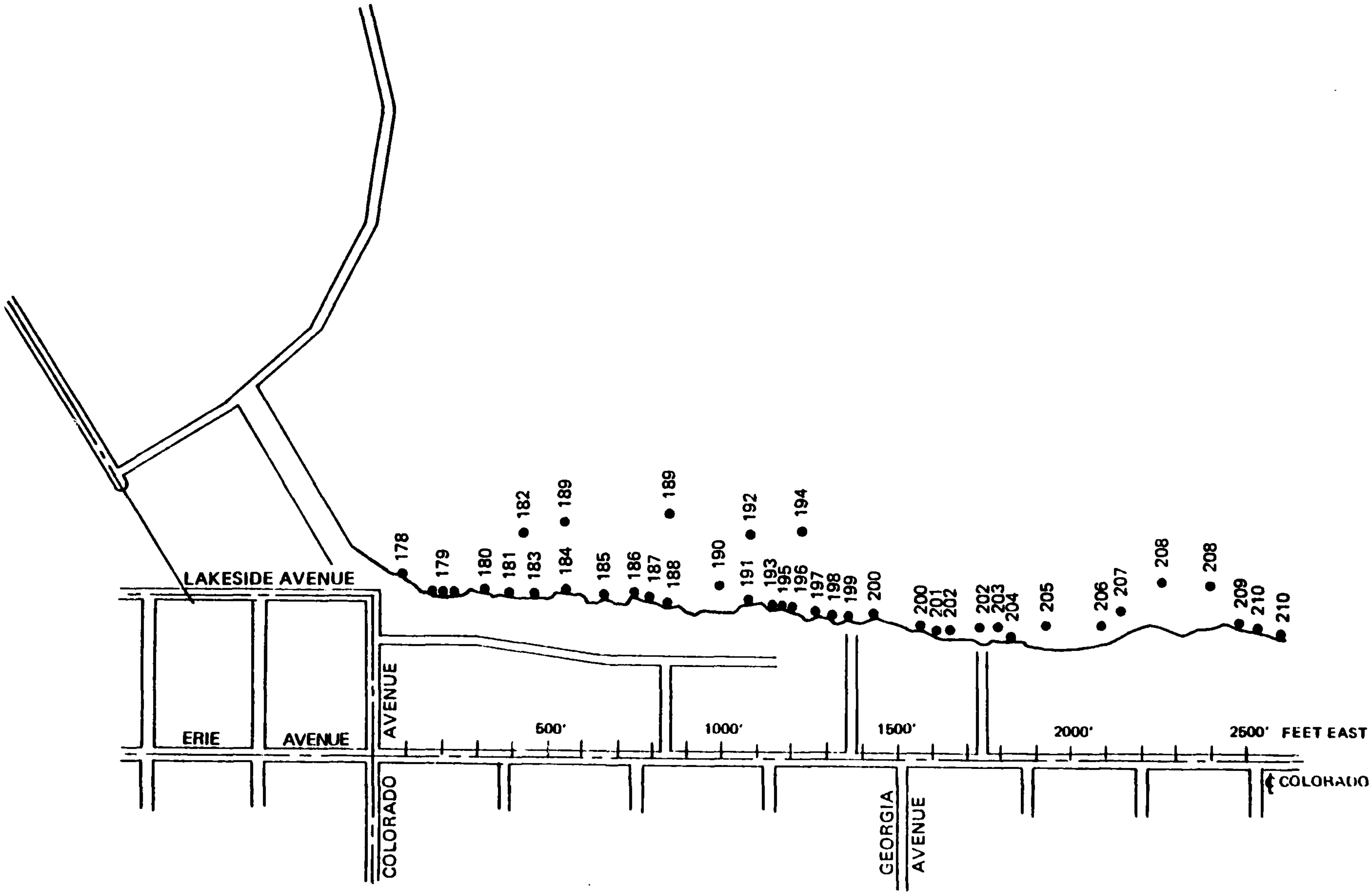


Figure 1-9 Location of Shore Structures

STRUCTURAL[2] INVENTORY FOR 2500 FT. EAST OF COLORADO AVE.

Structure No.[1] and Type[4]		Construction[3] Date	Condition in 1974	Condition in 1980
177	G	1937 - 1949	not found in 1974	not found in 1980
178	S	1937 - 1949	fair-oversteepened slope	not found in 1980
179	S	1949 - 1956	fair	fair
180	S	1968 - 1973	good	good
181	S	1973	good	good
182	GF	1937 - 1949	not found in 1956	
183	S	1973	fair-washed out behind	not found in 1980
184	S	1937 - 1949	poor	poor/barely visble
185	S	1973	poor-flanked	poor/flanked
186	S	1949 - 1956	good	good
187	S	1973	good	good
188	S	1968 - 1973	fair	fair
189	GF	1937 - 1949	not found in 1956	
190	S	1937 - 1949	not found in 1974	
191	S	1968 - 1973	fair-washed out behind	poor/washed out behind
192	G	1876 - 1937	not found in 1956	
193	S	1949 - 1956	fair backed by timber crib wall	poor/damaged/ barely visible
194	G	1937 - 1949	not found in 1956	
195	B	1947	poor-too low	poor/too low
196	S	1973	poor-flanked	poor/flanked
197	S	1956 - 1968	fair	poor
198	S	1949 - 1956	poor-damaged	not found in 1980
199	S	1973	good	good
200	S	1937 - 1949	fair-damaged	fair/damaged
201	GF	1973	fair	fair
202	S	1974	good	good
203	G	1876 - 1937	not found in 1974	
204	S	1974	good	good
205	G	1937 - 1949	not found in 1974	
206	GF	1937 - 1949	not found in 1974	
207	B	1949 - 1956	poor-badly damaged	barely visble/ badly damaged
208	B	1949 - 1956	not found in 1974	
209	B	1937 - 1949	poor-damaged	not found in 1980
210	S	1968 - 1973	fair	not found in 1980

NOTES:

1) Inventory per Ohio Department of Natural Resources unpublished 1977 Report.
2) All structures were privately owned.
3) Not built before first year but appears on photos in second year listed.
4) B, breakwater; G, groin; GF, groin field; S, seawall

STRUCTURAL INVENTORY 2500 FT. EAST OF COLORADO

PER ODNR SURVEY 1974

BREAKDOWN OF 34 STRUCTURES IN AREA OF INTEREST

STRUCTURES BUILT	NUMBER	PERCENTAGE
1876 - 1937	2	6
1937 - 1949	12	35
1949 - 1956	6	18
1956 - 1968	1	3
1968 - 1973	4	12
1973 - 1974	9	26
1974 STRUCTURAL CONDITION		
NON EXIST	10	29
POOR	10	29
FAIR	7	21
GOOD	7	21
CONDITION OF 1968 to 1974 STRUCTURES IN 1974		
POOR	2	15
FAIR	5	39
GOOD	6	46
1980 STRUCTURAL CONDITION		
NON EXIST	15	44
POOR	8	23
FAIR	4	12
GOOD	7	22
CONDITION OF 1968 to 1974 STRUCTURES IN 1980		
NON EXIST	2	15
POOR	3	23
FAIR	2	15
GOOD	6	46

Hydrographic Surveys

In connection with the Dike Disposal structure design and construction, a hydrographic survey was made in June, 1974 of the nearshore and offshore zone easterly of the shore connected breakwater. The contour lines of this survey for the coverage easterly of the rubble spending beach sector and the dike structure (out to about the 15 foot depth contour) are shown on figure 1-10.

In October, 1979 the U.S. Army Engineer Buffalo District obtained soundings of the area easterly of the rubble spending beach and dike structure. In this October survey, a control point was established at the intersection of Lakeside Avenue and Colorado Avenue and nine radial sounding lines were run from this point covering an arc from about the north through the northeast direction. The soundings on each line began at the 2-foot depth contour and terminated at about the 20-foot depth contour. Resulting depth contour lines from this survey are also shown on figure 1-10 for comparison with those of June, 1974.

In April, 1980 the U.S. Army Corp of Engineers, Buffalo District, conducted yet another survey in the affected area similar to the one done in 1979. This survey also radiated from a control point on Colorado Avenue at Lakeside. The depth contours from this survey are also shown on figure 1-10 so that all three surveys can be compared simultaneously.

To determine whether the bottom is accreting or eroding from one survey to another, profile sections were taken from the baseline offshore to about the 18 foot depth contour. The spacing of these profile sections was 100 feet apart in the area covered by all three surveys (-200 to +400 feet); then 200 feet apart from 400 to 1400 feet; and 300 feet apart from 1400 to 2500 feet. The survey accuracy in predicting exact profiles decreases as the sounding lines grow farther apart to the east.

The location of these sections are shown on figure 1-10 and the actual profile comparisons are shown in figures 1-11, 1-12 and 1-13 for the survey years 1974, 1979 and 1980 respectively.

Because of the methods used in the 1974, 1979 and 1980 hydrographic surveys, information on depths in the nearshore zone are scarce close to the spending beach and become non existent east of this area. For the purposes of this study it was imperative that profiles be continued from offshore through the nearshore zone at least to the low water datum. The 1980 hydrographic survey was fortunately supplemented with a February, 1980 survey of the bluffline, existing protective structures and the nearshore zone out to approximately the 6 foot depth contour.

The only other source for comparison for the nearshore detail necessary to determine changes along the 2500 feet of shoreline in question was found in the 1975 Parsons, Brinckerhoff, Quade and Douglas Report, "Design Analysis Criteria for Contained Spoil Disposal Facilities". In this report, plates 4 thru 7 depict profiles at various intervals east of the diked disposal structure. Five of these profiles occur within the bounds of our study area and these five are compared in figure 1-14 to the 1980 survey profile to obtain accretion and erosion estimates.

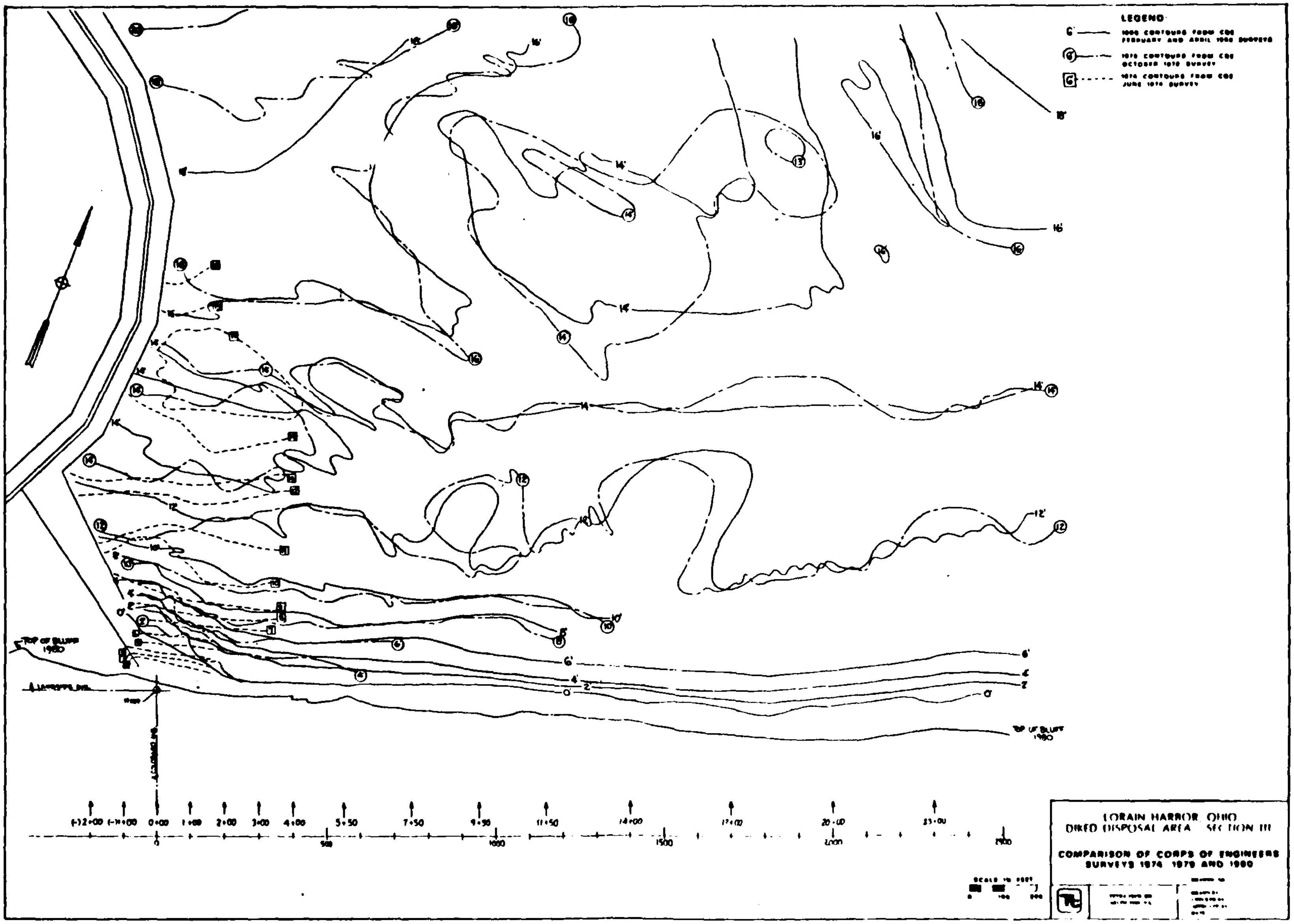

LEGEND
TOP OF BLUFF 1980
(-)2+00
(-)1+00
0+00
1+00
2+00
3+00
4+00
5+50
7+50
9+50
11+50
14+00
17+00
20+00
23+00
0
500
1000
1500
2000
2500
LORAIN HARBOR, OHIO
DIKED DISPOSAL AREA SECTION III
COMPARISON OF CORPS OF ENGINEERS
SURVEYS 1974 1979 AND 1980

Figure 1-10

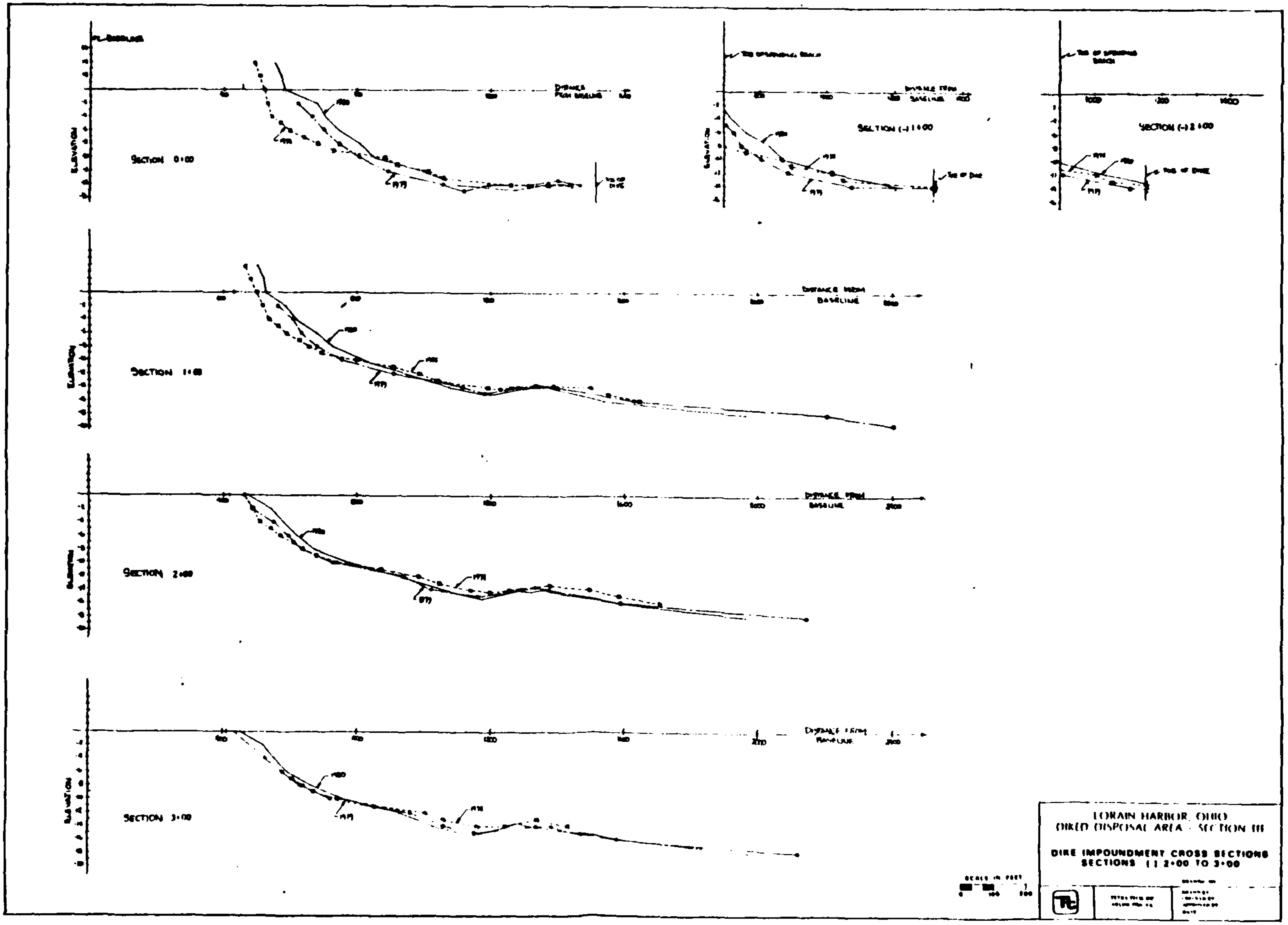
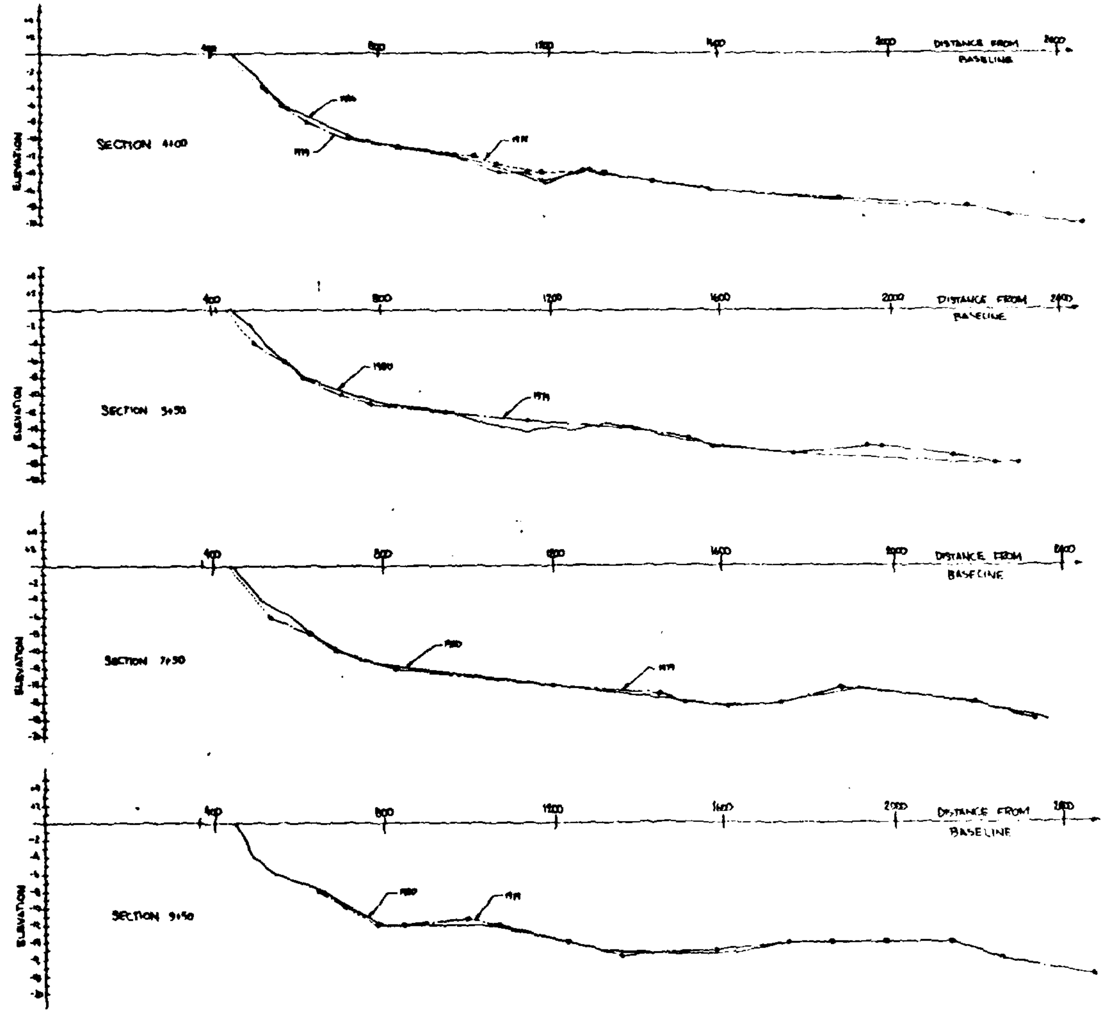

SECTION 0+00
SECTION 1+00
SECTION 2+00
SECTION 3+00
SECTION (-)1+00
SECTION (-)2+00
ELEVATION
DISTANCE FROM BASELINE
TOE OF DIKE
LORAIN HARBOR, OHIO
DIKED DISPOSAL AREA - SECTION III
DIKE IMPOUNDMENT CROSS SECTIONS
SECTIONS (-)2+00 TO 3+00
SCALE IN FEET

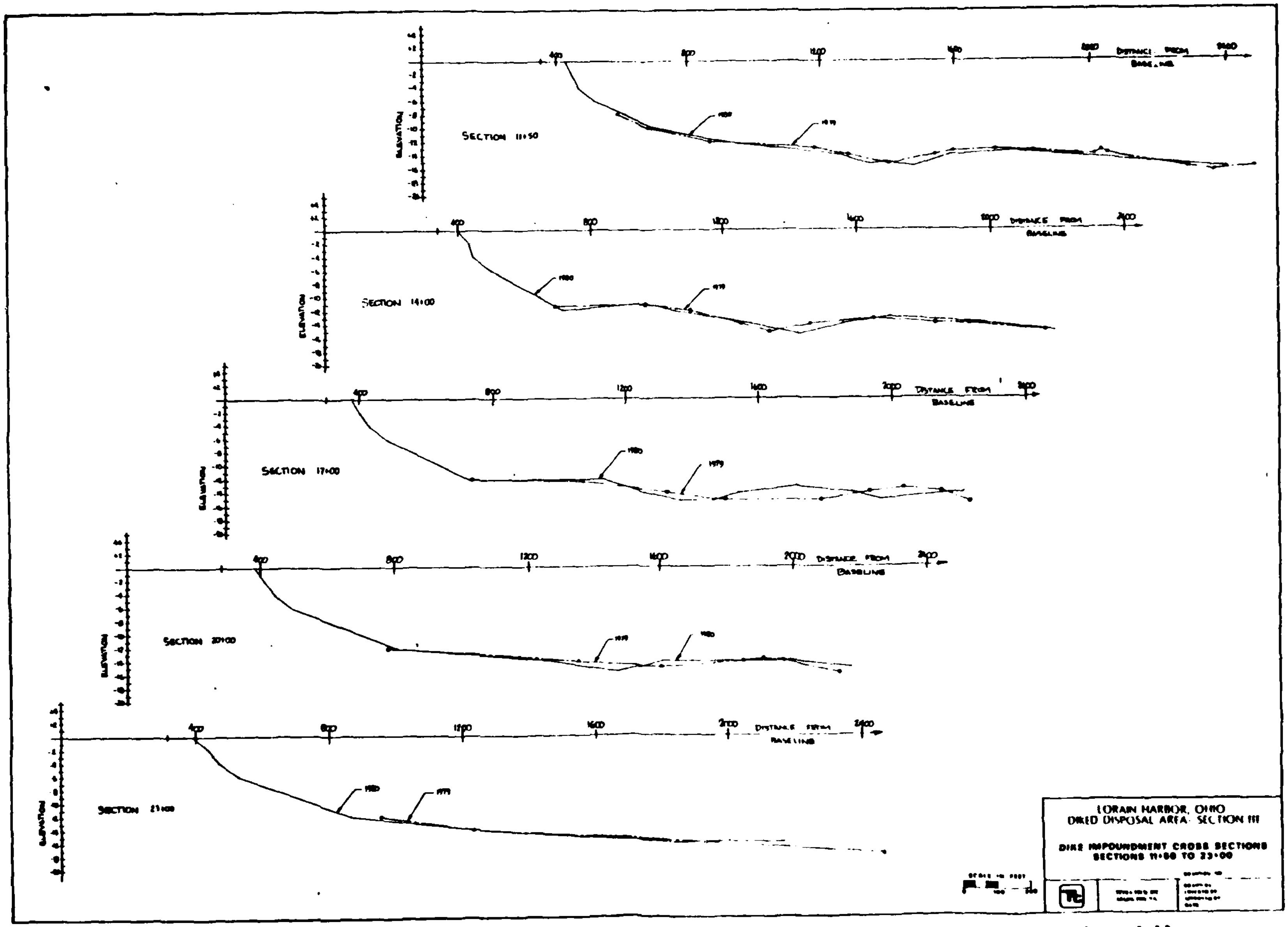
Figure 1-11



LORAIN HARBOR, OHIO
DIKED DISPOSAL AREA: SECTION III

DIKE IMPOUNDMENT CROSS SECTIONS
SECTIONS 4+00 TO 9+50

Figure 1-12



SECTION 11+50
SECTION 14+00
SECTION 17+00
SECTION 20+00
SECTION 21+00
DISTANCE FROM BASELINE
ELEVATION
1980
1979
LORAIN HARBOR, OHIO
DIKED DISPOSAL AREA: SECTION III
DIKE IMPOUNDMENT CROSS SECTIONS
SECTIONS 11+50 TO 23+00

Figure 1-13

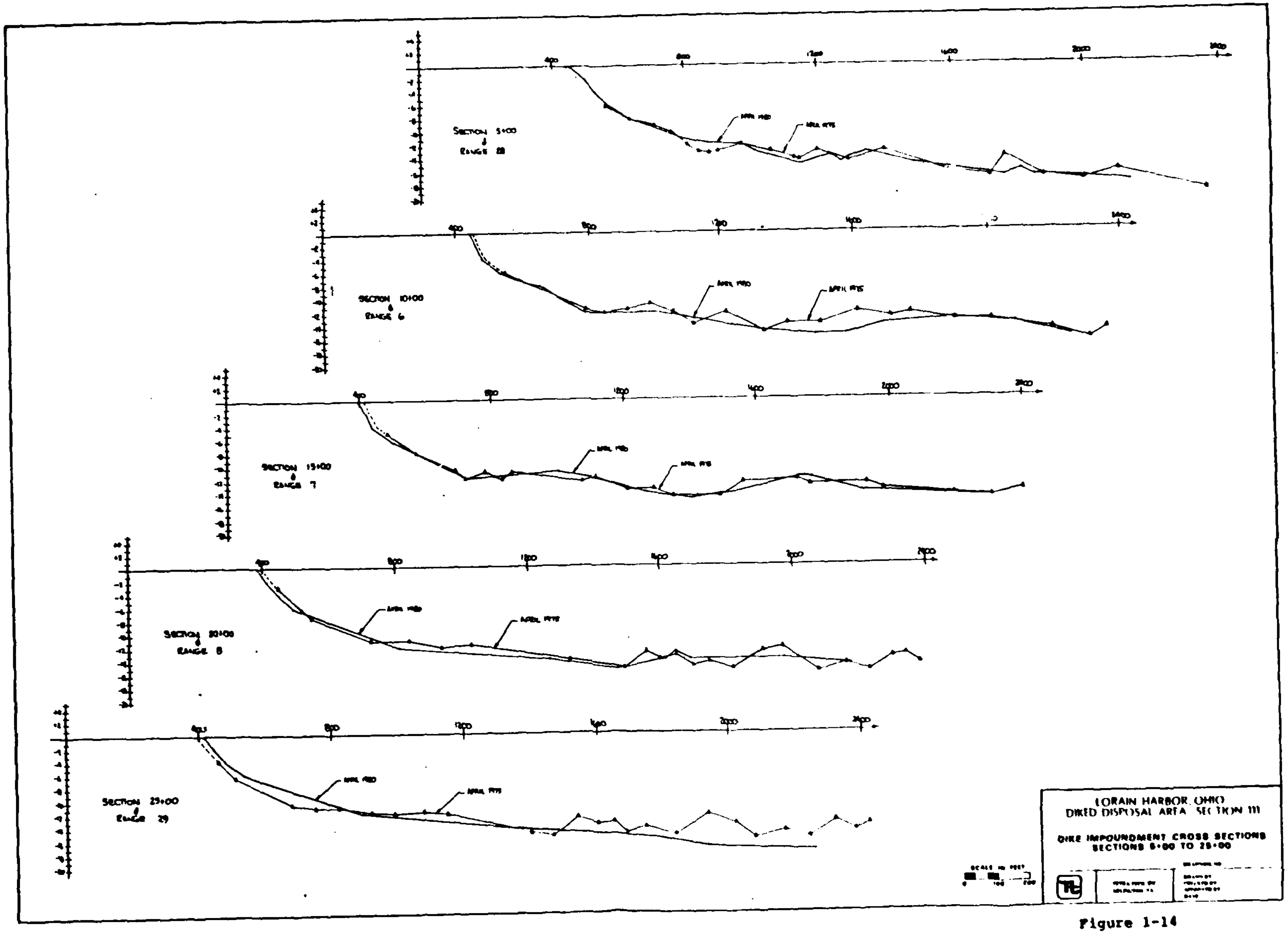

SECTION 5+00 & RANGE 28
SECTION 10+00 & RANGE 6
SECTION 15+00 & RANGE 7
SECTION 20+00 & RANGE 8
SECTION 25+00 & RANGE 29
LORAIN HARBOR, OHIO
DIKED DISPOSAL AREA SECTION III
DIKE IMPOUNDMENT CROSS SECTIONS
SECTIONS 5+00 TO 25+00

Figure 1-14

Impoundment

The Stage 1 Reconnaissance Report for the area east of the diked disposal structure identified impoundment as the probable cause of increased erosion in the study area. The cause of this impoundment and subsequent erosion of the shoreline east of Colorado Avenue is the shielding effect that the dike has on incoming waves from Northwest thru West directions. This shielding allows wave energy from the eastern quadrants to move littoral material to the west up against the spending beach, but does not allow its return when incoming wave direction shifts to the western quadrants. However, this is considering the worst case that prior to dike construction, all material which moved west would eventually also be moved east; but since dike construction, all accumulation is caused by dike entrapment. The net effect is an accretion in the area adjacent to the spending beach, while updrift there is a zone of erosion dominated by a unidirectional littoral drift.

With the addition of the 1980 Corps of Engineers' Survey and a 1975 survey from the Parsons, Brinckerhoff, Quade and Douglas report, there is better data at hand to predict the impoundment behind the dike disposal structure. These impoundment calculations are presented on the next few pages.

As a result of the density of coverage in the 500 feet adjacent to the dike spending beach, we have a high degree of confidence in the estimate of accretion in this area based upon a comparison of 1974 vs 1980 surveys (see also figures 1-11 and 1-12). Unfortunately, the 1975 vs 1980 comparisons (see figure 1-14) are spaced every 500 feet and, at best, we can only assume a trend of erosion in this zone.

Figure 1-15 summarizes the results of these profile comparisons. As assumed in the Reconnaissance report, the zone of accretion extends from 0 to 800 feet east of Colorado Avenue. An erosion zone extends from 800 to 2400, feet east of Colorado Avenue, followed by a zone of accretion again.

Since only 3 data points at station 10+00, 15+00 and 20+00 define the erosion zone east of station 8+00 the exact quantity of erosion cannot be calculated. These three points merely define a zone of erosion.

The quantity of accretion in the fillet being formed east of the spending beach was found to be 5400 yds^3 per year.

IMPOUNDMENT CALCULATIONS

TO ESTIMATE THE AMOUNT OF IMPOUNDMENT EAST OF THE DIKE DISPOSAL STRUCTURE USE:

1) 1974-1980 PROFILE COMPARISONS
2) TAKE INTO ACCOUNT ACCRETION & EROSION ZONES PER EACH PROFILE ONLY OUT TO THE "TOE OUT DEPTH" CALCULATED BELOW
3) DUE TO THE SHORTFALLS OF THE 1974 SURVEY, EXTRAPOLATE THE DATA FOR THE COMPLETED PROFILES TO FIND THE INTERSECTION OF THE ACCRETION FILLET WITH THE SHORELINE

TO ESTIMATE TOE OUT DEPTH EVALUATE THE FOLLOWING DATA:

A) HIGHEST OBSERVED SSMO DEEP WATER WAVE HEIGHT IN LORAIN AREA IS $H_0 = 12$ FT. (FROM NE $T_0 = 5-6$ sec)
B) EXTREME ESTIMATES FOR 10 YR RETURN PERIOD WAVE HEIGHTS IN LORAIN AREA IS
   9.8 FT WINTER FROM NORTH-NORTHWEST
   11.6 FT ALL SEASONS, ALL ANGLES
C) OFFSHORE BOTTOM SLOPE IS NOT AN IMPORTANT FACTOR TO THE TOE OUT DEPTH CALCULATION
D) TO CALCULATE THE YEARLY LIMIT DEPTH TO PROFILE ACTIVITY ON SEASONAL BEACHES USE METHOD DESCRIBED IN HALLERMEIER, R.J. "USES FOR A CALCULATED LIMIT DEPTH TO BEACH EROSION" PROCEEDINGS OF THE 16th COASTAL ENGINEERING CONFERENCE, HAMBURG, WEST GERMANY, AUG 28 - SEPT 1, 1978

$$d_{se} = 2.28\,H_e - 68.5\left(H_e^2 / g\,T_e^2\right)$$

d_{se} = limit depth (use mean low tide ((lake)) level for maximum depth)
H_e = nearshore significant height of extreme waves (ie. waves that are exceeded only 12 hours per year)
T_e = typical significant period of the measured high waves

FOR MEAN LOW LAKE LEVEL ASSUME THE AVERAGE OF THE LOWER LEVELS FOR PERIOD 1974 THRU 1980 FROM NOAA DATA TABLE ON PAGE 1-18

YEAR	LOWEST LEVEL
1974	571.67
1975	571.68
1976	570.70
1977	570.22
1978	570.47
1979	570.43
1980	571.51
AVERAGE	570.95

AVERAGE LOW LAKE LEVEL DURING PERIOD OF PROFILE COMPARISONS IS 570.95

570.95
− 568.60
2.35

FOR SIGNIFICANT WAVE HEIGHT OF EXTREME WAVES USE 5 YR RETURN INTERVAL WAVE HEIGHTS SEE PAGE 1-12

ANGLE APPROACH	He	Te	dse*	dse
ENE to N	7.9	6.8	15.1	12.7
N to NW	8.9	6.9	16.8	14.4
NW to WNW	9.5	7.7	18.4	16.0

* unadjusted for water level
dse = dse* − 2.35 or depth with respect to L.W.D

THE RANGE OF LIMIT (TOE OUT) DEPTH BELOW L.W.D IS 13 to 16 FT

FOR PURPOSES OF IMPOUNDMENT CALCULATIONS ASSUME 15 FT IS THE LIMIT DEPTH FOR SIGNIFICANT PROFILE ADJUSTMENTS

ACCRETION / EROSION CALCULATIONS PER PROFILE
1974-1980 OUT TO -15 FT FROM L.W.D.

SECTION -200

ACCRETION = 20 × [1.9/2 + .9 + .8 + .6 + .5 + .3 + .5 + .7 + .8 + .7 + .6 + .4 + .3/2] = 149 FT³/FT

EROSION = 0 FT³/FT

SECTION -100

ACCRETION = 20 × [3.7/2 + 4.6 + 3.8 + 3.2 + 2.6 + 2.3 + 1.9 + 1.4 + .6 + 0 + .5 + .6 + .5 + .4 + .3 + .2 + 0 + .2 + .6 + .6 + .4 + .3 + .2 + 0/2] = 561 FT³/FT

EROSION = 20 × [0/2 + .1 + .3 + .4 + .3 + .3 + .2 + .2 + .2/2] = 38 FT³/FT

SECTION 0

ACCRETION = 20 × [0/2 + 2.3 + 4.5 + 5.3 + 5.7 + 5.8 + 5.9 + 5.9 + 5.9 + 4.8 + 4.1 + 3.3 + 2.8 + 2.3 + 1.7 + 1.1 + .3/2 + 0/2 + .1 + .2 + .1 + .1 + .1/2] = 1242 FT³/FT

EROSION = 20 × [0/2 + .3 + .4 + .2 + 0/2 + 0/2 + .1 + .2 + .3 + .2 + .2 + .5 + .7 + .8 + .7 + .6 + .4 + .3 + 0/2] = 200 FT³/FT

SECTION +100

ACCRETION = 20 × [0/2 + 2.2 + 3.6 + 3.8 + 3.8 + 3.6 + 3.2 + 2.7 + 2.7 + 2.5 + 2.3 + 1.7 + 1.2 + .7 + .5 + .2 + 0/2] = 688 FT³/FT

EROSION = 20 × [0/2 + .1 + .3 + .4 + .4 + .5 + .6 + .6 + .6 + .5 + .5 + .6 + .7 + .8 + .9 + 1.0 + 1.1 + 1.0 + .9 + .6 + .5 + .4 + .3 + .2 + .1/2] = 271 FT³/FT

SECTION +200

ACCRETION = 20 × [0/2 + 1.1 + 2.4 + 2.9 + 3.0 + 2.8 + 2.5 + 2.0 + 1.4 + 1.3 + 1.0 + .8 + .7 + .6 + .7 + .4 + .2 + 0/2] = 476 FT³/FT

EROSION = 20 × [0/2 + .1 + .2 + .3 + .4 + .5 + .6 + .7 + .8 + .8 + .8 + .7 + .8 + .8 + .8 + .9 + 1.1 + 1.0 + .7 + .5 + .4 + .3 + .2 + .1 + .1/2] = 287 FT³/FT

SECTION +300

EXTRAPOLATED ACCRETION = 20 × [0/2 + 1.1 + 2.3 + 2.7 + 2.2 + 1.8 + 1.3 + .9 + .9 + .9 + .9 + .8 + .8 + .8 + .6 + .5 + .4 + .2 + .1 + .1 + 0/2] = 368 FT³/FT

EROSION = 20 × [0/2 + .1 + .1 + .1 + .2 + .3 + .4 + .6 + .9 + 1.2 + 1.4 + 1.5 + 1.5 + 1.4 + 1.3 + 1.4 + 1.4] = 276 FT³/FT

SECTION +400

EXTRAPOLATED ACCRETION = 20 × [7/2 + .7 + 1.9 + 2.2 + 1.4 + 1.1 + .7 + .6 + .7 + .7 + .8 + .8 + .7 + .6 + .4 + .2 + .2 + .2 + .1 + .1 + .1 + 0/2] = 280 FT³/FT

EROSION = 20 × [0/2 + .1 + .1 + .1 + .2 + .4 + .6 + .5 + .4 + .4 + .5 + .3 + .7 + .9 + 1.1 + 1.2 + .7 + .3 + 0/2] = 174 FT³/FT

1975 - 1980 PROFILE COMPARISONS OUT TO -15FT FROM LWD.

SECTION +500

EXTRAPOLATED ACCRETION = 20 × [0/2 + .6 + .7 + .8 + .8 + .5 + .6 + .3 + .2 + .1 + 0/2 + 0/2 + .8 + 1.2 + 1.5 + 1.5 + 1.3 + 1.0 + .7 + .4 + 0/2] = 260 FT³/FT

EROSION = 20 × [0/2 + .1 + .3 + .4 + .4 + .3 + .2 + 0/2 + 0/2 + .3 + .5 + .6 + .7 + .7 + .7 + .3 + .7 + .8 + 1.0 + 1.3 + .6 + 0/2] = 208 FT³/FT

SECTION +1000

EXTRAPOLATED EROSION = 20 × [.2/2 + 1.0 + .7 + .5 + .5 + .3 + .3 + .2 + .1 + 0/2 + 0/2 + .2 + .4 + .4 + .5 + .4 + .3 + 0 + .2 + .4 + .6 + .8 + .9 + 1.1 + 1.2 + .8 + .6 + .5 + 0/2 + 0/2 + .7 + 1.3 + 1.8 + 1.5 + 1.2 + .7 + .5 + 0/2] = 414 FT³/FT

ACCRETION = 20 × [0/2 + .2 + .4 + .2 + 0/2 + 0/2 + .4 + .8 + .3/2] = 43 FT³/FT

SECTION +1500

EXTRAPOLATED EROSION = 20 × [.3/2 + 1.3 + 1.7 + .8 + .7 + .7 + .5 + .3 + .1 + 0 + .1 + .2 + .2 + .3 + .3 + .4 + .2 + 0 + .3 + .6 + .5 + 0/2 + 0/2 + .4 + .1/2 + 0/2 + .3 + .5 + .7 + .5 + .3 + 0/2 + 0/2 + .2 + .3 + .3 + .2 + 0/2] = 262 FT³/FT

ACCRETION = 20 × [0/2 + .6 + 0/2 + 0/2 + .2 + .5 + .6 + .9 + 1.0 + ... + .1 + .2 + .1 + 0/2 +] = 141 FT³/FT

SECTION + 2000

EXTRAPOLATED EROSION = 20 × [1.3/2 + 1.1 + 1.0 + 1.1 + 1.1 + 1.1 + .6 + 0/2 + 0/2 + .4 + .8 + ... + 1.1 + 1.1 + 1.0 + .9 + .7 + .6 + .7 + .9 + 1.0 + 1.2 + 1.3 + 1.2 + .2 + 1.1 + 1.0 + .9 + .8 + .7 + .6 + .6 + .6 + 11 × .5 + 0/2] = 663 FT³/FT

ACCRETION = 20 × [0/2 + .4 + 9 × .5 + 0/2] = 98 FT³/FT

SECTION + 2500

EXTRAPOLATED ACCRETION = 20 × [.1/2 + 1.2 + 1.2 + 1.3 + 1.0 + 1.2 + 1.3 + 1.1 + 1.2 + 1.4 + 1.5 + 1.7 + 1.8 + 1.9 + 2.1 + 1.9 + 1.7 + 1.5 + 1.2 + .9 + .6 + .3 + 0/2] = 561 FT³/FT

ACCRETION = 20 × [0/2 + .2 + .4 + .3 + .3 + .4 + .4 + .5 + .5 + .7 + .8 + 1.0 + 1.2 + 1.2 + 1.3 + 1.3 + 1.1 + 1.0 + .9 + .7 + .6 + .5 + .4 + .3 + .1 + 0/2] = 322 FT³/FT

IMPOUNDMENT CALCULATIONS- AREAS EAST OF DIKE

FROM A COMPARITIVE ANALYSIS OF 1974 VS 1980 AND 1975 VS 1980 PROFILES AT VARIOUS SECTIONS EAST OF THE DIKE DISPOSAL STRUCTURE, THE FOLLOWING TABLE PRESENTS THE AMOUNT OF ACCRETION AND EROSION AT A GIVEN SECTION

PROFILE CHANGES (FT^3/FT) LWD to -15 FT.

	SECTION	ACCRETION	EROSION	ADJUSTMENT	NET	RATE $FT^3/FT/YR$
1974-1980	-2+00	+149	0	+30	+179	+ 74
	-1+00	+561	-38	+112	+635	+262
	00	+1242	-200	+248	+1290	+533
	1+00	+688	-271	+138	+555	+229
	2+00	+476	-287	+95	+284	+117
	3+00	+368	-276	+74	+166	+69
	4+00	+280	-174	+56	+162	+67
1975-1980	5+00	+260	-208	+52	+104	+43
	10+00	+43	-414	-83	-454	-188
	15+00	+141	-262	-52	-173	-72
	20+00	+98	-663	-132	-697	-288
	25+00	+561	-322	+112	+351	+145

NOTES:

1) 1974-1980 COMPARISONS BASED UPON CORPS OF ENGINEERS SURVEYS. 1974 SURVEY STOPS APPROXIMATELY 400 FT EAST OF COLORADO AVE. SO 1975-1980 COMPARISONS WERE MADE TO SUPPLEMENT THE DATA

2) 1975 SURVEY TAKEN FROM PLATES 4 THRU 7 IN PARSONS, BRINCKERHOFF, QUADE & DOUGLAS REPORT OF JUNE 1975 ON "DESIGN ANALYSIS CRITERIA FOR CONTAINED SPOIL DISPOSAL FACILITIES, LORAIN HARBOR, OHIO

3) ALL PROFILE COMPARISONS WERE CALCULATED FROM L.W.D TO THE -15 FT CONTOUR I.E. THE TOE CUT DEPTH AS PREVIOUSLY CALCULATED

4) A PROFILE ADJUSTMENT OF 20% IS MADE FOR EACH COMPARISON TO ACCOUNT FOR CHANGES OCCURING

NOTES CONT'D:

ABOVE L.W.D. BUT BELOW ELEVATION +4
THIS FIGURE OF 20% IS BASED UPON
1974-1980 COMPARISONS AT STA. 00 & +100
WHERE DATA EXISTED ABOVE L.W.D.

5) THE NET CHANGE IN EACH SECTION IS THE
ACCRETION + EROSION + ADJUSTMENT = NET
THE ADJUSTMENT MAY BE + OR − DEPENDING
UPON WHETHER ACCRETION OR EROSION OCCURRED
ON THE FORESHORE

6) THE RATE OF PROFILE CHANGE PER YEAR IS
THE NET CHANGE DIVIDED BY THE PERIOD
OF TIME SINCE THE DIKE SPENDING BEACH
WAS COMPLETED
NOVEMBER 1977 to APRIL 1980 = 2.42 YRS
THIS PERIOD WAS CHOSEN RATHER THAN
THE ENTIRE JUNE 1974 - APRIL 1980 OR
APRIL 1975 - APRIL 1980 PERIODS ASSUMING THAT
PRIOR TO THE COMPLETION OF THE DIKE
STRUCTURE & SPENDING BEACH NO ACCRETION
FILLET AND ATTENDANT UPSTREAM EROSION
EXISTED IN THIS STRETCH OF BEACH
IE. THE ACCRETION FILLET HAS FORMED SINCE
NOVEMBER 1977.

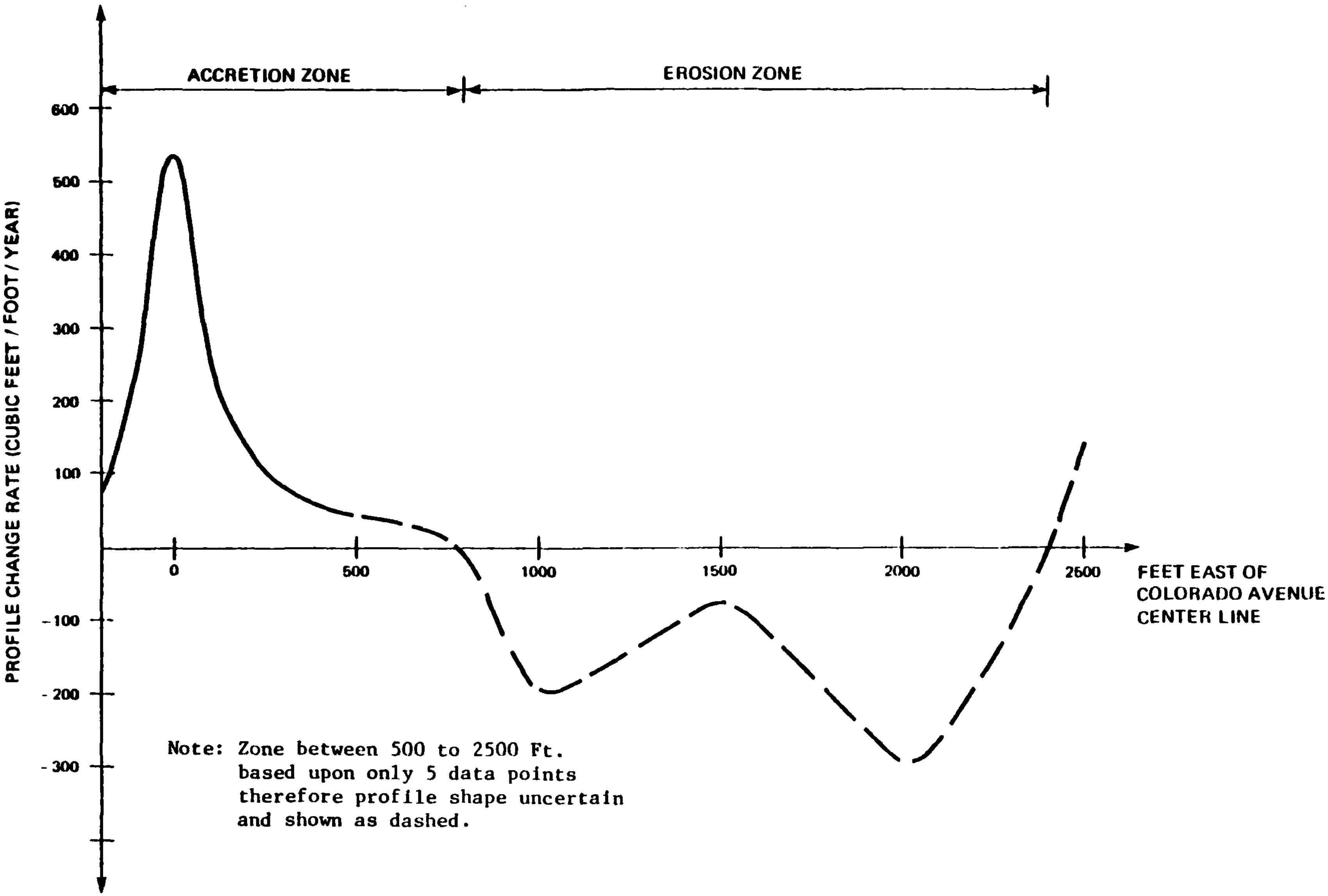


Figure 1-15 Profile Change East of Dike Disposal Structure

IMPOUNDMENT CALCULATIONS - ACCRETION FILLET

USING THE PROFILE CHANGE RATES CALCULATED FOR SECTIONS -2+00 to 5+00 AND INTERPOLATED RATES FOR SECTIONS 6+00 to 8+00 FROM THE FIGURE ON THE PREVIOUS PAGE, THE ACCRETION IN THE AREA ADJACENT TO THE DIKE STRUCTURE IS SHOWN IN THE TABLE BELOW

SECTION	EXTENT FT	RATE $FT^3/FT/YR$	ACCRETION FT^3/YR
-2+00	-250 to -150	74	7400
-1+00	-150 to -50	262	26200
00	-50 to +50	533	53300
1+00	50 to 150	229	22900
2+00	150 to 250	117	11700
3+00	250 to 350	69	6900
4+00	350 to 450	67	6700
5+00	450 to 550	43	4300
6+00	550 to 650	36	3600
7+00	650 to 750	22	2200
8+00	750 to 800	8	400
		TOTAL ACCRETION	145600 FT^3/YR
			5400 YD^3/YR

ACCRETION FILLET EXTENDS TO 800 FT EAST OF ℄ COLORADO AVE.

Refraction

A study of wave refraction by the nearshore bottom contours in the vicinity of the dike disposal structure was conducted using the 1980 Corps of Engineers Bathymetric Survey. Storm waves with period T=7 seconds were refracted from directions northeast, north and northwest starting at the edges of the 1980 survey in approximately 18 feet of water at L.W.D. and ending in shallow water.

The tables of calculations to refract each wave ray are not presented here but the resulting ray refractions are presented in figure 1-16 on an overlay of the 1980 survey.

From this figure, one can observe the divergence of some wave rays, denoting decrease wave energy with reference to deep water conditions. Other rays converge, denoting a focusing of wave energy with reference to deep water conditions, while still other rays cross which cannot be corrected by the mathematical theory governing refraction at this time. The cause of these wave rays bending is the complicated bathymetry east of the dike structure. Of special interest is a localized shallow water area occurring between stations 500 and 2000 on the baseline. This rise offshore has changed the bathymetry from bottom contours parallel to the shoreline, which is the normal condition in the nearshore zone where the bottom is reworked by wave action. This rise can be found on bathymetric charts as far back as 1949, well before the construction of the east breakwater shorearm, and therefore cannot be a dike induced phenomenon. Nevertheless, the convergence of wave rays caused by this rise and other bottom abnormalities has a negative effect on the shoreline in the study area and may be a contributing factor to structural degradation and bluff recession.

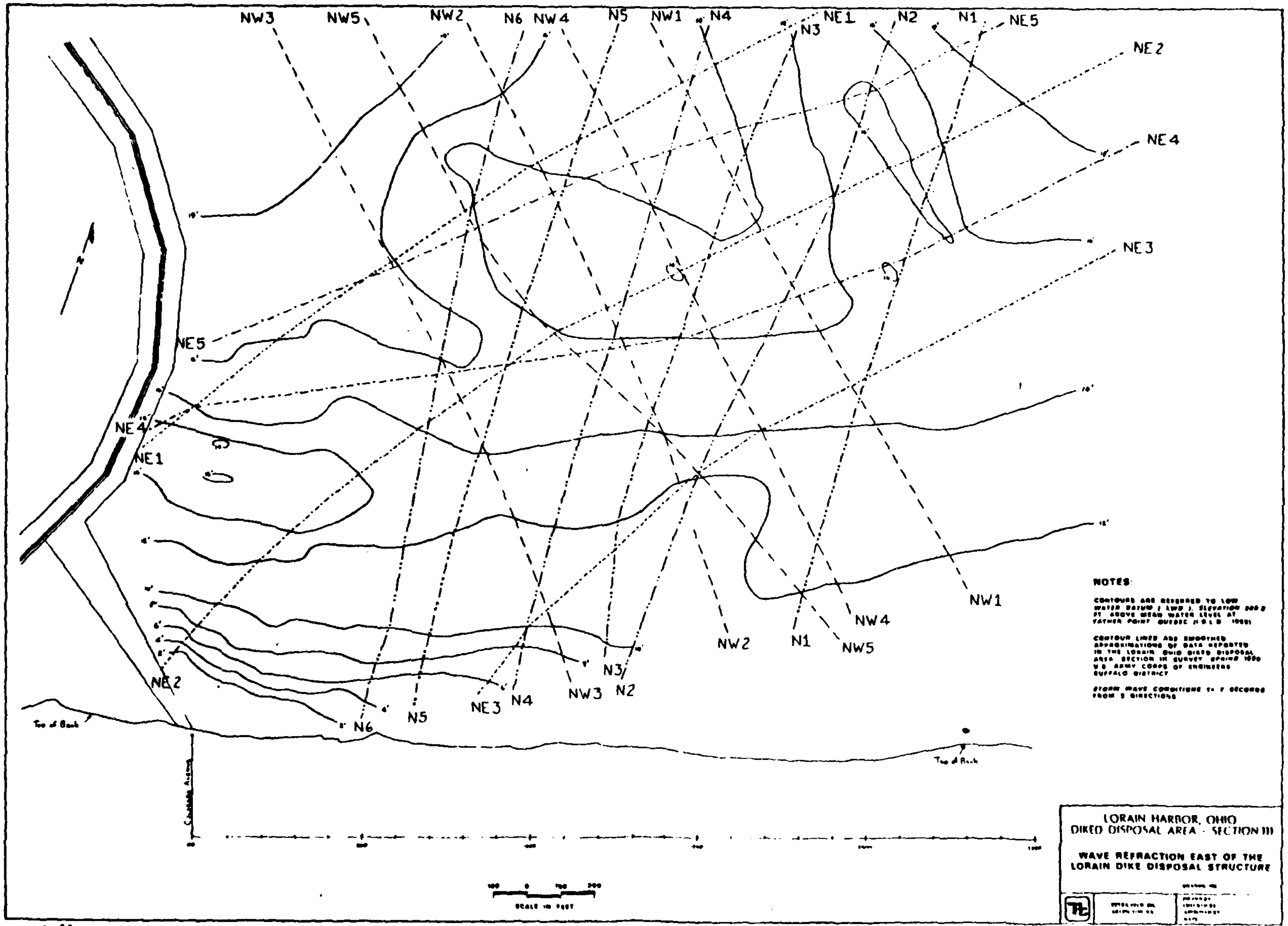

NW3
NW5
NW2
N6
NW4
N5
NW1
N4
N3
NE1
N2
N1
NE5
NE2
NE4
NE3
NE5
NE4
NE1
NE2
N6
N5
NE3
N4
NW3
N3
N2
NW2
N1
NW5
NW4
NW1
NOTES
LORAIN HARBOR, OHIO
DIKED DISPOSAL AREA - SECTION III
WAVE REFRACTION EAST OF THE
LORAIN DIKE DISPOSAL STRUCTURE
SCALE IN FEET

Figure 1-16

The shielding effect of the dike structure on areas east of Colorado Avenue was raised in the reconnaissance report as a cause of littoral material impoundment. The description of this mechanism will be repeated here because it is still felt that this shielding causes a unidirectional littoral movement in areas east of the dike and therefore establishes that the dike disposal structure has a contribution to the erosion experienced along this shoreline.

To determine the effect of the dike structure as compared to pre-dike conditions unrefracted wave rays approaching the shoreline from the W, WNW, NW, NNW and N directions were constructed (see figure 1-17). What these rays indicate:

1. There is no impact on waves from N to NE quadrants.
2. Waves from NNW could reach the pocket formed by the breakwater shorearm (pre-dike condition) or the pocket formed by the dike and spending beach (post-dike condition). These waves unfortunately approach perpendicular to the beach and thus provide minimal assistance in eastward transport of littoral material.
3. Pre-dike waves from the NW could reach the pocket (foot of Arizona Avenue) without masking and could cause eastward drift. Post-dike waves from the NW are masked for a distance of 800 feet east of Colorado Avenue and therefore cannot cause eastward drift until east of this shadow zone.
4. Pre-dike waves from the WNW could not reach a zone 1600 feet to the east of Arizona Avenue (or 1000 feet east of Colorado) where as post-dike WNW waves are masked for a distance of 2200 feet east of Colorado Avenue. The difference of 1200 feet of masking is a direct influence of the dike

construction.

5. There is no impact on waves from the W in that 6200 feet of masking is apparent in pre and post-dike configurations.

Therefore masking effects of dike construction are:

A. From 0 to 800 feet east of Colorado Avenue, under post-dike conditions, <u>no</u> waves with eastward drift components can reach this stretch of beach. i.e., what littoral material that enters during periods of westward drift cannot now be pushed back to the east in this zone. Prior to dike construction waves from the NW could provide this eastward drift component.

B. From 1000 to 2200 Feet east of Colorado Avenue pre-dike waves from the WNW could provide eastward components of transport where as post-dike masking prohibits this. This is a zone of reduced efficiency of eastward transport (only waves from NW can provide eastward drift).

C. From 2200 feet to 6200 feet east of Colorado Avenue only waves from W cannot contribute to eastward transport in either pre or post-dike configurations i.e., no net impact of dike.

D. East of 6200 feet from Colorado Avenue normal conditions of east and west transport prevail.

This shielding scenario supports the theory that the dike impounds westward littoral drift, prohibiting eastward reversals which would aid in reducing the erosion experienced on this shoreline by maintaining protective beaches fronting the bluff.

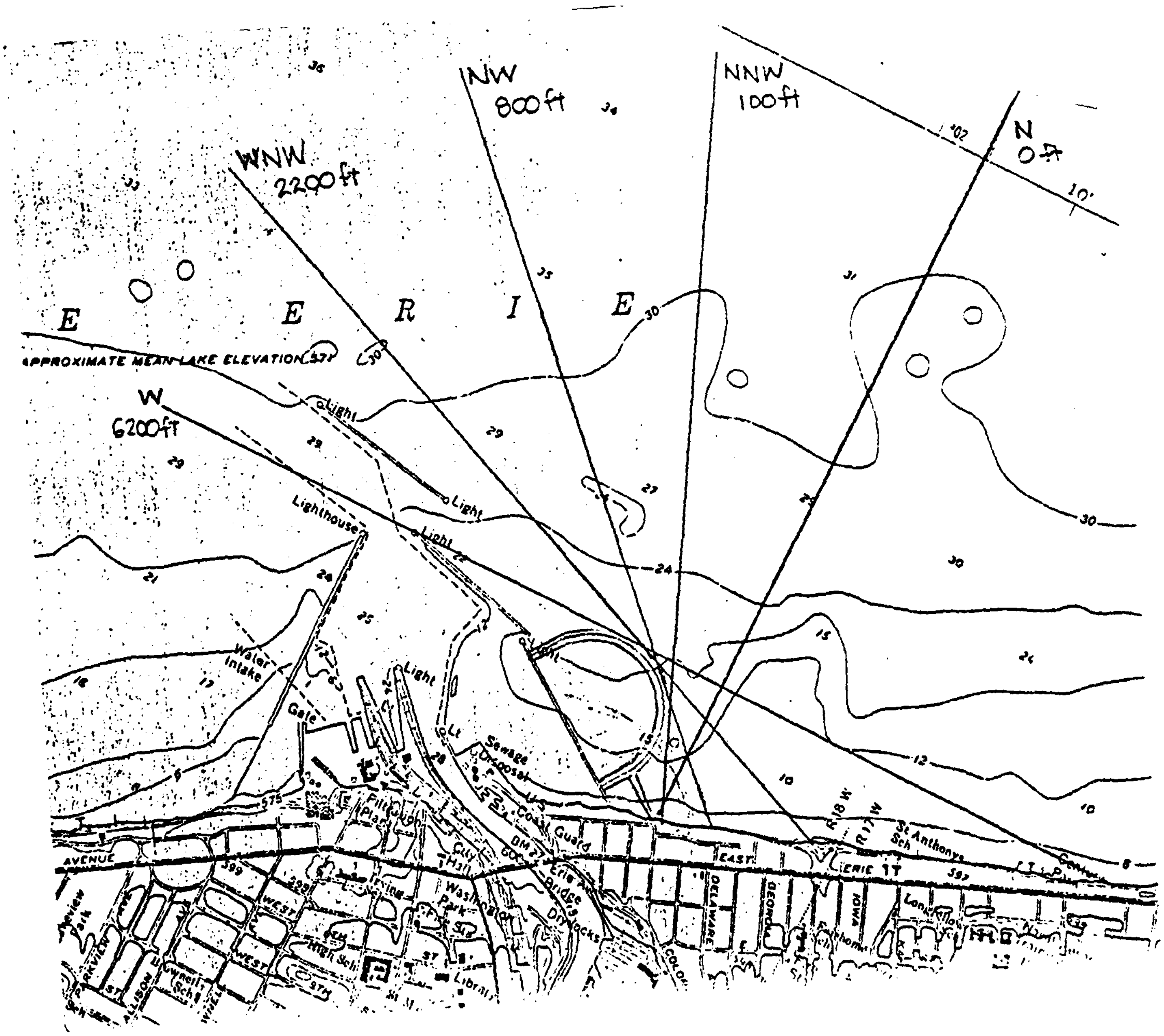


Figure 1-17
Wave Shielding Effect of Dike Structure

Reflection

Wave reflection off the dike and spending beach was an issue raised by local inhabitants as a possible cause of increased erosion of the shoreline fronting their property.

In their 1975 report on the detailed design of the spending beach, Parsons, Brinckerhoff, Quade and Douglas, Inc. did an extensive study of this reflection effect from the rubble mound dike and the revetment spending beach. The findings of this report will be used here to evaluate the possibility that reflection is a major contributor to shoreline erosion in the study area.

The 1975 Parsons Report found:

1. the spending beach (with a 1 on 5 slope) had a reflection coefficient of less than 0.1 with attendant energy absorption of greater than 95%
2. the dike sections (with a 1 on 2 riprap slope) had a reflection coefficient of 0.1 to 0.2 with estimated energy absorption of 90% or greater

Upon close examination of aerial photographs during the post-dike period (since 1977), no noticeable reflection patterns could be observed resulting from the presence of the dike or spending beach. In fact, reflection patterns from the vertical walled private shore protective structures were quite evident in these same aerial photos.

Therefore the mechanism of reflection due to the disposal dike is considered to have a negligible effect on erosion of the shoreline in question.

Set-Up

Another local residents' complaint about the dike disposal structure was that it formed an embayment into which storm waves were driven until the water piled up upon itself causing wave attack higher up on the bluff. This mechanism is called set-up or the super elevation of the still water level caused by incoming storm waves.

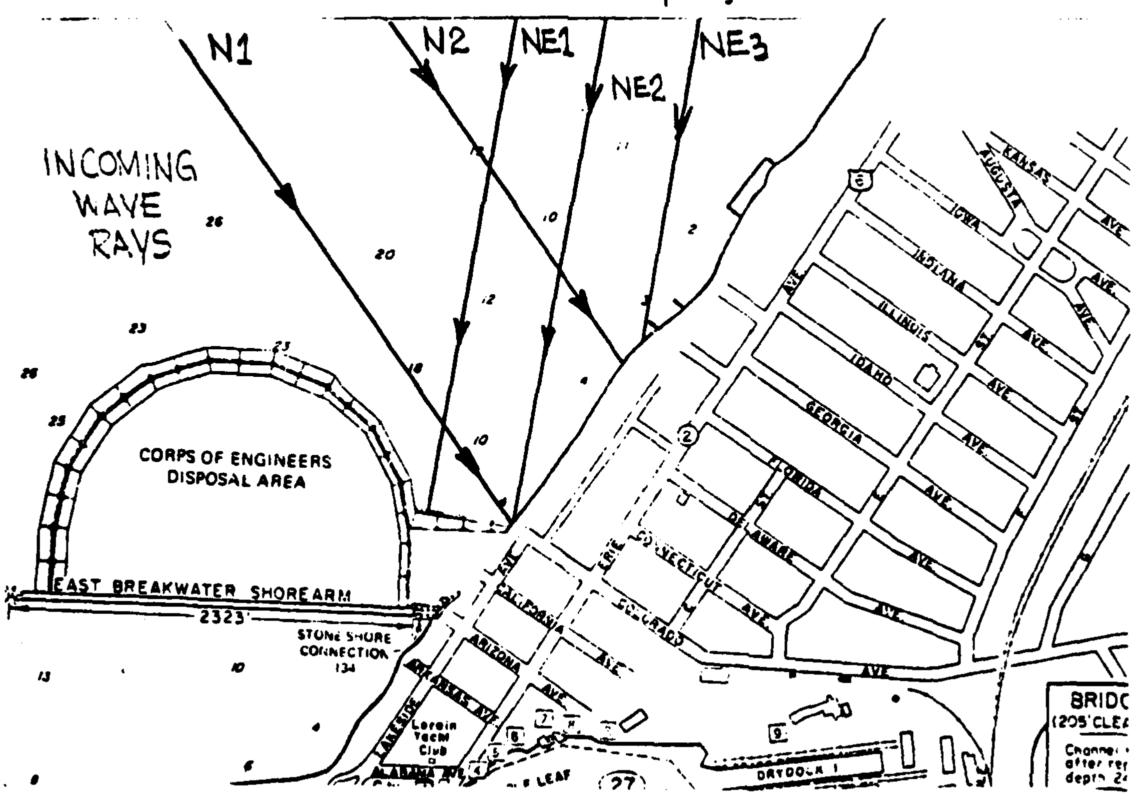
Calculations were performed using the 10 year return interval storm waves previously developed, and irregular wave theory to produce set-up computations for the 1980 Corps bathymetric profile data. Wave rays from the north and northeast were shoaled into shore to determine the maximum set-up which would occur.

The calculations on the following pages reveal a maximum set-up of 0.75 feet for incoming waves from the north. When considering the height of run up that would occur during these storm conditions a 0.75 foot increase in the mean water level would hardly be noticeable. Therefore set-up was considered to have a negligible effect on the shoreline erosion east of the dike disposal structure.

SET-UP CALCULATIONS - AREAS EAST OF DIKE

IN AN EFFORT TO QUANTIFY THE CHANGE IN WATER SURFACE ELEVATION DUE TO THE SETUP (SUPER-ELEVATION OF MEAN WATER LEVEL CAUSED BY WAVE ACTION ALONE) OF INCOMING STORM WAVES THE FOLLOWING ANALYSIS WAS PERFORMED

1) CHOSE INCOMING WAVE RAYS SUCH THAT THEY WILL PORTRAY WAVE SETUP FOR THE SPENDING BEACH SECTION OF SHORELINE IN QUESTION (SEE SKETCH BELOW)
2) USE CORPS OF ENGINEERS 1980 OFFSHORE SURVEY TO DETERMINE BOTTOM SLOPES ALONG EACH WAVE RAY.
3) USE IRREGULAR WAVE THEORY TO DETERMINE WAVE SETUP FROM REFERENCE "ESTIMATING NEARSHORE CONDITIONS for IRREGULAR WAVES" By SEELIG AND AHRENS, UNPUBLISHED DRAFT CERC MANUSCRIPT, JULY 16, 1979



SET UP CALCULATIONS

A PREVIOUS ANALYSIS OF INCOMING WAVES ASSUMING A 10 YEAR RETURN PERIOD STORM CONDITION (SHOWN ON FOLLOWING PAGE) CAN BE USED TO DEFINE WAVE PARAMETERS NEEDED IN THE SETUP ANALYSIS

THE TABLE BELOW IS A REDUCTION OF THE DATA ON BOTTOM SLOPES ALONG EACH WAVE RAY FROM THE 1980 CORPS SURVEY

CHANGE IN BOTTOM SLOPES

CONTOUR	N1	N2	NE1	NE2	NE3
18					
	>1/100		>1/100		
16					
	>1/100		>1/100	>1/100	>1/100
14					
	>1/100	>1/100	>1/50	>1/100	>1/100
12					
	1/50	1/100	HITS SPENDING BEACH	>1/100	>1/100
10					
	1/25	1/35		1/50	1/50
0					

SET UP COULD BE DETERMINED AT ANY POINT ALONG THE WAVE RAY, BUT THE MAXIMUM SET UP OCCURS CLOSEST TO SHORE, AS PREDICTED BY THE CURVES FROM SEELIG & AHRENS ON THE FOLLOWING PAGES

FOR RAY N1 THE FORSHORE SLOPE DURING A STORM MEAN LAKE LEVEL IS $1/25 = m$

DIRECTION 2 $H_o = 9.9'$ $H_o' = 8.8'$ in 3 ft water

ASSUMING SLOPE $= 1/20$ $H_o'/L_o = 0.033$ say 0.04

FROM FIGURE 1-18 $S_w/H_o' = 0.085$, $S_w = 0.75'$

MAXIMUM SETUP

PREDICTED NEARSHORE SIGNIFICANT WAVE HEIGHTS

DIRECTION 1 : H_o = 8.5 ft, T_s = 7.0 sec, α_o = 60°, S^* = 4 assuming wind waves

d_{SWL} (ft)	d/gT_s^2	K_R	α	H_o'	H_o'/L_o	d_{SWL}/H_o'	H_s (ft)
18	0.0114	0.74	23°	6.29	0.025	2.86	6.23
15	0.0095	0.73	20°	6.21	0.025	2.42	6.27
12	0.0076	0.72	18°	6.12	0.024	1.96	6.24
9	0.0057	0.71	16°	6.04	0.024	1.49	5.50
6	0.0038	0.70	13°	5.95	0.024	1.01	4.22
3	0.0019	0.69	9°	5.87	0.023	0.51	2.47

DIRECTION 2 : H_o = 9.8 ft, T_s = 7.2 sec, α_o = 0°, S^* = 4

d_{SWL} (ft)	d/gT_s^2	K_R	α	H_o'	H_o'/L_o	d_{SWL}/H_o'	H_s (FT)
18	0.0108	0.94	0°-1°	9.21	0.035	1.95	8.93
15	0.0090	0.918	0°-1°	9.00	0.034	1.67	8.19
12	0.0072	0.916	0°-1°	8.98	0.034	1.34	7.36
9	0.0054	0.912	0°-1°	8.94	0.034	0.99	5.63
6	0.0036	0.907	0°-1°	8.89	0.033	0.67	4.18
3	0.0018	0.90	0°-1°	8.82	0.033	0.34	2.65

DIRECTION 3 : WILL NOT BE CONSIDERED DUE TO THE SHADOWING EFFECT OF THE LORAIN HARBOR NAVIGATION STRUCTURES ON INCOMING WAVES WEST OF NORTH-WEST ON THE LENGTH OF SHORELINE UNDER CONSIDERATION

NOTES: 1) S^* = DIRECTIONAL SPREADING COEFFICIENT = 4 FOR WIND DRIVEN WAVES
2) THIS METHOD NEGLECTS BOTTOM FRICTION
3) BOTTOM SLOPE m = 1/100 for d > 6 ft. m = 1/50 for d > 3 < 9 ft
4) $H_o' = K_R H_o$; $H_o'/L_o = H_o'/5.12 T_s^2$

FOR RAY N2 $m = 1/35$
DIRECTION 2 $H_o = 9.8'$ $H_o' = 8.8'$
FIND SW FROM SLOPE = $1/50$ $H_o'/L_o = 0.04$
FROM FIGURE 1-19 $S_w/H_o' = 0.075$ $S_w = 0.66'$
FOR $m = 1/35$ USE INTERPOLATION
$S_w/H_o' = \frac{0.075 + .0085}{2} = 0.080$ $S_w = 0.70'$ MAX.

FOR RAY NE1 $m = 1/50$
DIRECTION 1 $H_o = 8.5'$ $H_o' = 6.1'$ in 12 ft water
ASSUMING SLOPE = $1/50$ $H_o'/L_o' = 0.024$ say 0.020
FROM FIGURE 1-20 $S_w/H_o' = 0.032$ $S_w = 0.20'$ MAX
FOR $d/H_o' = 1.96$ IN 12 FT WATER

FOR RAY NE2 $m = 1/50$
DIRECTION 1 $H_o = 8.5'$ $H_o' = 5.9'$ in 3 ft water
ASSUMING SLOPE = $1/50$ $H_o'/L_o' = 0.023$ say 0.020
FROM FIGURE 1-20 $S_w/H_o' = 0.092$ $S_w = 0.54'$ MAX

FOR RAY NE3 $m = 1/50$
SAME CONDITIONS AS NE2 THEREFORE $S_w = 0.54'$ MAX

SUMMARY

1) WAVE SETUP IS A PHENOMENON INVOLVING THE ACTION OF A TRAIN OF MANY WAVES OVER A SUFFICIENT PERIOD OF TIME TO ESTABLISH AN EQUILIBRIUM WATER LEVEL CONDITION (SPM SECTION 3.85). VERY HIGH WAVES ARE TOO INFREQUENT TO MAKE A SIGNIFICANT CONTRIBUTION IN ESTABLISHING WAVE SETUP.
2) THE WAVE SETUP CALCULATION IS USUALLY INCORPORATED AS PART OF THE WAVE RUNUP CALCULATION AND, AS THE ANALYSIS SHOWS HERE, WOULD BE A FRACTION OF THE ACTUAL HEIGHT THAT WAVES WILL REACH DUE TO RUNUP
3) MAXIMUM SETUP RANGE IS $S_w = 0.2$ to $.75'$ ABOVE STILL WATER LEVEL FOR A 10 YEAR R.I. STORM

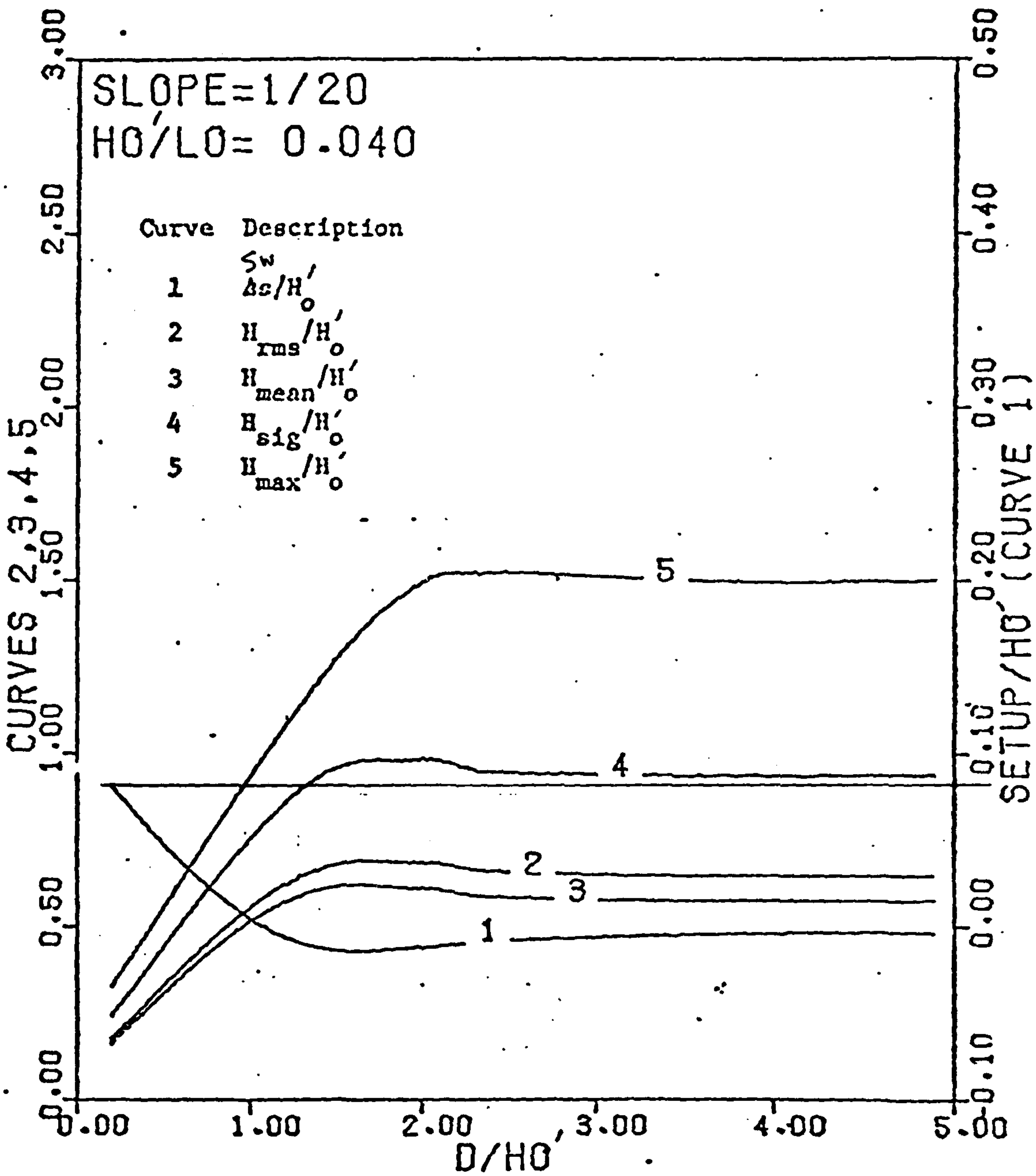
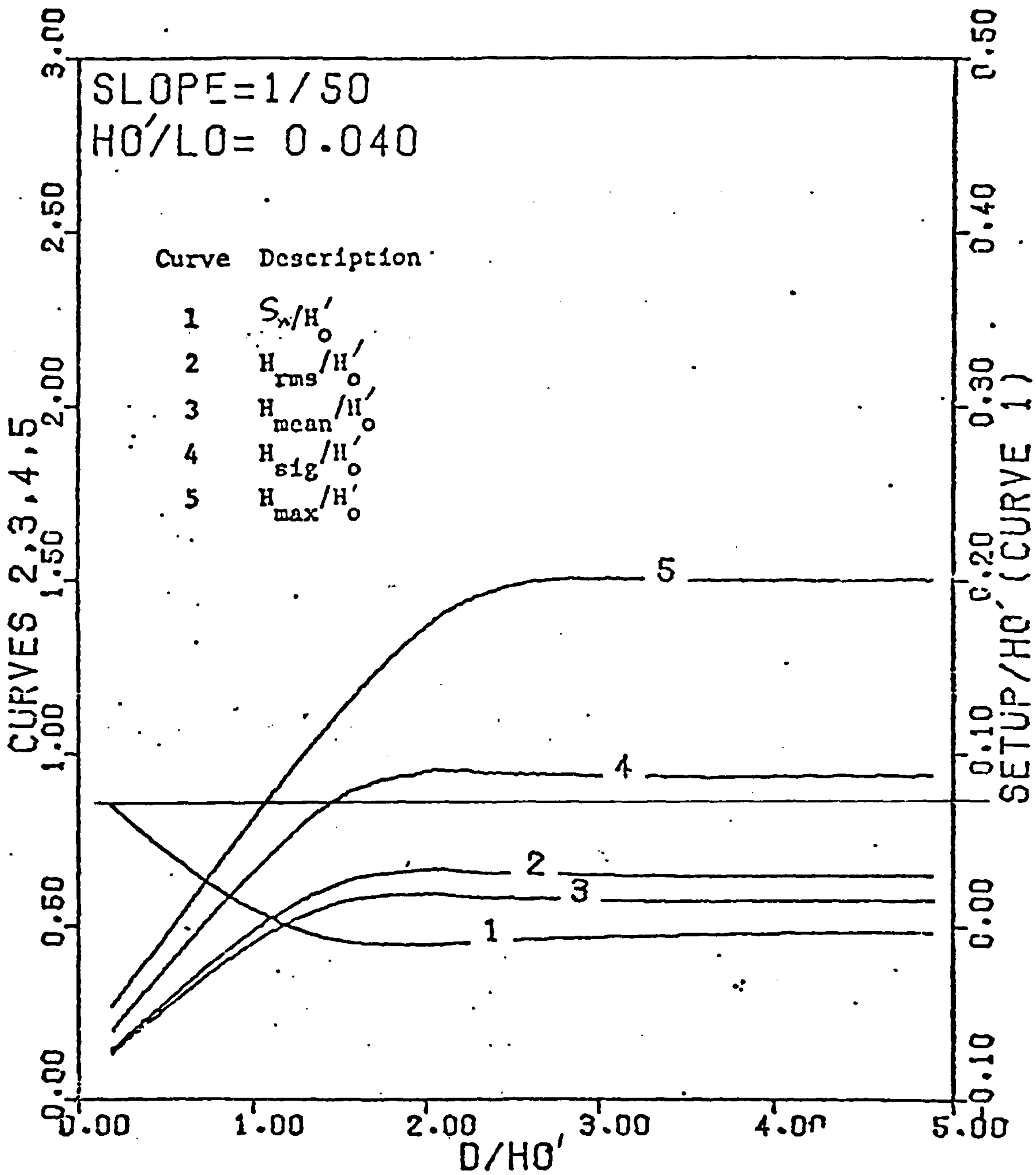
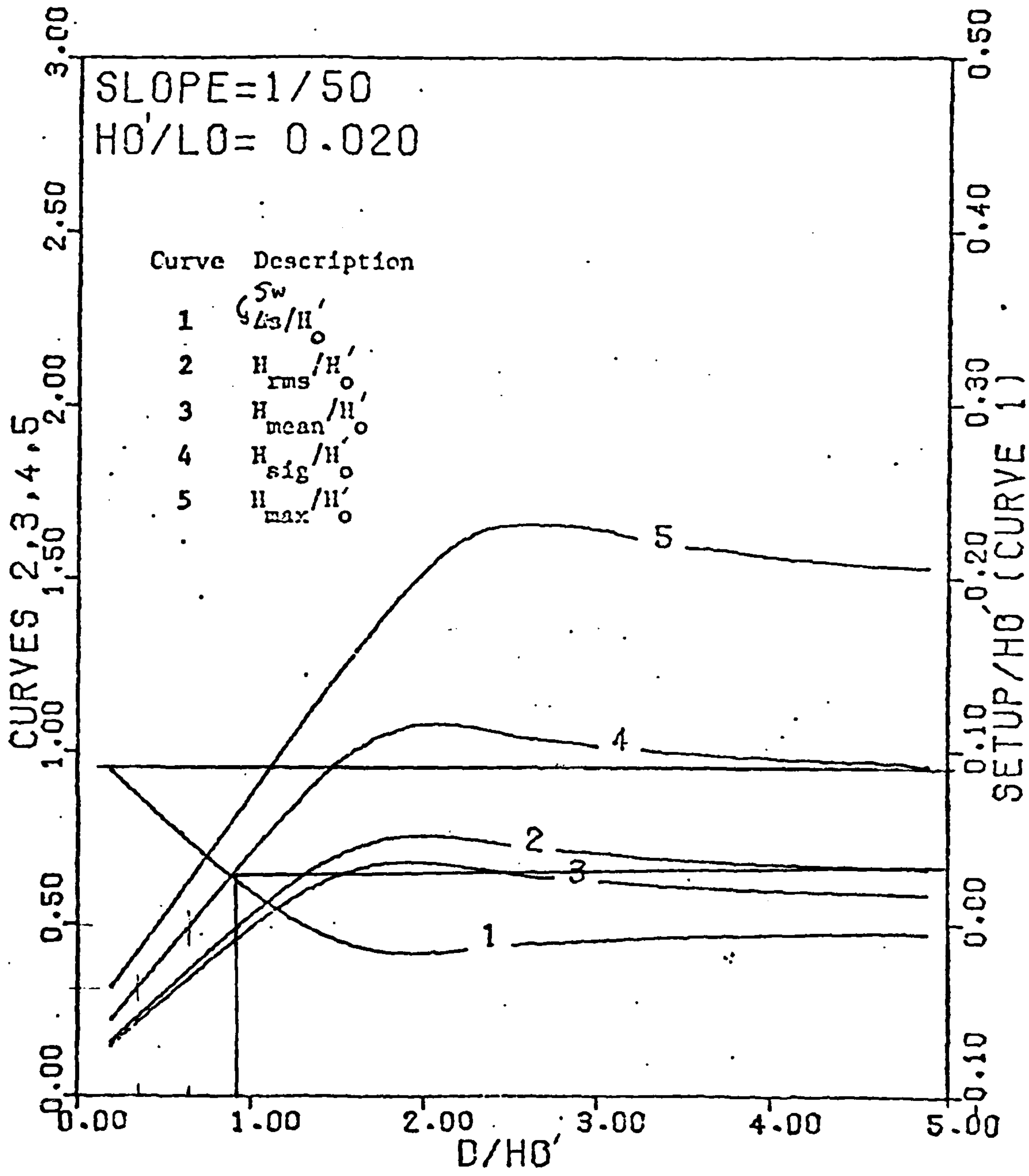

SLOPE=1/20
HO'/LO= 0.040
Curve Description
1 Δs/H'o
2 Hrms/H'o
3 Hmean/H'o
4 Hsig/H'o
5 Hmax/H'o
CURVES 2,3,4,5
0.00
0.50
1.00
1.50
2.00
2.50
3.00
SETUP/HO' (CURVE 1)
-0.10
0.00
0.10
0.20
0.30
0.40
0.50
D/HO'
0.00
1.00
2.00
3.00
4.00
5.00

Figure 1-18



SLOPE=1/50
HO′/LO= 0.040
Curve Description
1 S_x/H_o'
2 H_{rms}/H_o'
3 H_{mean}/H_o'
4 H_{sig}/H_o'
5 H_{max}/H_o'
CURVES 2,3,4,5
SETUP/HO′ (CURVE 1)
D/HO′
0.00
0.50
1.00
1.50
2.00
2.50
3.00
-0.10
0.00
0.10
0.20
0.30
0.40
0.50
1.00
2.00
3.00
4.00
5.00

Figure 1-19



SLOPE=1/50
HO'/LO= 0.020
Curve Description
1 ζ_{sw}/H_o'
2 H_{rms}/H_o'
3 H_{mean}/H_o'
4 H_{sig}/H_o'
5 H_{max}/H_o'
CURVES 2,3,4,5
SETUP/HO' (CURVE 1)
D/HO'
0.00
0.50
1.00
1.50
2.00
2.50
3.00
-0.10
0.00
0.10
0.20
0.30
0.40
0.50
1.00
2.00
3.00
4.00
5.00
1
2
3
4
5

Figure 1-20

Summary

The possible causes of erosion along the study shoreline that have been identified in the foregoing "Problem Identification" analysis were:

1. Natural wave forces
2. Lake level fluctuation
3. Refraction of incoming waves
4. Impoundment of westerly littoral drift
5. Reflection of waves off the dike or spending beach
6. Storm wave set-up in the pocket formed by the dike structure

Lake level data presented in this appendix has shown that the post-dike period has been dominated by higher than normal lake stages. The mean lake stage has been slowly dropping from the record high stages of 1973. The influence of lake level on waves impacting the shoreline is to allow higher than average waves to attack shore protective works and unprotected bluffs allowing more rapid deterioration and erosion.

In this study we have chosen a pre-dike bluff recession rate based upon the period 1937-1973. This period reflects many cycles of high and low lake levels and provides a good indication of long term average pre-dike recession rates. The period 1973-1978, just prior to dike construction, is represented by aerial photography data for bluff recession analysis. This period is dominated by the post 1973 high lake levels and, as such, is biased toward abnormally high recession rates. This biasing precluded the use of this data as representative of long term conditions in favor of the ODNR 1937 to 1973 data.

The post-dike period represented by 1978-1980 aerial photography data is also a period of higher than average lake levels. Data limitations prevent the analysis of a post-dike rate based upon average (high and low) lake level conditions. This influence of high lake levels on the post dike erosion rate cannot be separated from other influences without longer term data therefore the post-dike rate should be considered a "worst case" estimate of recession.

Refraction influences the post-dike erosion rate by focusing wave energy on sections of the shoreline bringing protective structures and bluff under increased wave attack. Under ordinary circumstances this would have no impact on the pre vs post dike recession rates because the offshore rise which causes the refraction is a non-dike induced phenomenon. But, during the post-dike high lake level period, wave focusing has a pronounced effect on structure and bluff degredation.

The analysis of wave shielding by the dike disposal structure provides the cause for impoundment of eroded littoral material adjacent to the spending beach revetment. Based upon hydrographic survey comparisons, the quantity of material impounded was estimated as 5400 cubic yards per year since dike construction. Some amount of this material would have been available for redistribution to updrift (easterly) shores when waves approach from the northwest.

This analysis again assumes a "worst case" condition that all material impounded would have been available for updrift transport if the dike were nonexistant.

For a stretch of shoreline already deficient in littoral material the additional loss of this 5400 yd^3/yr is severe. The small trapped beaches which normally help protect the bluff and private structures are being transported to the west to form a fillet adjacent to the spending beach. This material is not available for transport reversal. The zones of accretion and erosion defined by the hydrographic survey comparisons agree favorably with a similar analysis made of historical beach distribution from aerial survey comparisons.

Reflection and storm wave set-up have been discounted as having negligible effects on shoreline erosion in the study area.

A comparison of pre and post-dike bluff recession rates per shoreline increments is presented in the following table.

Shoreline Increments*	1937-1973 Pre-Dike Rate	1978-1980 Post-Dike Rate
0 to 50	0.4 ft/yr	0.0 ft/yr
50 to 450	1.2	0.0
450 to 950	1.2	0.2
950 to 1950	0.8	1.5
1950 to 2350	0.7	2.9
2350 to 2500	0.0	1.1

*Refers to distance in feet east of the Colorado Avenue centerline measured along the north side of Erie Avenue.

Although the magnitudes of the above post-dike recession rates should be questioned because of the high lake level and refraction effects on wave activity, the fact remains that the area adjacent to the dike is sustaining reduced bluff recession when compared to pre-dike levels and the area east of station 9+50 is suffering higher recession rates when compared to pre-dike levels. These changes are consistent with the findings of the hydrographic survey comparison that the nearshore zone is accreting in the area adjacent to the dike to station 8+00 and eroding from station 8+00 to 24+00.

In the area between station 24+00 to 25+00, bottom soundings data indicates an accretion in the offshore profile. However, bluff recession data indicates that the shoreline is eroding. A possible explanation for this discrepancy is the recent failure of structure #210, a seawall at station 25+00, which was considered to be in fair condition in 1973. This failure would show up as recession in the bluff analysis while the slumped material would show up as an accretion on the profile comparisons.

Even is these recession levels are inaccurate, the plots of pre and post-dike recession rates as a function of distance suggest that erosion has been transferred easterly due to the dike. This redistribution constitutes the negative impact of the dike on the study shoreline.

The difference between the pre and post-dike rates represents a "worst case" estimate of the effects of the dike disposal structure on the study shoreline. The influence of high lake levels and failing private protective structures could not be quantified for the short post-dike period and therefore the increased recession rate has been attributed solely to the federal navigation works as an estimate of the upper limit of federal responsibility. A weighted average recession rate comparison for the 2500 ft of study shoreline reveals that the post-dike average of 1.1 ft/yr is not significantly greater than the pre-dike average of 0.8 ft/yr considering the inaccuracies of aerial photography bluff recession data.

The bluff recession data alone would not be sufficient proof that the federal navigation works had negatively influenced the study shoreline. As has been previously mentioned, high lake levels and failing private protective structures may be the major influence in higher post dike recession levels.

However, the existence of dike impoundment of westerly littoral drift provided by bathymetric survey comparisons is positive proof that the dike disposal structure has had a detrimental effect on updrift shoreline. The magnitude of this effect remains elusive due to the short two year period over which post-dike effects could be studied.

It is for this reason that a "worst case" approach to the solution has been adopted here.

APPENDIX 2

DESCRIPTION OF ALTERNATIVE PLANS

APPENDIX 2

DESCRIPTION OF ALTERNATIVE PLANS

TABLE OF CONTENTS

INTRODUCTION

The alternative plans considered in this study cover the range of possible coastal engineering solutions for shoreline erosion problems: offshore breakwaters, groins, revetment and beach fill. An additional alternative of acquisition/evacuation of affected properties was also studied as a non-structural solution to the shoreline erosion problem. An "no-action" alternative is also carried thru the planning process to provide a base case for comparison with other alternatives.

ALTERNATIVE PLANS CONSIDERED

Seven alternatives were originally studied as solutions to shoreline erosion east of the dike disposal structure. They are:

I No Action
II Land Acquisition
III Feeder Beach
IV Groin System with Fill
V Revetment
VI Offshore Segmented Breakwaters with Fill
VII Single Long Groin with Shore Restoration

PLANS ELIMINATED FROM FURTHER STUDY

Of the seven preliminary alternatives, including no-action, only two were eliminated from further study. These two were the offshore segmented breakwater and the single long groin with shore restoration.

The offshore segmented breakwaters were excluded largely on the basis of excessive costs incurred to duplicate the effectiveness of protection available from other structural alternatives. The revetment plan, for instance, would be much more effective in protecting the bluff against erosion than an offshore breakwaters with fill plan.

The single long groin concept was rejected because its effect would be to reinstate conditions similar to those when only the east breakwater shorearm was influencing the shoreline to the east. This, of course, would not solve the erosion problem and it would be a much more costly alternative than the non structural feeder beach plan which accomplishes the same purpose of mitigating only dike attributable erosion.

WITHOUT CONDITIONS

The Without or No Action alternative is the baseline against which other alternative will be measured to determene their effectiveness in preventing the damages which would occur over the 50 year project life if no mitigation occurs. The monetary value of these damages are quantified in the damages section of Appendix 5.

The types of damages which will occur as a result of the post dike recession rate stipulated in the Problem Identification Appendix are:

1. private property lost due to bluff recession;
2. private dwellings and structures lost due to bluff recession; and
3. additional expenditures by private property owners to protect their property because of an increase in the rate of failure of private protective structures.

The nature of the No Action Plan is to allow bluff recession and erosion to continue at the post dike recession rate. This will effect the shoreline over the entire length studied because accretion is occurring in the first 800 ft. of shoreline, while erosion dominates over the remaining 1600 ft. The damaged portion of shoreline, however, extends only over the actively eroding area from Station 8 +00 to Station 24 +00.

The economic impact of this plan is adverse in that an estimated $22,500 will be lost annually in the three damage types identified: land loss, structural loss and increased cost of protective structures.

This loss is a result of the higher post dike recession rates occurring in the eroding area. In the accreting area from 0 to 800 ft east of the dike spending beach there is a net benefit of $8050 annually because post dike recession rates are lower than pre-dike rates in this area. (See damage calculation in Appendix 5)

Since there is no plan, no recreational or intangible benefits accrue and there will be no impact on employment potential. The safety of people and property remain in jeopardy because the bluff continues to erode unchecked.

There is virtually no impact on environmental quality, regional development, or social well-being other than the gradual loss of structures in the study zone and an attendant gradual loss of tax revenues as property values decline and structures are removed.

The plan contributes nothing to the planning objectives per provisions of Section 111 and would be considered unacceptable as an option for consideration by residents in the study area.

PLANS CONSIDERED IN DETAIL

Alternative II - Land Acquisition

This alternative is put forth as a non-structural option to the traditional coastal engineering solutions to shoreline erosion problems. It is actually not a solution to shore erosion at all since the plan requires that the affected parties be evacuated rather than protected. The plan requires for implementation that all parcels (property and structure) that are adjacent to the bluff in the eroding zone from 800 to 2400 ft east of Colorado Avenue must be purchased at fair market value. This would amount to the purchase of 26 parcels and the evacuation of 27 families in the 1600 feet of affected shoreline.

Public Law 91-646, the Uniform Relocation Assistance and Real Property Acquisition Act of 1970 also requires that the affected parties be paid "actual reasonable expenses in moving" and an additional payment not to exceed $15,000 for displaced person to include such items as:

1. increased interest costs required when financing the acquisition of a comparable replacement dwelling. (The increased interest cost shall only be computed on a new mortgage amount not exceeding the mortgage balance on the acquired dwelling).
2. the difference between the acquisition cost paid to the displaced person and the reasonable cost of acquiring a comparable replacement dwelling.
3. reasonable expenses incurred as closing costs.

Assuming these parcels are acquired in an orderly fashion the structures thereon must be razed and the land cleared. In addition, utility service into and out of the affected area must be relocated if necessary to provide continued service at other locations. This will create an open space adjacent to the bluff from approximately 800 to 2400 ft east of Colorado Avenue. This open space could possibly be used for recreational purposes, but this is not assumed as a benefit in this plan because this would be a self-liquiding benefit.

The evacuation of these properties will involve abandonment of shore protective works as well. Without maintenance these structures will eventually deteriorate to a point where no protection will exist for this stretch of shoreline. This will undoubtedly result in an accelerated recession of this shoreline even greater than that now exhibited as post dike conditions. It is impossible to predict how this situation will affect those properties adjacent to the abandoned zone, but most likely the area 0 to 800 ft east of the revetment spending beach will accrete even faster when it receives the increased sediment load from the eroding shore. East of station 24 + 00 the existing structures may fail as they are flanked by an eroding unprotected bluff.

A benefit assumed from this alternative is the savings to private property owners on private shore protective structures that they no longer need build. This amounts to a savings of $17,900 annually. An intangible benefit to this plan would be alleviation from future concern about property erosion for evacuated homeowners. There is also increased safety in the affected area because structures are removed before sudden accidental losses could occur.

Acquisition has no impact on marine environmental quality because no activity from the plan occurs below the bluff. There would be a regional development impact in that homes razed no longer contribute tax revenues.

In the social well-being area the plan could have a positive impact if potential park land is created for the public good. A negative impact to the area will be the loss of 27 private dwellings.

The plan's end result does meet and actually exceeds the objectives under the Section 111 provisions. The plan is technically feasible and could be implemented given the acceptance necessary from both Corps' higher authority and local interests.

The Land Acquisition Plan removes the endangered residents from the eroding area and therefore exceeds the maximum federal responsibility under Section 111. As such, costs of this alternative must be shared between local interests and the federal government. The maximum federal financial responsibility is limited by law to only those costs to mitigate erosion attributable to the federal navigation works. The remaining costs must be assumed by non-federal interests such as at the state or local level. The cost apportionment is based upon maximum federal contributions toward the feeder beach plan - alternative III.

The first cost of this plan was estimated to be $2,173,500 with no recurrent annual costs. If this plan were adopted, the federal government would contribute $1,021,600 toward this first cost subject to Congressional authorization (for sums over one million dollars). This contribution represents the present worth of the feeder beach plan. If the plan first cost is amortized over the 50 year project life at 7 1/8% interest the annualized cost would be $160,000. Annualized benefits amount to $17,900 and the benefit to cost ratio is 0.11.

A Relocation Plan was considered as an alternative very similar to the Land Acquisition Plan but this plan was rejected at an early stage in the study. This plan called for Federal relocation of residents in the damaged area as an alternative to structural modification of the shore and bluffline. This possibly meant either relocating only the family or the entire structure. But, at an early stage, a determination was made that ample housing existed within the Lorain area with purchase prices and socioeconomic characteristics similar to those in the study area. Federal policy (see Public Law P.L. 91-646, Section 206) prohibits any type of relocation (except physical movement of the structure) when these types of purchase options are available to homeowners who receive fair compensation for evacuating their property. The possibility of physically relocating the houses is precluded by lack of available land and, often, the age and condition of the structure.

Alternative III-Feeder Beach Plan

This alternative satisfies the objective of mitigating only the erosion attributable to the dike disposal structure. The nature of the plan is to put back in the shore zone a quantity of sand equal to that impounded behind the dike structure on a periodic basis. In effect this provides the reversal of littoral drift that nature cannot provide because of the shielding by the dike of waves approaching from western quadrants.

Implementation of the plan would require a first time placement of 18,500 yd^3 of fill to restore an essentially stable shoreline condition similar to that which occurred prior to dike construction. This first placement would be deposited in 3 segments along the affected shoreline at the street ends of Georgia and Idaho Streets, and at approximate station 22+40 where an easement on private property would have to be acquired for access and construction purposes.

Periodically after this first placement additional quantities of fill would be necessary to replace that amount eroded by the waves and impounded behind the spending beach revetment. An estimate of this quantity would be approximately 5400 yd^3 per year since this is the quantity presently estimated as eroding from the effected shoreline. The actual quantity would be estimated by an annual inspection of the site prior to ordering nourishment materials. These inspections may determine that the periodic nourishment is much less than 5400 yd^3

as this quantity was established during a period of high lake levels when erosion is most severe. Each fill placement would cover an area approximately 160 x 200 feet on the lake bottom adjacent to the bluff and the placement is estimated to take about a month to complete.

Benefits accrue in this plan because of a reduction in the bluff recession from the post dike to the pre dike rate. This is accomplished by the addition of a protective beach fronting the bluff formed when the feeder beaches are dispersed by natural wave energy. An annual benefit of $22,500 is estimated in reduced loss of private property, residential structures and shore protective structures as a result of plan implementation.

No benefit is claimed for recreational use of the feeder beach because the fill would be barely above the water line and the beach would be dispersed by wave activity not long after placement. There is a small intangible benefit of aesthetic improvement of the beach as the dispersed fill begins to take hold and build out a beach years frc now.

During the short construction period and each year hence, there will be a slight economic advantage from increased employment due to plan activities. There will be no increase in safety in the bluff area because it will continue to erode but at the pre dike rate.

Impacts on environmental quality caused by this plan will be short-term turbidity and periodic burial of benthic organisms during the placement of the fill. These are minor effects and they are reversible.

During the construction phase of this alternative there will be minor but periodic annoyance to local residents from the noise of trucks and equipment. This effect will be very localized.

From a social well-being and regional development aspect, the impact will be a gradual loss of dwellings in the study area.

The plan, as specified, satisfies the planning objective of mitigating only that erosion attributable to the dike disposal structure. The plan is technically feasible but its effectiveness is only on the order of 30 to 50% in curtailing total erosion along the study shoreline. This level of effectiveness is unacceptable to the Corps of Engineers as the plan would not significantly affect the total erosion problem that the residents of the area are experiencing. Even with the reduction in bluff recession rate, an estimated 13 homes will be lost and about 1.4 acres of private property eroded over the 50 year period of study.

The environment effects of the plan are to periodically bury benthic habitat in the area of fill placement. This area amounts to about 2 acres during the first placement and about ½ acre in the periodic placements. The distribution of fill material by wave forces is a natural littoral process and should have no lasting effect on the environment. Besides the marine habitat alteration,terrestrial habitat will be continually lost at the average pre dike recession rate of 0.8 ft/yr (weighted average for entire 2500 ft of shoreline).

Since the Feeder Beach Plan mitigates only the erosion attributable to the dike disposal structure it is eligible for 100% federal funding. This makes alternative III the base case for financial comparisons since it represents

AD-A120 366 CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT F/G 13/2
DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT. SECTION 1--ETC(U)
NOV 81

UNCLASSIFIED NL

3 OF 4
AD A
120366

the maximum federal financial responsibility for this study. The first cost of this plan, including the 18,500 yd^3 of fill and easements of access, was estimated at $287,800. Annualized costs, which include amortization of first cost, the periodic placement of 5400 yd^3 of fill and inspection costs, was calculated to be $75,200. Compared to an annualized benefit of $22,500, the benefit/cost ratio for this plan comes to 0.30.

Alternative IV Groin System with Fill

This alternative is one of two considered which provides protection against natural erosion as well as the aggravated erosion caused by the dike disposal structure. The principal features of this alternative are the four 270 foot long groins spaced at 500 foot intervals along the affected shoreline. These groins are located at stations 5+00, 10+00, 15+00 and 20+00 which also represents their distances east of the Colorado Avenue center line. The groins are constructed of the standard 3 layers of quarrystone rubble and the top elevation of each groin slopes from +12 (L.W.D.) at the bluffline to +8(L.W.D.) at the roundhead. A steel sheet pile diaphram would be included along the groin centerline to prevent sand transport through the groin armor layer from compartment to compartment. The compartments between each groin are filled with 9630 yd^3 of beach fill in a manner that will provide a 25 foot wide beach at M.L.S. on the updrift end of the fill and 87.5 wide fill at M.L.S. on the downdrift end. This placement mimics the assumed equilibrium profile that the fill will adjust to with incoming wave incidence, thereby facilitating the minimum re-adjustment of fill after construction. The elevation of fill slopes from +4.0ft in the lee of the updrift groin to +8.0ft (L.W.D) adjacent to the downdrift groin.

In order to maintain this protective beach, periodic nourishment will be necessary as no groin field is 100% effective in trapping and maintaining sand. The actual efficiency of the groins would have to be determined by a yearly inspection of fill quantity maintained. For the purposes of this study, it was assumed that the groin field is 50% effective. Therefore a periodic nourishment program is needed as part of this plan. The quantity of nourishment is estimated to be 2700 yd^3 per year as this is 50% of the estimated quantity which erodes in this stretch of shoreline and is impounded behind the revetment spending beach assuming the "worst case" condition that all impounded material is caused by dike entrapment.

There are no recreational benefits associated with this plan because the beach fill is not at a sufficiently high elevation to support recreational bathing activity. There is the possibility however of using the groins as fishing piers but this incidential benefit has not been considered here.

Access to the site during construction would be provided at six points along the study area. Three of these accesses are on public property at the foot of Colorado, Georgia, and Idaho Avenues. The three remaining accesses would be easements on private property at approximately stations 4+20, 8+90 and 22+40. The construction equipment and sequence will probably require ramps down to the beach from the bluff at many of these accesses. Some of these will have to be returned to their original state as part of the project sequence while others will be maintained for beach nourishment purposes.

The implementation of this plan assumes partial protection for the area fronted by the groins and beach fill from station 5+00 to 25+00. The area 0 to 5+00 is assumed to be a compartment formed by the dike spending beach and the groin at station 5+00. The accreted fill contained from 0 to 5+00 should be adequate to maintain a protective beach fronting the bluff in this zone.

Since this alternative partially protects the shoreline against future erosion, only a portion of the full benefit can be claimed due to damages prevented. The value of this benefit is estimated to be $29,850 annually in losses prevented to property, structures and private protective structures.

Intangible benefits accrue as a result of the implementation of this plan by alleviating concern against property or structural loss for residents in the protected area; possible enhancement of property values due to a stabilized bluffline, and aesthetic improvement of the beach due to the creation of compartmented fill.

Other economic benefits which may result if the plan is implemented are the temporary creation of employment opportunities during the construction phase of this plan and the increased safety of having all structures in the eroding zone fully protected against accidental loss.

The environmental effects of plan implementation are to bury 2 acres of marine habitat under the groins and 10 acres under the beach fill. On the other hand, habitat is created by the rocky nature of the groins and the clean fill may stimulate new growth not now occuring on the moderately polluted bottom. No terrestrial habitat is lost and perhaps the groins may create a habitat suitable for gulls and shorebirds.

The effects of the plan on social well-being of the area are to temporarily increase employment during the construction phase. However, the residents will experience noise and nuisance from construction activity in the area. Housing is preserved in the affected area which will also mean increased tax revenues due to the higher property value of the preserved property.

This plan exceeds the objectives of mitigation of only dike induced erosion. The plan is estimated to be 70% effective in curtailing natural erosion along the study shoreline. This is due in part to the low elevation of the placed fill and partly to the limited effectiveness of groins in maintaining the trapped sand in its compartment. With the addition of a periodic sand nourishment feature this effectiveness should improve.

Financial responsibility for the implementation of this plan is based upon the maximum Federal responsibility to mitigate only erosion attributable to the dike disposal structure. Since alternative plan III accomplishes this goal, the financial responsibility of the Federal government will be limited to the maximum Federal financial responsibility from alternative plan III. Accordingly, the breakdown of financial responsibility for this groin and beach fill plan is: $287,800 federal portion of first cost, $1,956,100 local portion of first cost, $2,243,900 total first cost; $75,200 federal portion of annualized costs, $153,200 local portion of annualized costs, $228,400 total annualized costs which include interest and amortization of first cost. When the total annualized cost of $228,400 is compared to the annualized benefit of $29,850 the benefit/cost ratio is 0.13.

Alternative V Revetment

This is another alternative which provides protection against natural erosion as well as the aggravated erosion caused by the dike disposal structure. The principal feature of this alternative is a 2000 ft. long rubble mound revetment extending from 500 to 2500 feet east of Colorado Avenue. The revetment is of standard three layer design. Its crest is 6ft wide at an elevation of +14.0 ft. above L.W.D. to prevent runup which might be injurious to the bluff face. A synthetic filter cloth is provided to prevent bluff sediments from eroding through the revetment voids. The revetment, where possible, will incorporate existing structures as part of its core, effectively covering over these structures with a uniform structural protective extending from the defined accretion zone through and past the eroding zone of shoreline. Some existing derelict structures may have to be removed if they interfere with the 3 layer construction of the revetment. The toe of the revetment extends approximately 50 feet offshore to about 3 foot depth contour with respect to low water datum.

During the construction phase access will be necessary from all six sites mentioned under alternative IV: 3 public and 3 private. The exception in this plan is that access ramps down to the beach from the bluff may only be necessary at the Colorado Avenue site and at station 22+40. The four other sites will be used to deliver construction materials but not for access or egress of equipment.

The implementation of this plan will totally protect the area fronted by the revetment between 500 to 2500 ft east of Colorado Avenue. The area 0 to 500 is assumed to be protected sufficiently by the accretion fillet so as not to require the extension of the revetment to Colorado Avenue.

Since this alternative protects the shoreline against any future erosion, the full benefit of all damages prevented at the post dike recession rate can be assumed. This benefit is estimated to be $33,000 annually in losses prevented to property, structures and private protective structures.

Intangible benefits accrue as a result of the implementation of this plan by alleviating concern against property or structural loss for residents in the protected area, possible enhancement of property values due to a stabilized bluffline, and aesthetic improvement of the bluff face as viewed from the lake. A possible recreational benefit may be realized if the revetment is used as a fishing pier by the local residents.

Other economic benefits which may result if the plan is implemented are the temporary creation of employment opportunities during the construction phase of the plan and the increased safety of having all structures in the eroding zone fully protected against accidental loss.

The environmental effects of plan implementation are that 2.5 acres of marine habitat will be buried under the revetment. This may be partially offset by the rocky habitat created by the existence of the revetment. The terrestrial habitat is preserved because the bluff is permanently armored against retreat. The revetment may provide a habitat suitable for use by gulls and shorebirds.

The effects of the plan on social well-being of the area are to temporarily increase employment during the construction phase which will be offset by the noise and nuisance of construction activity in the area. Housing is preserved in the area which will also mean increased tax revenues due to the higher property value of the preserved property.

This plan exceeds the objectives of mitigation of only dike attributable erosion. It is technically feasible and its effectiveness is considered to be 100 percent in stopping natural and dike induced erosion along the study shoreline.

Financial responsibility for the implementation of this plan is based upon the maximum Federal responsibility to mitigate only erosion attributable to the dike disposal structure. Again, the maximum Federal responsibility would be governed by the minimum expenditures to achieve this objective, which is achieved by Alternative III. The Federal expenditures in alternative III then become the maximum Federal responsibility for cost sharing purposes.

Accordingly, the breakdown of financial responsibility for the revetment plan is: $287,800 federal portion of first cost, $1,508,200 local portion of first cost, $1,796,000 total first cost; $75,200 federal portion of annualized cost, $86,700 local portion of annualized cost, $161,900 total annualized cost which includes interest and amortization of first cost. When the total annualized cost of $161,900 is compared to the annualized benefit of $33,000 the benefit/cost ratio is 0.20.

APPENDIX 3

PUBLIC VIEWS AND RESPONSES

APPENDIX 3

PUBLIC VIEWS AND RESPONSES

TABLE OF CONTENTS

THE PUBLIC COORDINATION PROGRAM

A thorough effort toward public involvement on this Section 111 study was instituted in both the reconnaissance stage and the combined plan formulation and detailed design stage. Telephone contacts, letters, a public workshop, and a public meeting were utilized to gain public input during the preparation of this draft report. A listing of contacted agencies follows:

(a) Federal:
1. U.S. Fish and Wildlife Service
2. National Marine Fisheries Service
3. Environmental Protection Agency
4. U. S. Geological Survey

(b) State:
1. Ohio State Clearinghouse
2. Department of Natural Resources
   a. Division of Fish and Wildlife
   b. Division of Geological Survey
   c. Coastal Zone Management Office
3. Ohio Historical Society
4. Ohio Environmental Protection Agency
5. Ohio Department of Economic & Community Development

(c) Regional:
1. Northeast Ohio Areawide Coordinating Agency
2. Lake Erie Watershed Conservation Foundation

(d) Lorain County:
1. Lorain County Regional Planning Commission

(e) City of Lorain:
1. Engineering Department
2. Mayor's Office
3. Recreation Department
4. Port Authority

VIEWS OF NON-FEDERAL INTERESTS

Official agency response to the Section 111 study is not expected until after review of this draft report. However, some agencies have made comments by telephone or letter based upon data developed during preparation of the draft report. Copies of pertinent letter responses have been included in the correspondence section of this appendix.

The city of Lorain has expressed great concern that the Buffalo District Corps of Engineers expend all appropriate efforts to aid in erosion control measures easteri of the diked disposal area. To this end, the Corps instituted this study under Section 111 authority in respon to a July 19, 1979 letter from former Mayor Joseph Zahorec.

Recently, in a September 15, 1980 letter to the Buffalo District from present Mayor William E. Parker, the City of Lorain has pledged to cooperate and assist in combating the shore erosion problem. However, the city would not pledge support in any cost sharing alternatives with the Federal government as this would be an illegal use of public funds for private uses.

The Lorain County Regional Planning Commission expects the study to have no effect on any current regional plans.

The Lorain Port Authority is aware of the claims of increased erosion east of the dike disposal area structures. However, the authority also recognizes the critical importance of the diked disposal structure on the maintenance of the commercial harbor and therefore on the economy of the City of Lorain. To maintain commercial interests at Lorain, the entrance channel and harbor complex must be periodically dredged and the spoil disposed of. The dike disposal area was constructed to contain this dredge spoil in compliance with national environmental policies.

The Ohio Environmental Protection Agency's initial reaction to the alternatives presented in this study is that the agency does not expect significant adverse effects on water quality or the physical environment as a result of implementation of any of the alternatives presented. The use of clean, approved construction materials to preserve water quality during and after construction was emphasized.

Residents in the study area are convinced that the dike disposal structure is causing most, if not all, of their erosion problems. They attribute the failure of private shore protective works fronting their homes to the presence of the dike and point out that since the dike was built beaches fronting their property have disappeared.

The residents feel that the federal government should repair or replace the damage caused by the dike structure and remedy the erosional trend. Upon learning at the September 17, 1980 public meeting that the Corps of Engineers, Buffalo District was recommending no action in their case, the residents were angry and feel abandoned by their federal and local governments. They realized that the support they felt they deserved and needed would not be forthcoming and yet their property continues to erode.

REVIEW OF FEDERAL AGENCIES

Review of the study by Federal agencies will not be completed until after distribution of this draft report. Preliminary coordination efforts have revealed that no Federal agency has substantial negative concerns relative to environmental impacts or functional aspects of study alternatives.

PUBLIC MEETING SUMMARY

A public meeting on the U.S. Army Corps of Engineers (COE) study of the effects of the diked disposal area(DDA) on shoreline erosion was held at 7:30p.m. on September 17, 1980 in the City Council Chambers, Lorain City Hall. In attendance were about 30 people including Buffalo District and Chicago Division-Corps of Engineers personnel, representatives of Tetra Tech, Inc., officials of the State of Ohio and City of Lorain, the Mayor of Lorain, a representative of Congressman Pease, and the general public.

A Corps of Engineers presentation was made on the history of the DDA and related Corps of Engineer activities. Included in the presentation were material on the nature of the problem, alternatives considered by the COE to mitigate the problem, costs of various mitigation options, and tentative study recommendations. An explanation was made of COE policy on mitigation costs and the limits to COE authority and financial resources imposed by law. The Buffalo District indicated that based upon previous studies and the present draft detailed project report, little evidence suggesting increased shoreline erosion resulting from the presence of the DDA was found. The District's federal financial responsibility could be considered to be $287,000 or less, since this amount was sufficient to cover a sand replenishment option. However, such a plan would be ineffectual toward halting long term erosion. Other options were presented as being too costly, ineffective, or requiring state/local financial committments. District contacts with state/local officials indicated that cost sharing funds would not be available. Based upon these facts, the District's tentative recommendation is that no action by the COE be undertaken to mitigate shoreline erosion east of the DDA. Tentative recommendations are subject to change by the District or by higher COE authority.

A period of questions, answers and comments followed the presentation. Generally, the tone of public comments were that the COE was in error about impacts of the DDA on shoreline erosion and that the amount of federal financial responsibility was too low. Charges were made that the Corps caused the problem and is now unwilling to act to mitigate the situation. Some persons, in the minority, indicated that they understood both the need for the DDA in providing port improvements and the COE's position with respect to its statutory limits.

After observing that no additional comments or questions were pending, the meeting was adjourned. The District stated that transcript copies of the public meeting would be available on request and that a fact sheet concerning the main points of the Section 111 study would be sent to all in attendance. Attendees were thanked for their participation.

PUBLIC WORKSHOP SUMMARY

The information workshop was conducted on 31 March 1980 from 7:30p.m. - 10:30p.m. in Lorain City Council Chambers. The workshop consisted of a presentation of the findings of a Corps Reconnaissance Report and a presentation of Corps future study plans. Afterwards, a question and answer session regarding the information that was presented was held.

Highlights of the Presentation

Information was presented about the findings and conclusions of the Reconnaissance Report on Shores East of Diked Disposal Area, Lorain, Ohio which was basically contained in a handout presented at the meeting and presented in the Appendix to this memorandum. The report concluded that shore erosion east of the diked disposal structures had not been caused by them. However, the diked disposal structures had impounded westerly-moving littoral drift due to shielding of wave energy from the northwest through west-northwest directions. Thus, there has been reduced reversal of the movement of the impounded sand back in an eastward direction which has contributed to the erosion problem.

The presentation continued with details given about possible alternatives to mitigate the impact of entrapped sand, which amounted to approximately 3,700 cubic yards annually. The alternatives included a feeder-beach plan, a beach and groin plan, and a revetment plan. Specifics of the plans were contained in the handout. Of the alternatives, only the feeder-beach plan could be pursued without local cost-sharing and it would not stop shore erosion, but only mitigate damages associated with the dike structures. The beach and groin and revetment alternatives would involve considerable local expense. However, they would mitigate damages associated with the dike structures and would protect properties against natural erosion in the historically receding shore area. It was stressed that the amount contributed by the Federal government would only be equivalent to that necessary to mitigate impacts of the structures. This amount, based on the preliminary analysis, came to $37,000 annually; an amount necessary to mitigate the impacts of 3,700 cubic yards of sand being entrapped by the structures.

Based on the finding that the diked disposal structures did not cause the erosion, but did contribute to the problem, a proposed future study schedule was presented. The future study effort will result in a draft Detailed Project Report scheduled for public review in late August. That effort will concentrate on identifying more completely the impact of the structures on the erosion process and determining alternatives that would mitigate damages associated with the structures.

Question and Answer Session

The following covers pertinent questions and corresponding Corps answers to those questions regarding information related to the study. The questions and answers were paraphased from tapes of the workshop.

Question: Is the Federal share only $37,000 annually for any alternative?

Answer: Yes. This is how that was determined. First, what impact the structures were causing was determined. This was the prevention of impounded sediments from returning back eastward. The total amount of sand impounded since the structures were built was determined irregardless of whether all or part of that would have returned if the structures were not there. The annual amount was then determined by dividing the total by the number of years since construction. The cost to return the sediments to the beach was estimated to be $37,000 annually. This was the amount which would mitigate damages caused by the structures entrapping sand. The share is indicative of the degree to which the Federal structures contribute to the problem. Since mitigation is the limit of Federal authority and cost-sharing, only $37,000 annually could be applied towards any other alternatives such as the beach and groin, and revetment alternative, which would go beyond mitigation of the impact on erosion caused by the structure. Note that the $37,000 and other figures given for costs of alternatives, etc., are only rough estimates and further study will result in refinement of these figures.

Question: What will happen after the study is completed in August?

Answer: The study, scheduled for completion in August, will further delineate the degree of contribution to the erosion problem and develop detailed costs associated with alternatives to address the problem. It must be remembered that there is no promise that anything can be done. However, if a plan is developed that is feasible, is acceptable to locals, and is capable of Federal implementation, construction could begin next spring or during the construction season depending upon funding.

Question: Would the Corps have built the dike if they had known the erosion would be so severe?

Answer: First, the use of the word "severe" implies that the contribution to the problem by the structures is quantified as severe, that is 3,700 cubic yards entrapped annually by the structures is severe in relation to the overall problem. The erosion problem in the area is severe, but only the 3,700 cubic yards entrapped is the portion contributed by the structures. This is not the cause of erosion. If it was known that the 3,700 yards would be entrapped, maybe some sort of mitigation measures, such as the feeder beach, would have been incorporated into the dike design to replace that entrapped sand. In fact, the spending beach was included as a part of the dike design to reduce the possibility of impact on the existing erosion process.

Question: Why doesn't the Corps admit that they have caused the erosion problem?

Answer: The diked structures did not cause the erosion problem. The structures have, however, contributed to the problem by hindering movement of sediments back in an eastward direction. This is different from causing the erosion problem which has been the status quo for the shore east of Lorain, as documented by the many relic structures and the historically receding shoreline.

Question: What about the storms out of the northeast that raise the water (being trapped by the dike) and push it over the diked structures and up along our waterfronts? Isn't this similar to when storms occur on the lake and water levels are much higher on one side of the lake than the other? Doesn't that apply here?

Answer: The degree to which the diked structures trap water such that water levels are raised along the waterfront beyond what would be the condition if the structures weren't there, has not been identified. The impact of such a condition will be examined during further study.

Conclusion

Conditions have been such that, historically, erosion along the shoreline in this area has been the norm and there has been a deficinecy of littoral material even without the diked disposal structures. The diked disposal structures , therefore, are not the cause of the erosion problem. However, the structures do contribute to the problem by hindering littoral movement in an eastward direction.

Further study will determine more precisely the amount of contribution to the erosion process that the structures do have and define more precisely alternatives that will mitigate the effects of that amount of contribution. This effort will be done as expeditiously as possible, seeking public comment throughout.

Comments on this memorandum or requests for additional information may be directed to the Project Manager, Timothy Byrnes.

PERTINENT CORRESPONDENCE

Copies of letters pertinent to the Section 111 study are included on the following pages. Most coordination inputs have involved telephone conversations, however after distribution of the draft report the number of substantive letters should increase.

OFFICE OF THE MAYOR
City of Lorain
OHIO
"Pride Grows With Progress"
JOSEPH J. ZAHOREC
MAYOR
ROOM 714 - CITY
LORAIN, OHIO
(216) 244-3

July 19, 1979

U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Gentlemen:

This correspondence is in regards to severe erosion condition that has recently occurred just east of the newly-constructed dike disposal which the affected land owners claim to be the direct cause of their property damage.

My City Engineer has met at this site with your associates, Messrs. Thomas P. Sloan and Dennis Rimer, who suggested to him that the City of Lorain to request you and your department to make the study necessary to determine the direct cause of this new wave action in this area.

My City Engineer said that the solution to this problem is to construct breakwaters to dissipate the wave energy causing this damage. A project of this magnitude would need Federal assistance and since it appears that the dike construction has intensified the wave action, your assistance is needed.

Immediate protection should be considered because this erosion is inundating the area by twenty to thirty feet per storm, where the retaining walls have failed. At this rate, the residents will soon lose their homes to Lake Erie and Lakeside Avenue, along with our sanitary sewer trunk line and other utilities will follow.

I trust you will take immediate action to make the needed investigation and determine the required solution and financial assistance to this new problem. It appears to us that the dike disposal has created this new problem for our City. I am transmitting herewith the letters sent to my Engineer from the affected residents and I thank you in advance for your assistance in this serious matter.

Sincerely yours,

Joseph J. Zahorec, Mayor
City of Lorain, Ohio

JJZ:ms
Enclosures

NCBED-PF 31 August 1979

Honorable Joseph J. Zahorec
Mayor, City of Lorain
Room 714 City Hall
Lorain, OH 44052

Dear Mayor Zahorec:

This is an interim reply to your letter of 19 July 1979, regarding the erosion problem east of the newly constructed dike disposal area in Lorain.

Under Section 111 of the 1968 River and Harbor Act, I have authority to investigate, study, and construct projects for the prevention or mitigation of shore damages attributable to Federal navigation projects. However, this authority has always been defined as applicable to features of projects that were either specifically authorized by Congress or were constructed under the Corps continuing authorities program. Neither of these definitions applies to the Lorain disposal facility, so that I am having to "break new ground," so to speak, to determine the legal limits of my authority. I hope to have an answer very soon and will certainly let you know as soon as I have it.

Sincerely,

Lt. Colonel, Corps of Engineers
Deputy District Engineer
and in the absence of

GEORGE P. JOHNSON
Colonel, Corps of Engineers
District Engineer

CF:
NCBED-PF
NCBCO-CL

Riser________
Pieczynski________
Zorich________
Gilbert________
Foley________
Halleck________
Liddell________
Braun________
Johnson________

ODNR
Ohio Department of Natural Resources
Fountain Square · Columbus, Ohio 43224 · (614) 466-3770

September 19, 1979

The Honorable Donald J. Pease
U.S. House of Representatives
1641 Longworth House Office Building
Washington, D.C. 20515

Dear Congressman Pease:

The Lake Erie shoreline east of Lorain is subject to above average erosion rates. As you may be aware, erosion rates are much higher during periods of high lake levels such as we have experienced the past few years. A number of houses in the vicinity of Lakeside Avenue are in danger of being washed into the lake within the next year.

The Department of Natural Resources is authorized to pay up to one third of the cost of erosion protection structures. However, cost of protective structures in this area would be quite high; therefore, we are reasonably certain the local residents cannot afford the necessary protective structures.

In general, there is no federal legislation which authorizes construction of shore protective works for private property. An exception is Section 111 of P.L. 90-483, the "River and Harbor Act of 1968," which authorizes corrective action when the damage is caused by a federal navigation project. It is possible the reflection of waves off the new dike disposal area at Lorain may be contributing to increased erosion at Lakeside Avenue. Frankly, this is a "thin straw," but we consider it the only possible legislation which could be used to protect these houses.

With your strong support there is some chance the Buffalo District Corps of Engineers may be able to provide help through the Section 111 process. We would support this effort.

Sincerely,

ROBERT W. TEATER
Director

RWT/cl

cc: Buffalo District Corps of Engineers

Congress of the United States
House of Representatives
Washington, D.C. 20515

COMMITTEE ON FOREIGN AFFAIRS
SUBCOMMITTEE ON INTERNATIONAL ECONOMIC POLICY AND TRADE
SUBCOMMITTEE ON EUROPE AND THE MIDDLE EAST
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

PART-TIME OFFICES:
MRS. DOROTHY LITMAN
157 COLUMBUS AVENUE, SANDUSKY
(419) 625-7193
—
COUNTY ADMINISTRATION BUILDING, MEDINA
(216) 725-6123
—
MUNICIPAL BUILDING, BARBERTON
(216) 848-1001

September 24, 1979

Col. George P. Johnson
District Engineer
Army Corps of Engineers
1776 Niagara Street
Buffalo, NY 14207

Dear Colonel Johnson:

Bette Welch of my staff has told me of her conversation with you concerning the Lorain Dike Disposal structure and of the information you passed along to her about the constraints under which you feel you must operate in this situation.

I want to try to be understanding of your problems, but frankly, Col. Johnson, I don't think your response is satisfactory under the circumstances. Following your reasoning, there could be no Corps action to ameliorate a problem even if it were perfectly clear that a Corps structure was causing the problem; and, that---instead of a dozen homes being threatened---it was a ten million dollar public building, you would have to sit helplessly by and watch it slip into the lake. In other words, you would still have to go through the cumbersome study, design and construction sequence which you outlined to Mrs. Welch.

That helplessness in the face of potential disaster seems totally unreasonable to me. Surely, the Corps of Engineers must have the authority to act immediately to prevent such a disaster. And if it does have such authority in a major disaster scenario such as is outlined above, then that same legal authority ought to be available in the situation of my constituents, for whom the loss of their land and possibly of their homes would certainly be a personal disaster.

I realize that this whole question involves a major policy determination by the Corps of Engineers. Accordingly, I am writing today to General John W. Morris, Chief of Engineers, to raise the same question with him. If the Corps of Engineers is so hamstrung by the law that it is unable to respond in less than two to three years to a major problem, the law must be changed or the Corps is going to have to stop building such structures.

A second concern disturbs me greatly. While I fully appreciate the efforts that you are making to expedite a Section 111 study, observers on the scene in Lorain are convinced that the Corps has already made up its mind that the dike is not creating the problem and that the Corps has no responsibility. I certainly hope that the local observers are incorrect and that there is no predisposition on the part of the Corps in this case. Otherwise the Section 111 study would be a waste of time and money, and a cruel deception for the residents whose property is threatened.

Incidentally, the question has been raised as to whether the Corps ever conducted a study before the project was approved for construction, as to the possibility of the structure creating problems for nearby lands. If so, I would like to have a copy of that study or report.

You mentioned to Bette the possible responsibility on the part of the City of Lorain. It is hard for me to see how the City could have responsibility for having caused the problem, and I would think the laws of Ohio would make it difficult, if not impossible, for the City to use public funds to try to correct such a situation as this on private property.

In conclusion and summary, it appears that what we have here in a situation where the property of citizens without great financial resources is immediately threatened, and that a project of the Corps of Engineers may be contributing to that problem. It seems to me that the Corps has a responsibility to make a determination as to the extent of its responsibility and, in the meantime, has a responsibility to keep the situation from deteriorating any further. If three months from now the Corps determines that it does have some responsibility, while much of this property has slipped into Lake Erie, it will be too late to take effective action.

Please note the enclosed news items from the Lorain Journal, and let me know as soon as possible if there is not some way to cut through the red tape and extend help to these affected property owners while there still is time to help them.

Sincerely yours,

DON J. PEASE
Member of Congress

DJP:wnh

cc: General John W. Morris

Congress of the United States
House of Representatives
Washington, D.C. 20515

COMMITTEE ON FOREIGN AFFAIRS
SUBCOMMITTEE ON INTERNATIONAL ECONOMIC POLICY AND TRADE
SUBCOMMITTEE ON EUROPE AND THE MIDDLE EAST
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

PART-TIME OFFICES
MRS. DOROTHY [illegible]
157 COLUMBUS AVENUE, SANDUSKY
(419) [illegible]-7193
COUNTY ADMINISTRATION BUILDING, [illegible]
(216) 725-6120
MUNICIPAL BUILDING, [illegible]
(216) [illegible]-1001

September 24, 1979

Lt. General John W. Morris
Chief of Engineers
Army Corps of Engineers
Washington, D.C. 20314

Dear General Morris:

I am addressing this letter to you because of the broad policy question raised. As I state in the enclosed letter to Colonel Johnson, I really find it unacceptable that the Corps can construct projects which may or may not cause a problem at some future date; and, if they do, that the Corps must then say it is unable to ameliorate in the any the problem without a lengthy study, and without going through the whole time-consuming congressional process.

Aslo enclosed for your additional information are copies of news items to further explain the urgent situation I discuss in my letter to Colonel Johnson.

Please let me know as soon as possible if there is not some way you can cut through the red tape and extend help to these affected property owners while there still is time to help them.

Thank you.

Sincerely yours,

DON J. PEASE
Member of Congress

DJP:wnh

Enclosures

cc: Col. George P. Johnson

ps2225

NCBED-DC 5 October 1979

Ray Henry, City Engineer
Engineering Department
Fourth Floor
Lorain City Hall
200 West Erie Avenue
Lorain, Ohio 44052

Dear Mr. Henry:

Please reference recent conversations between Mr. Paul Shulsky of your office and Ms. Joan Pope of my staff regarding our Section 111 study for the Diked Disposal area at Lorain.

Tetra Tech, Inc. has been hired to conduct this Section 111 reconnaissance study. Members of my staff and Tetra Tech, Inc. will meet at your office at 8:30 a.m. on 11 October 1979 to discuss the study and also meet with some concerned citizens at 10:00 a.m.

A few of the residents of the Lakeside Avenue area have requested access to some reference reports. The reports requested are: a. The appropriate Engineering Regulation (ER-1105-2-50) which describes the Corps Section 111 authority; b. The Section 111 report dated 22 January 1970 entitled "Investigation of Effects of E. Breakwater Shorearm at Lorain Harbor, Ohio on Adjacent Shore"; and c. The Dike Disposal Area report on shore erosion including the spending beach design.

In order to make these reports immediately available to the public, I am enclosing two copies of each with this letter. Could you please make one set of the reports available to those citizens who wish to review them? Should the demand become excessive or for any reason you need more copies, please let me know and we will photocopy additional copies for a wider circulation.

Thank you for your assistance in developing public access to these reports and also for inviting the citizen participants for the 11 October meeting.

Sincerely yours,

Incl
as stated

KENNETH R. HALLOCK, P.E.
Acting Chief, Engineering Division

NCBED-DC
NCBED-D
✓NCBED-PP

Gilbert ______
Hallock ______
Pope ______
Clark ______
Foley ______

NCBED-DC 5 October 1979

Honorable Donald J. Pease
House of Representatives
Washington, DC 20515

Dear Mr. Pease:

Your letter of 24 September 1979 raised several concerns regarding the shore erosion east of Lorain Harbor and the Federal Dike Disposal area. First of all, let me emphasize that I am very concerned about the erosion damages east of Lorain, particularly in view of the erosion threat to some homes. I have directed my staff to take any action necessary to expedite a Section 111 study.

I have reviewed all options which are available to the Corps of Engineers, including continuing authorities and the emergency authority granted by Public Law 84-99, to identify what measures, if any, can be taken immediately. In summary, I have found that all authorities which govern the Corps of Engineers specifically prohibit the Corps from engaging in the protection of private lands from shoreline erosion. For example, Section 14 of Public Law 79-526, which allows for emergency shoreline protection, can be applied only when public works or nonprofit public services are threatened. Even this emergency authority is time consuming and cannot be implemented immediately. The benefits must exceed the costs, the maximum Federal expenditure cannot exceed $250,000, and there must be a local cooperator to assume any additional costs and provides assurances before emergency action under Section 14 can be authorized. The only option available for me to use for the privately-owned shoreline east of Lorain is Section 111 of the River and Harbor Act of 1968 (Public Law 90-483). Section 111 authorizes the Corps of Engineers to "...investigate, study, and construct projects for the prevention or mitigation of shore damage attributable to Federal navigation works." Federal law prohibits the Corps of Engineers from taking any steps to protect private lands from shore erosion unless it is determined that Federal navigation works are responsible for causing or contributing to the erosion problem.

Therefore, the only immediate action available to me in this situation is to initiate a Section 111 study. Extraordinary measures have been taken to initiate the Section 111 study and obtain additional funding to allow this work to be done by an independent Architect-Engineer firm. I received authorization to conduct a Section 111 study on 13 September 1979. To avoid any claims of predisposition in this case, I determined that the reconnaissance level study, which is intended to identify the presence of any Federal responsibility for shore erosion, should be conducted by an independent contractor. A scope of work was developed, negotiation conducted, and on 28 September 1979 the work order was awarded to Tetra Tech, Inc. Tetra Tech, Inc. is a highly regarded coastal engineering firm with a great deal of experience in shore erosion and in conducting Section 111 studies.

A major point which I must make is that there is no evidence, other than circumstantial, that the Dike Disposal area has accelerated the shore erosion. A Section 111 report entitled "Investigation of Effect of E. Breakwater Shorearm at Lorain Harbor, Ohio on Adjacent Shore" was prepared by the Buffalo District and dated 22 January 1970 (Inclosure 1) in response to the apparent increased shore erosion rates east of Lorain after the 1963 construction of a breakwater extension. This study concluded that the shore east of Lorain has historically been an eroding shore and that "...the increased erosion is due to the coincidental occurrence of higher lake levels and the deterioration or complete lack of shore protection rather than to detrimental effects of the new structure."

The entire shoreline of Lake Erie has experienced accelerated shore erosion during the 1970's due to high lake levels. The shore east of Lorain is a high glacial till bluff area which is protected by various types of structures with varying levels of effectiveness. The bluff is so oversteepened and unstable that the failure of one shore protection structure will cause the failure of neighboring protection works as the weight of the bluff exceeds the strength of that protection.

During the design phase of the Dike Disposal area, a study was made to investigate methods of reducing any debris accumulation and shore erosion that might be related to the Dike Disposal structure. This included an evaluation of the existing shore and offshore conditions as well as the wave climate. As a result of the shore protection study (Inclosure 2) a "spending beach" was incorporated into the project to reduce the chance of any accelerated shore erosion. The Corps of Engineers made every effort to eliminate any anticipated adverse shore erosion impacts from the Disposal Dike plan. However, if something was overlooked, such as a disruption to offshore sediment transport patterns, we intend to find this out as soon as possible under our existing authorities. Should the Federal Government be found responsible for creating a situation which accelerates shore erosion, I intend to act as expeditiously as the law allows to mitigate any erosion attributable to the Dike Disposal Area.

In your letter you referred to the city of Lorain's role in correcting the erosion situation. If the Section 111 analysis shows that the diked disposal structure has accelerated erosion of the adjacent shoreline, the Federal Government would assume responsibility for, and mitigate only that portion of the damage attributable to the disposal area. Costs for shore protection beyond that which is necessitated by the Federal structure must be borne by a non-Federal entity (i.e., the local homeowners, the city of Lorain, or the State of Ohio). Thus, the Section 111 study will have to determine if the Federal structure contributed to the shore erosion; if so, to what degree the shore erosion was accelerated; and finally, develop the cost sharing and design package for acceptance by the local cooperator. In addition, if the Federal share of construction exceeds $1,000,000, approval by Congress is required. Only after the Section 111 study has been compiled, evaluated, reviewed, and approved, and after an agreement has been reached with a local cooperator, can the Corps of Engineers protect the threatened shore. Unfortunately, the above-described constraints prohibit immediate Federal relief to the landowners even though I share your concern that this would be a desirable action.

I hope this outline of my position not only clarifies the situation but also expresses my desire to do whatever I legally can to assist the involved property owners.

Sincerely,

GEORGE P. JOHNSON
Colonel, Corps of Engineers
District Engineer

2 Incl
as stated

ODNR
Ohio Department of Natural Resources
OFFICE OF OUTDOOR RECREATION SERVICES
Fountain Square · Columbus, Ohio 43224 · (614) 466-4974

July 17, 1980

Mr. Craig Holland, P.E.
Tetra Tech, Inc.
630 North Rosemead Boulevard
Pasadena, Claifornia 91107

Dear Mr. Holland:

The State Clearinghouse has referred your June 24, 1980 letter concerning shore erosion mitigations at Lorain, Ohio to the Department of Natural Resources. We would appreciate direct notification of the public meeting to be held for this project. Please direct future correspondence to this office and also to:

Charles Carter, Supervisor
Lake Erie Section
Division of Geological Survey
ODNR
P.O. Box 650
Sandusky, Ohio 44870

Sincerely,

Roger D. Hubbell

Roger D. Hubbell, Chief
Office of Outdoor Recreation Services

RDH/jd

cc: Horace Collins, Chief
Division of Geological Survey

The City of Lorain
OFFICE OF THE MAYOR
OHIO

"Where People Come First"

WILLIAM E. PARKER
MAYOR

ROOM 714 - CITY H
LORAIN, OHIO 440
(216) 244-3204

September 15, 1980

Department of The Army
Buffalo District, Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Att: George P. Johnson
Colonel, Corps of Engineers
District Engineer

Re: NCBED-PF

Dear Colonel Johnson:

Regarding your letter of September 4, 1980, I am sympathetic with the problem of erosion on Lakeside Avenue.

I will cooperate and assist in any way that the Mayor's Office can help, however, I cannot pledge support to cost sharing as that pledges public tax dollars for private use, and would not be legal.

We can provide lands, easements, right of ways, and relocations necessary for construction.

I want the record to show that I favor Federal assistance for this area as soon as possible.

Very truly yours,

WE Parker

William E. Parker,
Mayor of Lorain

WEP/mv
cc: File

APPENDIX 4

ENGINEERING INVESTIGATIONS

APPENDIX 4

ENGINEERING INVESTIGATIONS

TABLE OF CONTENTS

INTRODUCTION

The purpose of this appendix is to provide detailed design information for plans determined suitable for further consideration. These plans, by nature of reaching this stage, should be technically feasible, capable of achieving the objectives of the planning process, and have a high degree of certainty of achieving their engineering goals.

The designs arrived at here will provide the basis upon which each plan can be compared, one against another, in their impact on the NED, EQ, SWB, and RD accounts.

ALTERNATIVE PLANS

The following pages contain design calculations for Alternatives II through V. Alternative I, the "No Action" alternative is used as a base case against which the four other alternatives are compared. Although the "no action" alternative would not satify the planning objective to mitigate dike attributable erosion, it must be carried forward in the planning process because it avoids both monetary investments and potential adverse impacts associated with the four other structural and non structural alternatives.

ALTERNATIVE II LAND ACQUISITION PLAN

ONE OF THE REQUIREMENTS OF THE TECHNICAL FORMULATION AND EVALUATION CRITERIA ESTABLISHED FOR THIS STUDY IS THAT ALL PARCELS (LAND & STRUCTURE) WITHIN THE AREA CONSIDERED TO BE DAMAGED BY EROSION ATTRIBUTABLE TO THE DIKE DISPOSAL STRUCTURE MUST BE PURCHASED UNDER AN ACQUISITION PLAN.

DAMAGE PROJECTIONS DEVELOPED IN APPENDIX 5 OF THIS REPORT SHOW THAT NOT ALL PARCELS SUFFER THE LOSS OF A STRUCTURE IN ADDITION TO LAND LOSSES OVER THE 50 YEAR PROJECT LIFE.

THERE ARE TWO REASONS FOR NOT ACQUIRING ONLY THE LAND OR STRUCTURES PROJECTED TO BE LOST:

1. THE PROJECTIONS FOR 50 YEARS OF EROSIONAL DAMAGE ARE BASED ON ONLY 2 YEARS OF BLUFF RECESSION DATA. USING THE SCENARIO OF PURCHASING TODAY PROPERTY & STRUCTURES PROJECTED TO BE DAMAGED, THE FEDERAL GOVERNMENT WOULD BE SUBJECT TO LEGAL ACTION WHEN REALITY DIFFERS FROM PROJECTIONS IN THE FUTURE.
2. UNDER THE SCENARIO OF A "BUY AS YOU GO" PLAN OF PURCHASING ONLY THOSE PROPERTIES AND STRUCTURES ACTUALLY DAMAGED, THE FEDERAL GOVERNMENT WOULD BE CONTINUALLY FORCED TO REASSESS ITS PORTION OF THE ACTUAL EROSION INVOLVING MUCH STUDY AND POSSIBLE LEGAL ACTION.

THE CRITERIA WAS THEREFORE ESTABLISHED THAT ALL PARCELS (IN THEIR ENTIRETY) WOULD HAVE TO BE PURCHASED AT 1980 MARKET VALUE AS THE MOST EQUITABLE SETTLEMENT FOR THE RESIDENTS AND TO AVOID FUTURE STUDIES OR LEGAL ACTION ON THE PART OF THE GOVERNMENT.

SINCE THIS IS A NON-STRUCTURAL ALTERNATIVE DESIGN CALCULATIONS ARE NOT NECESSARY. THE FOLLOWING PAGES PRESENT THE COST/BENEFIT ESTIMATES FOR THIS PLAN.

ALTERNATIVE II ACQUISITION PLAN

1. COST TO ACQUIRE ALL PROPERTIES WITHIN THE DAMAGED AREA ESTIMATED TO EXTEND FROM 800 to 2400 FEET EAST OF COLORADO AVE. PER ANALYSIS PRESENTED IN APPENDIX 1 OF THIS REPORT.
SEE THE TABLE ON THE FOLLOWING PAGE FOR THE PARCELS WHICH MUST BE ACQUIRED AND THEIR LAND & STRUCTURE MARKET VALUES
A TOTAL OF 26 PARCELS COSTING:

TOTAL PROPERTY	376,360	
TOTAL STRUCTURES	1032,805	
TOTAL	1,409,165	say $1,410,000

INCIDENTIALS TO ACQUISITION

1) MOVING EXPENSES (per Sec 202 PL 91-646)
ACTUAL REASONABLE EXPENSES FOR MOVING EACH TENANT WOULD BE IMPOSSIBLE TO FIGURE AT THIS TIME BUT AN ESTIMATE OF $1500 PER HOUSE HOLD ON THE AVERAGE WILL BE USED HERE.
IN 26 PARCELS ; 2 ARE VACANT
3 HAVE 2 HOMES PER PARCEL
THEREFORE IN 27 HOMES MOVING EXPENSES ARE ESTIMATED AT 27 x 1500 = $40,500

2) REPLACEMENT HOUSING COSTS (per Sec 203 PL 91-646)
ACTUAL AMOUNTS TO ACQUIRE REPLACEMENT HOUSING CAN NOT BE DETERMINED UNTIL AFTER PURCHASES ARE MADE, BUT IT MAY BE REASONABLE TO ASSUME:
OF 27 TENANTS IN PROPERTY TO BE ACQUIRED
1) 25% ARE RENTORS ENTITLED TO A MAXIMUM PAYMENT OF $4000, ASSUMING THEY GET THE MAXIMUM THIS IS .25 (27) 4000 = $27,000
2) 75% ARE OWNERS ENTITLED TO A MAXIMUM PAYMENT OF $15,000, ASSUMING THEY GET AN AVERAGE PAYMENT THEN .75 (27) (7500) = $151,875

TOTAL REPLACEMENT HOUSING COSTS = $178,875 say $179,000

MARKET VALUE FOR PARCELS IN THE STUDY AREA

Parcel Number	Market Value		Lot Size (Front x Depth)	Land Value $/Ft^2
	Land	Structure		
1	3970	0	50x141	.56
2	3060	0	43x116	.61
3	5285	17850	43x95	1.29
4	5355	14420	43x99	1.26
5	1140	0	43x72	.37
6	1180	0	46x72	.36
7	5040	20320	47x91	1.18
8	5220	26620	46x97	1.17
9	1380	0	46x93	.32
10	5040	23400	46x92	1.19
11	5990	15070	42x101	1.41
12	6545	26340	42x119	1.31
13	6545	21460	42x119	1.31
14	6630	24760	43x118	1.31
15	6720	20040	44x112	1.36
16	6545	22500	43x112	1.36
17	6720	35950	43x120	1.30
18	6250	24610	43x102	1.43
19	6250	27070	44x97	1.46
20	2190	0	44x93	.54
21	3680	18150	30x97	1.27
22	3680	15590	30x95	1.29
23	4240	24760	30x98	1.44
24	5990	26930	42x100	1.43
25	5930	36310	40x106	1.40
26	5990	35470	40x108	1.39
27	6250	33970	40x115	1.36
28	21820	40500	98x117	1.90
29	20550	32110	96x100	2.14
30	20000	36850	55x148	2.46
31	19600	33970	55x135	2.64
32	19600	42540	55x132	2.70
33	17270	24680	45x132	2.91
34	4710	0	120x66	.59
35	12970	56700	120x66	1.64
36	21050	103145	57x154	2.40
37	22640	67710	57x304	1.31
38	39660	64450	118x307	1.10
39	[illegible]5200	62840	60x304	1.38
40	24550	67390	58x304	1.39
41	2740	0	17.75x304	.51
42	3600	81360	118x310	.98
43	49950	75700	118x307	1.38
44	22860	27600	60x302	1.26
45	22860	22800	60x302	1.26

26 PARCELS TO BE ACQUIRED UNDER ALTERNATIVE II (parcels 18–43)

NOTES: 1) Market value & lot size are based upon Corps of Engineers August 1980 Survey of Lorain County records, office of the County Treasurer, Elyria, Ohio.

2) Land value is based upon: land market value ÷ appraised lot size in feet^2.

ALTERNATIVE II ACQUISITION PLAN

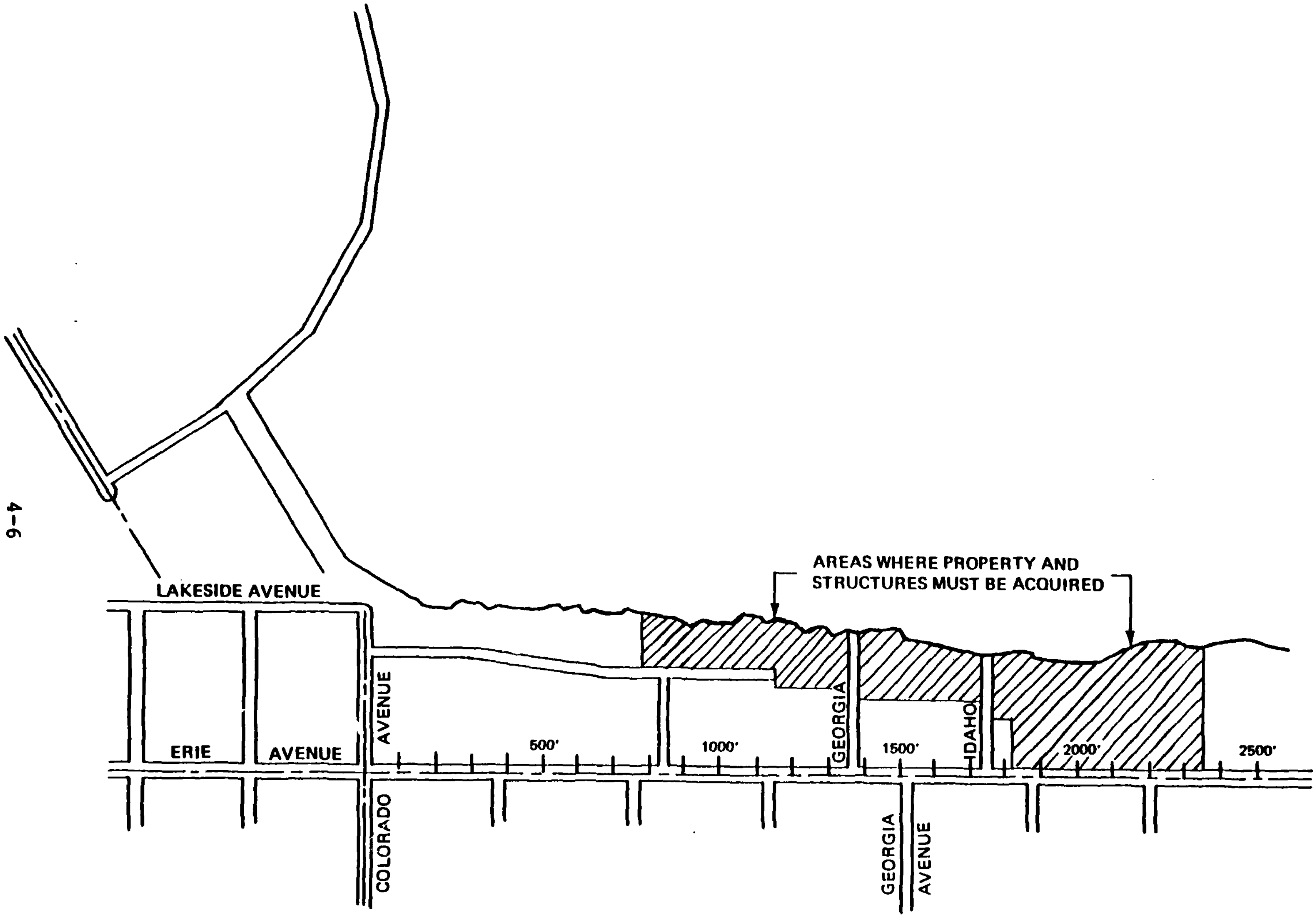
2. COSTS TO DEMOLISH ALL PROPERTIES, INCLUDING SITE IMPROVEMENTS, SALVAGEABLE ITEMS AND THE DISCONTINUATION OF UTILITY SERVICE INTO/OUT OF THE AFFECTED AREA WITH RELOCATION IF NECESSARY.
AN ESTIMATE OF DEMOLITION COSTS CAN BE MADE USING INFORMATION FROM THE LORAIN COMMUNITY DEVELOPMENT OFFICE'S ESTIMATE OF $3000 TO DEMOLISH THE MEDIUM SIZE STRUCTURES ALONG LAKESIDE AVE.
IF THESE STRUCTURES HAVE AN AVERAGE MARKET VALUE OF APPROXIMATELY $22,000 (parcels 12 to 24) THEN DEMOLITION COSTS CAN BE ASSUMED AT
3000/22000 = .136 OF STRUCTURAL MARKET VALUE
THEREFORE FOR ALL STRUCTURES TO BE DEMOLISHED THE COST WOULD BE .136 (1,032,805) = $140,461
SAY $140,500 FOR DEMOLITION COSTS

BENEFITS FOR ALTERNATIVE II

1) SAVINGS TO PROPERTY OWNERS ON PROTECTIVE STRUCTURES AT POST DIKE RECESSION RATES IN AFFECTED AREA. FROM DAMAGE CALCULATIONS THIS COST IS $17,850 SAY $17,900 ANNUALLY WHICH CAN NOW BE DECLARED A BENEFIT

2) LOCAL (COUNTY OR CITY) SAVINGS TO PROTECT STREET ENDS & UTILITIES ARE INCLUDED AS PART OF COSTS FOR 1 ABOVE

3) INTANGIBLE BENEFIT — ALLEVIATION OF CONCERN CANNOT BE QUANTIFIED BUT COULD LEND WEIGHT TO AN ALTERNATIVE IN COMPARISON TO OTHERS WHICH HAVE NO INTANGIBLE BENEFITS



ALTERNATIVE II ACQUISITION PLAN

ALTERNATIVE III FEEDER BEACH PLAN

PRIOR TO PERIODIC NOURISHMENT, THE SHORELINE SHOULD BE RESTORED TO AN ESSENTIALLY (DYNAMICALLY) STABLE CONDITION SIMILAR TO THAT WHICH EXISTED BEFORE DIKE CONSTRUCTION. TO ACCOMPLISH THIS, AN AMOUNT OF FILL EQUIVALENT TO THAT WHICH WAS ERODED AWAY BETWEEN DIKE CONSTRUCTION AND THE INSTITUTION OF MITIGATION IS NECESSARY.

ASSUMING MITIGATION COMMENCES APRIL 1981
AND THE DIKE WAS COMPLETED NOV 1977
THEN 3 YRS & 5 MONTHS OF EROSION HAS OCCURED AT AN AVERAGE RATE OF 5400 yd^3/yr.

TOTAL EROSION WOULD THEN BE $\frac{41}{12} \times 5400 = 18450\ yd^3$

TOTAL FILL PLACED THE FIRST YEAR = 18,500 yd^3

FILL MUST BE ALSO PLACED PERIODICALLY TO REPLACE THAT ERODED. THIS QUANTITY WILL BE DETERMINED BY YEARLY INSPECTION. FOR CALCULATION PURPOSES ASSUME A YEARLY AVERAGE PLACEMENT EQUAL TO THE 5400 YD^3/YR. IMPOUNDED BY THE DIKE.

ASSUMING A STANDARD 16 TON TRUCK FOR HAULING PURPOSES:

16 TONS = $16/1.512\ TON/YD^3 \approx 10.6\ yd^3$

ASSUMING 35 TRUCK TRIPS / DAY = 370 yd^3/day placed

ASSUMING 20 WORK DAYS / MONTH 10% OF WHICH ARE NOT WORKED BECAUSE OF WEATHER DIFFICULTIES, EQUIPMENT BREAKDOWN, ETC.

∴ DAYS WORKED / MO = 18

MONTHS TO PLACE 18500 yd^3 $= \frac{18500}{370(18)} = 2.8$ months

5400 yd^3 $= \frac{5400}{370(18)} = 0.8$ month

BOTH ESTIMATES ARE WITHIN THE APPROXIMATE 6 MONTH WORK SEASON FROM APRIL THRU SEPTEMBER

EASEMENT FOR ACCESS NEEDED AT ONE POINT ALONG SHORE AT STATION 22+40, PARCEL NO 43.

THIS WILL BE A TRUCK HAUL AND EQUIPMENT ACCESS ROAD WHICH WILL CREAT A DISTURBANCE TO RESIDENTS ESPECIALLY THOSE AT PARCELS NO. 42 and 43.

THIS ACCESS IS WELL SUITED TO THIS MITIGATION MEASURE IN THAT THERE IS SUFFICIENT AREA ADJACENT TO THE BLUFF TO SERVE AS A STAGING AREA.

EASEMENT WOULD CONSIST OF A TRUCK RIGHT OF WAY PLUS A 100'×50' STAGING AREA WHICH WOULD SPILL OVER INTO PARCEL # 42.

SINCE THIS CONSTRUCTION PLAN CALLS FOR CONTINUAL USE OVER A 50 YR. PERIOD, PURCHASE OF THE LAND SHOULD CONSTITUTE A FAIR ESTIMATE OF COST OF EASEMENT

PARCEL	AREA NEEDED	PROPERTY VALUE	COST
# 42	50X50	.98	$ 2450
# 43	50X50 + 20X300	1.38	$ 11730
			$ 14,180
			say $ 14,200

METHOD OF PLACEMENT:

TRUCK HAUL TO BLUFF & DUMP OVER EMBANKMENT. WHEN SUFFICIENT QUANTITY IS PLACED TO FORM A SMALL BEACH, PLACE A SMALL DOZER (BY CRANE) ON THE BEACH TO DISTRIBUTE MATERIAL EVENLY TO MEAN LAKE STAGE OR PREVAILING LAKE LEVEL WHICHEVER IS HIGHER.

IN CASE OF FIRST PLACEMENT THE QUANTITY IS LARGE ENOUGH THAT MULTIPLE FILL SITES WOULD BE USED. IN ADDITION TO THE SITE AT STA. 22+40 (APPROX), TWO STREET ENDS AT STA. 13+80 GEORGIA AVE AND STA. 17+60 IDAHO AVE. WOULD BE NEEDED TO PLACE THE 18,500 YD³ OF FILL EACH SITE WOULD RECEIVE ABOUT 1/3 OF THE TOTAL BUT THE PLACEMENT MAY BE MADE TWICE (1/6 OF TOTAL) AT THE START AND NEAR THE END OF THE CONSTRUCTION SEASON. IN THIS WAY THE FILL DISPERSION COULD BE MONITORED AND PLACEMENT QUANTITIES VARRIED AS NEEDED.

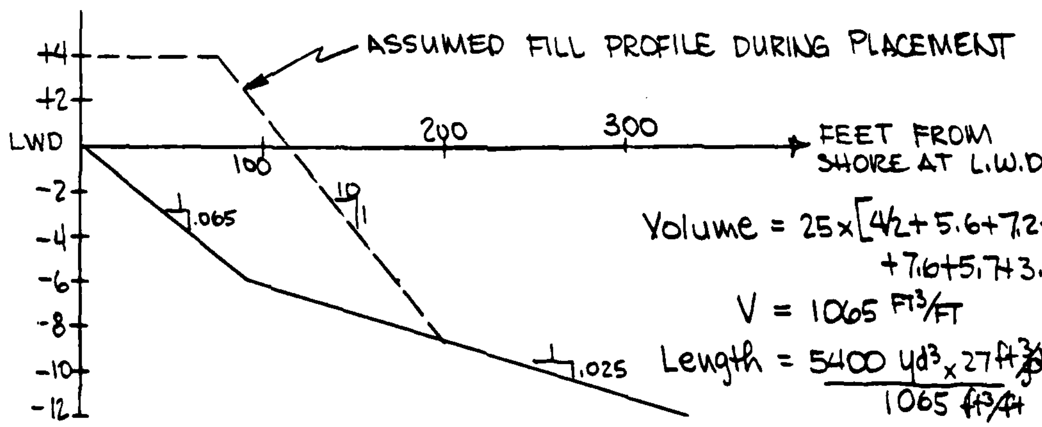
EASEMENTS FOR USE OF THE STREET ENDS ARE NOT NECESSARY (PER CITY ENGINEERS OFFICE) AS LONG AS THE STREET SURFACE IS RETURNED TO ITS ORIGINAL CONDITION AND THE STREET END IS REPAIRED TO ITS PROTECTED CONDITION

ASSUMING THE ONE TIME USE FOR APPROXIMATELY ONE MONTH AT EACH STREET END AND PLACEMENT AS STATED ABOVE THE SHOULD BE LITTLE OR NO DAMAGE TO THE STREET SURFACE OR EXISTING PROTECTION

THE MAXIMUM EXTENT OF FILL UNDER A FIRST YEAR OR SUBSEQUENT YEAR PLACEMENT SCENARIO IS FOR THE 5400 yd^3/yr PLACEMENT DONE IN 0.8 MONTH WHEN THE MATERIAL IS BUILT UP BEFORE THE WAVES HAVE TIME TO DISSIPATE THE FILL

USING THE 1980 CORPS SURVEY FOR AREAS EAST OF THE DIKE IT WAS DETERMINED THAT AVERAGE OFFSHORE SLOPES IN THE DAMAGED AREA ARE:

$m = 0.065$ L.W.D to −6 FT
$m = 0.025$ −6 FT to −12 FT
$m = 0.005$ −12 FT to −14 FT



$$\text{Volume} = 25 \times \left[4/2 + 5.6 + 7.2 + 8.8 + 7.6 + 5.7 + 3.8 + 1.9 + 0/2 \right]$$

$$V = 1065 \ ft^3/ft$$

$$\text{Length} = \frac{5400 \ yd^3 \times 27 \ ft^3/yd^3}{1065 \ ft^3/ft}$$

$$L = 137 \ ft$$

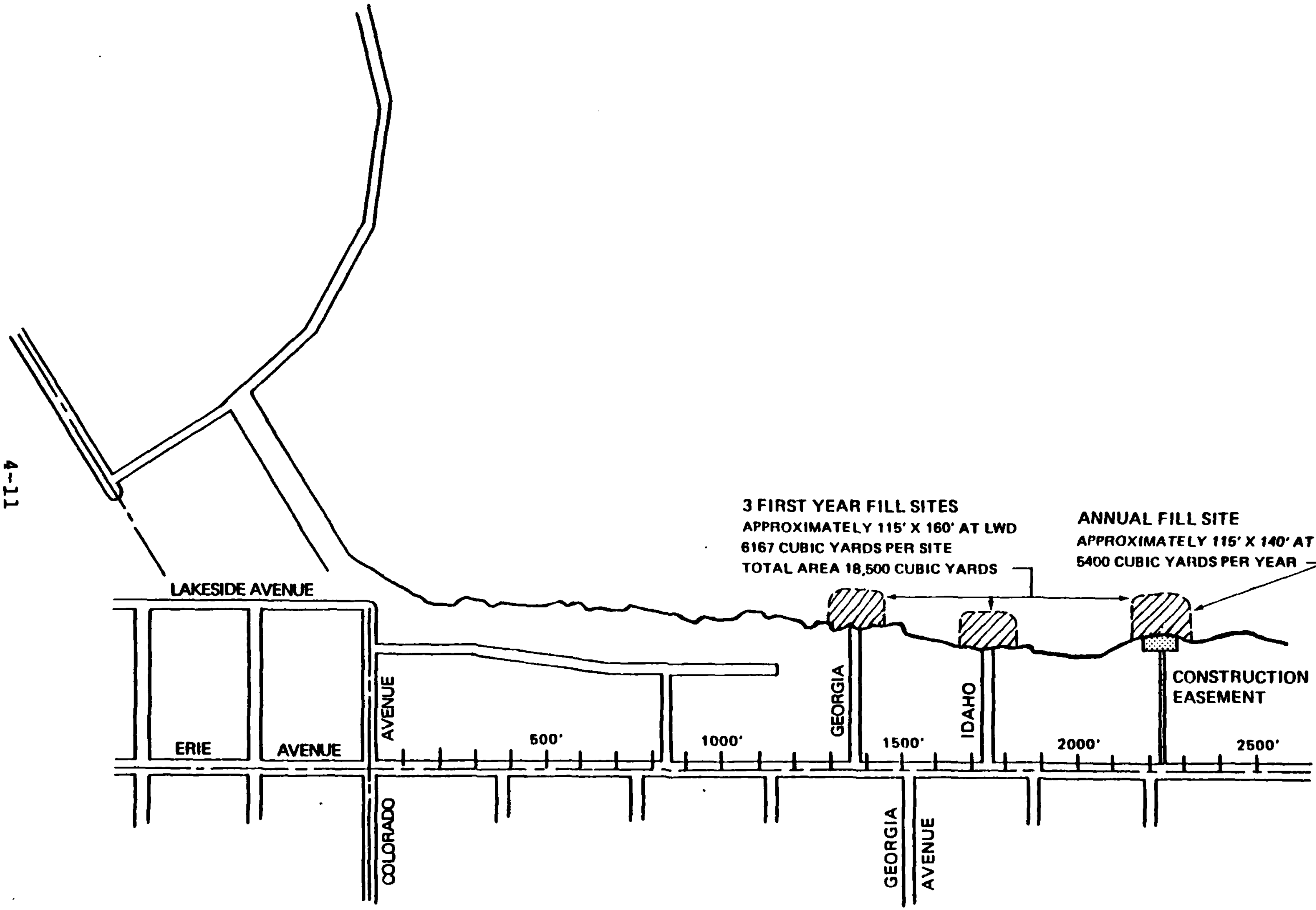
ASSUMING THE FILL TOP ELEVATION IS ABOUT +4.0 (572.6 IGLD)
AND IT WILL MAINTAIN A 1:10 SLOPE AT PLACEMENT
THE FILL EXTENT TO PLACE 5400 yd^3 WOULD BE

75 FT WIDE AT +4.0
115 FT WIDE AT 0.0 LWD
200 FT TOE OUT DIST.
140 FT ALONGSHORE

FOR THE 6 PLACEMENTS DURING THE FIRST YEAR
ASSUMING EQUAL FILLS AT EACH SITE
IF ALL MATERIAL DISPERSES FILL EXTENT AT LWD
IS 115 FT WIDE × 80 FT ALONGSHORE
IF NO MATERIAL DISPERSES FILL EXTENT AT LWD
IS 115 FT WIDE × 160 FT ALONGSHORE

IE. ALL MATERIAL IN FIRST PLACEMENT COULD BE MADE IN 3 RATHER THAN 6 FILLS WITHOUT SIGNIFICANT SHORELINE RUNS WITH THE DOZER FOR DISTRIBUTION PURPOSES.

THE FILL IS GROOMED AND DISTRIBUTED TO AS CLOSE AS POSSIBLE TO MEAN LAKE STAGE (AT THE TIME OF PLACEMENT) SO THAT THE SAND IS DISTRIBUTED BY THE WAVES AS SOON AS POSSIBLE. RAPID DISPERSAL OF THE FILL WOULD MORE LIKELY APPROXIMATE EVENLY DISTRIBUTED FILL WHICH WOULD PROVIDE WAVE PROTECTION TO ALL PARTS OF THE EFFECTED BLUFF.



ALTERNATIVE III FEEDER BEACH PLAN

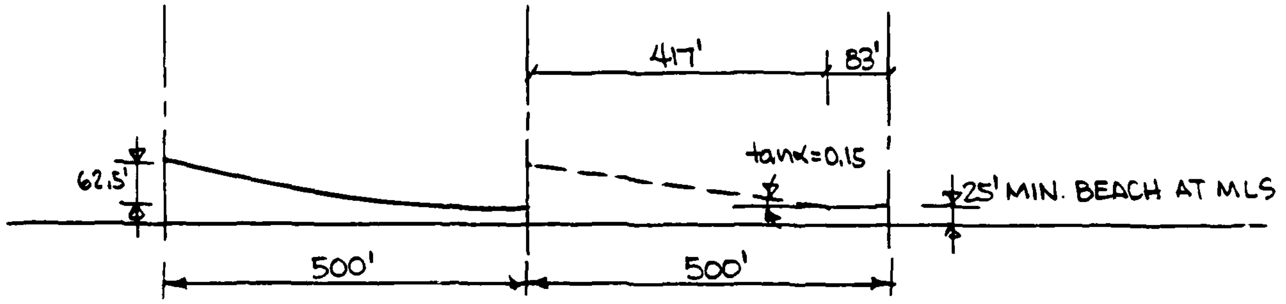
ALTERNATIVE IV GROIN SYSTEM WITH FILL

THE OBJECTIVE OF THIS PLAN IS TO PREVENT DIKE INDUCED AND NATURAL EROSION OF THE SHORELINE WITHIN THE DAMAGED ZONE DEFINED IN APPENDIX 1. THIS IS TO BE ACCOMPLISHED BY USING A GROIN FIELD TO MAINTAIN A PROTECTIVE BEACH FRONTING THE PROPERTIES NOW SUFFERING BLUFF EROSION. SINCE THE GROIN FIELD WILL NOT BE 100% EFFECTIVE IN MAINTAINING THIS PROTECTIVE BEACH, A BEACH NOURISHMENT PROGRAM WILL ALSO BE NECESSARY.

IN A SURVEY OF SHORE STRUCTURES ALONG THE LORAIN COUNTY SHORELINE, THE OHIO DEPARTMENT OF NATURAL RESOURCES FOUND THAT SHORES FRONTED BY BEACHES GREATER THAN 50 FEET WIDE WERE STABLE REGARDLESS OF THE SUBSTANCE OR CONDITION OF ADDITIONAL PROTECTIVE STRUCTURES. ASSUMING THAT THE GROIN FIELD WILL PROVIDE A DEGREE OF PROTECTION TO THE BLUFFS, ESPECIALLY FROM THE NORTHEAST, A NARROWER BEACH CAN BE UTILIZED AS A PROTECTIVE BEACH.
BY INSPECTION OF OTHER GROIN IMPOUNDMENTS EAST OF THE DIKE AREA, AN ESTIMATE WAS MADE ON THE SHAPE OF THE SHORELINE UNDER PREVAILING WAVE CONDITIONS. THIS LED TO THE CHOICE OF A 25 FT WIDE BEACH DIRECTLY IN THE LEE OF THE GROIN EXPANDING TO A WIDER BEACH DOWNDRIFT (SEE CALCULATIONS ON FOLLOWING PAGE)

IN ORDER TO MAINTAIN THIS PROTECTIVE BEACH, PERIODIC NOURISHMENT WILL BE NECESSARY AS NO GROIN FIELD IS 100% EFFECTIVE IN TRAPPING AND MAINTAINING SAND. THE ACTUAL EFFICIENCY OF THE GROINS WOULD HAVE TO BE DETERMINED BY A YEARLY INSPECTION OF FILL QUANTITY MAINTAINED. FOR THE PURPOSES OF THIS STUDY ASSUME THAT THE GROINS ARE 50% EFFECTIVE. THIS MEANS 50% of 5400 YD^3/YR WOULD HAVE TO BE REPLACED AS THIS 5400 YD^3 IS THE QUANTITY ERODING ALONG THIS SHORELINE AND TRAPPED BY THE DIKE, USING WORST CASE ESTIMATES.

AFTER A FEW ITERATIONS VARYING GROIN LENGTH TO GROIN SPACING THE FOLLOWING COMBINATION WAS CHOSEN FOR DESIGN:



SPACING: 500 FT ℄ to ℄

FROM AERIAL PHOTOS EQUILIBRIUM BEACH UPDRIFT REMAINED PARALLEL TO SHORE FOR 1/6 OF DISTANCE BETWEEN GROINS THEN ANGLED LAKEWARD $\alpha = 8.5°$ ($\tan\alpha = 0.15$)

THEREFORE MAXIMUM WIDTH OF BEACH ON DOWNDRIFT SIDE OF GROIN FIELD WOULD BE

$$25' \text{ MIN} + \frac{5}{6}(500)(0.15) = 25 + 62.5 = 87.5 \text{ FT}$$

UTILIZING THE MEAN OFFSHORE SLOPES FROM THE 1980 SURVEY WITHIN THE STUDY AREA

$m = 0.065$ L.W.D to −6 FT

$m = 0.025$ −6 FT to −12 FT

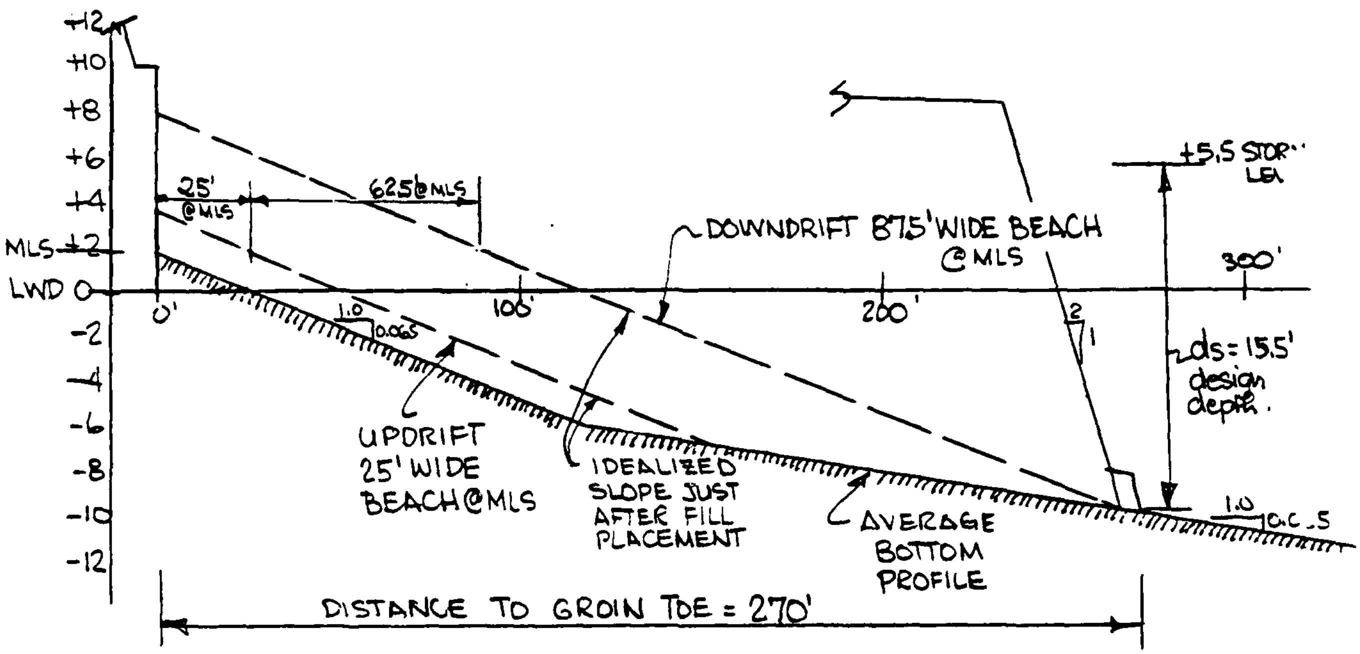
$m = 0.005$ −12 FT to −14 FT

DETERMINE THE GROIN LENGTH USING THE DOWNDRIFT WIDTH OF FILL OF 87.5 FT @ M.L.S.

THIS WILL ALSO DETERMINE THE DESIGN WATER DEPTH FOR DETERMINATION OF GROIN ARMOR STONE SIZES

IN ALL CALCULATIONS THE 20 YEAR RETURN PERIOD LAKE LEVEL OF 574.1 IGLD (ELEV. +5.5 WRT L.W.D) WILL BE USED

GROIN LENGTH & DESIGN DEPTH



PRELIMINARY GROIN LENGTH = 270'

DESIGN WATER DEPTH AT TOE = 15.5' UNDER STORM CONDITIONS

WAVE HEIGHT AT 15.5 FT DEPTH USING IRREGULAR WAVE THEORY ASSUME DIRECTION 2 : $H_o = 9.8'$, $T = 7.2$ sec, $\alpha_o = 0°$

$$\frac{d_s}{gT^2} = \frac{15.5}{32.2(7.2)^2} = 0.0093$$

$K_R = 0.92$ $H_o' = H_o K_R = 9.02'$

$$\frac{H_o'}{L_o} = \frac{9.02}{5.12(7.2)^2} = 0.034 \qquad \frac{d_s}{H_o'} = 1.72$$

use $m = 0.01$ ½ to 1 wave length seaward of toe

$H_s/H_o' = .93$ $H_s = 8.4'$
$H_{max}/H_o' = 1.21$ $H_{max} = 10.9'$ } STRUCTURAL HEAD

FOR STRUCTURAL TRUNK $d_s = 14.0'$ $H_{s\,max} = 10.0'$ per IRREGULAR WAVE THEORY.

6

REGULAR WAVE THEORY FROM SPM FIGURE 7-4 SUGGESTS A BREAKING WAVE HEIGHT OF 12.8 FT FOR THESE CONDITIONS. CONSIDERING THE CURRENT INADEQUACIES OF IRREGULAR WAVE THEORY AS APPLIED TO EMPIRICAL FORMULAE USED FOR DESIGN, USE $H_{MAX} = 10.9$ FT FROM THE IRREGULAR THEORY AND CONSIDER THIS A BREAKING WAVE FOR CONSERVATISM.

$$H_b \text{ design} = 10.9 \text{ FT}$$

- DESIGN OF ARMOR LAYER

$$W = \frac{w_r H^3}{K_D (S_r - 1)^3 \cot\theta}$$

W = weight of armor unit lbs.
w_r = stone density 155 lb/ft³
H = design wave height
K_D = stability coefficient
= 2.5 for breaking wave condition on structural head
= 3.5 for breaking wave condition on structural trunk
S_r = specific gravity of armor
= 155/62.4 = 2.48
$\cot\theta$ = side slope = 2.0

structural head

$$W = \frac{155\,(10.9)^3}{2.5\,(2.48-1)^3(2.0)} = 12{,}400 \text{ lbs.}$$

structural trunk

$$W = \frac{155\,(10.0)^3}{3.5\,(2.48-1)^3(2.0)} = 6830 \text{ lbs}$$

- HEAD ARMOR ALLOWABLE GRADATION

0.9W to 2.0W = 11,160 lbs to 24,800 lbs
OR 5.5 TONS to 12.5 TONS

- MINIMUM CREST WIDTH

$$B = n_2 k_\Delta \left(\frac{W}{W_r}\right)^{1/3} = 3\,(1.15)\left(\frac{12400}{155}\right)^{1/3} = 14.86' \text{ say } 15.0'$$

MAKE ROUNDHEAD DIAMETER = 15.0'

- ARMOR LAYER THICKNESS AT ROUNDHEAD

$$r = n k_\Delta \left(\frac{W}{w_r}\right)^{1/3} = 2(1.15)\left(\frac{12400}{155}\right)^{1/3} = 9.91' \text{ say } 10'$$

$r = 10'$ FOR 2 LAYERS OF ARMOR
ARMOR EXTENDS TO BOTTOM SINCE $d_s < 1.5H$.

- ROUNDHEAD

UNDERLAYER STONE

SIZE: 0.06W to 0.2W = 744 lbs to 2480 lbs
say 750 to 2500 lbs

THICKNESS: $r = 2(1.15)\left(\frac{1240}{155}\right)^{1/3} = 4.6'$

BEDDING STONE

SIZE: 0.00015 W to 0.01W = 1.86 lbs to 124 lbs
THICKNESS: ASSUME 2 FT. say 2 to 125 lbs.

- TRUNK ARMOR ALLOWABLE GRADATION

0.9 W to 2.0W = 6150 lbs to 13660 lbs
OR 3 tons to 7 tons

- TRUNK CREST WIDTH

$$B = 3(1.15)\left(\frac{6830}{156}\right)^{1/3} = 12.1' \quad \text{use } 12'$$

ARMOR THICKNESS

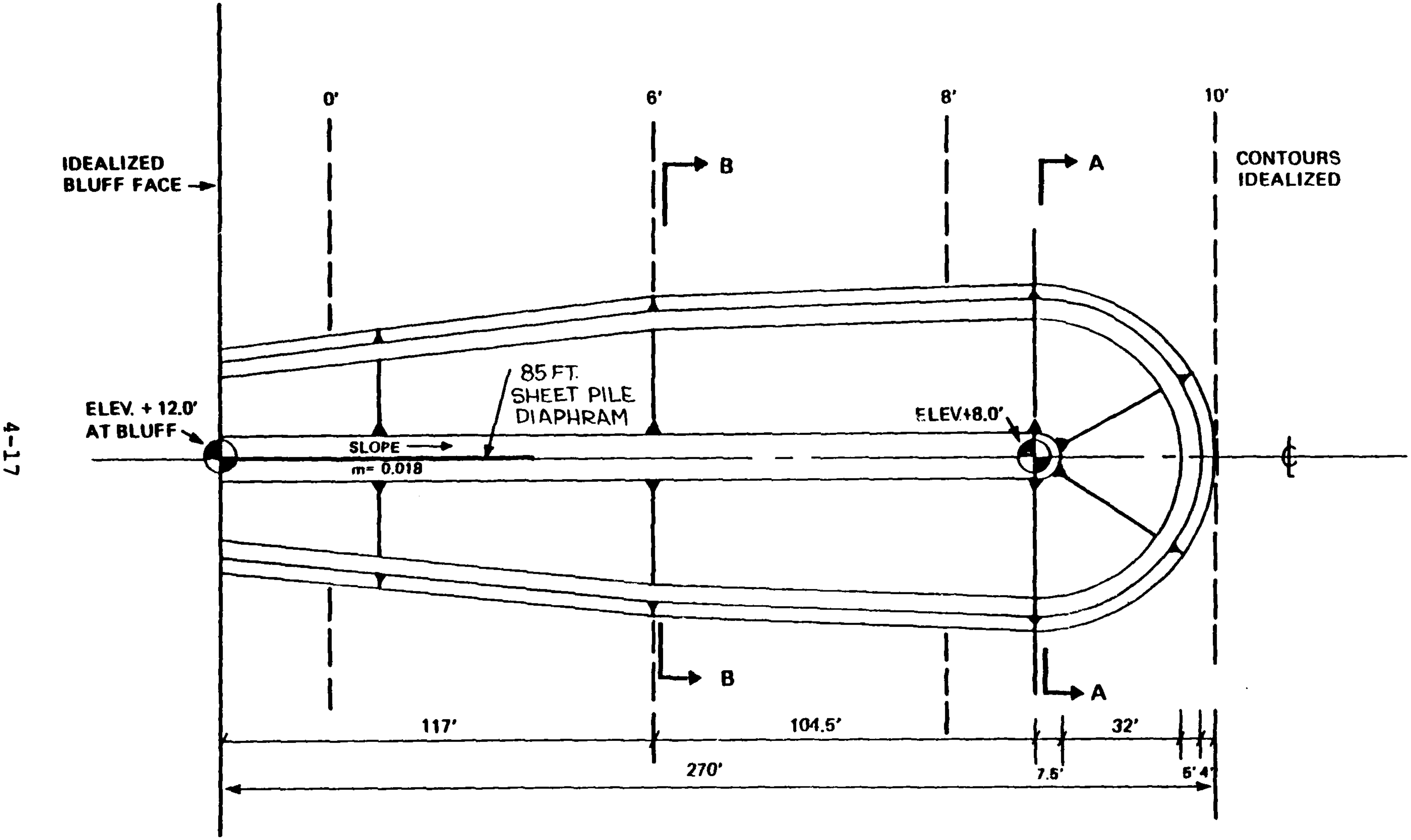
$$r = 2(1.15)\left(\frac{6830}{155}\right)^{1/3} = 8'$$

- TRUNK UNDERLAYER

SIZE: 0.06W to 0.2W = 410 to 1400 lbs
THICKNESS: $r = 2(1.15)\left(\frac{683}{155}\right)^{1/3} = 3.8'$ say 400 to 1400 lbs

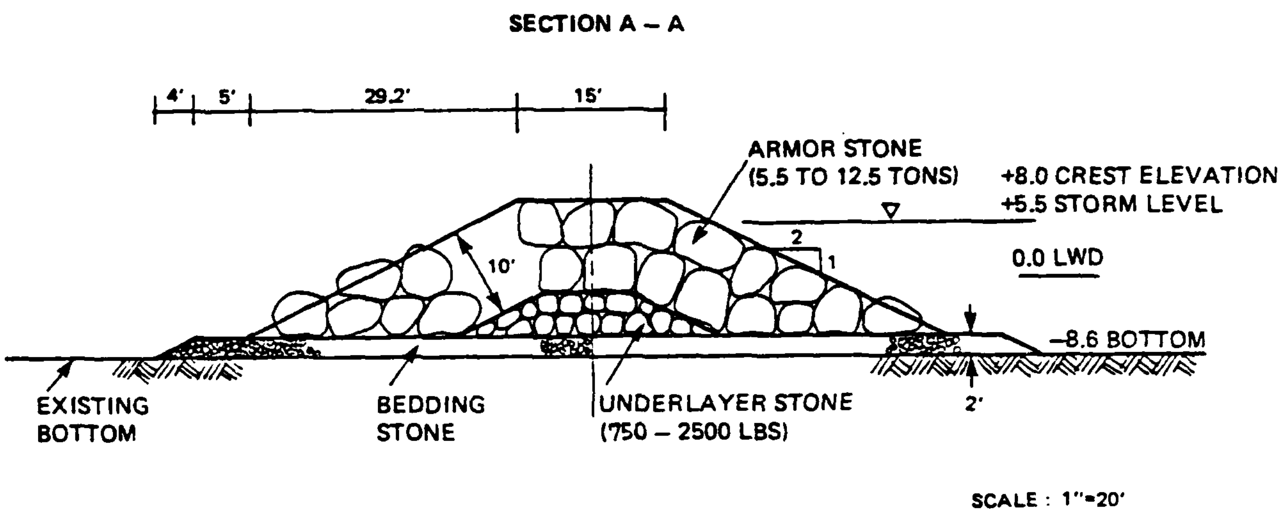
BEDDING STONE

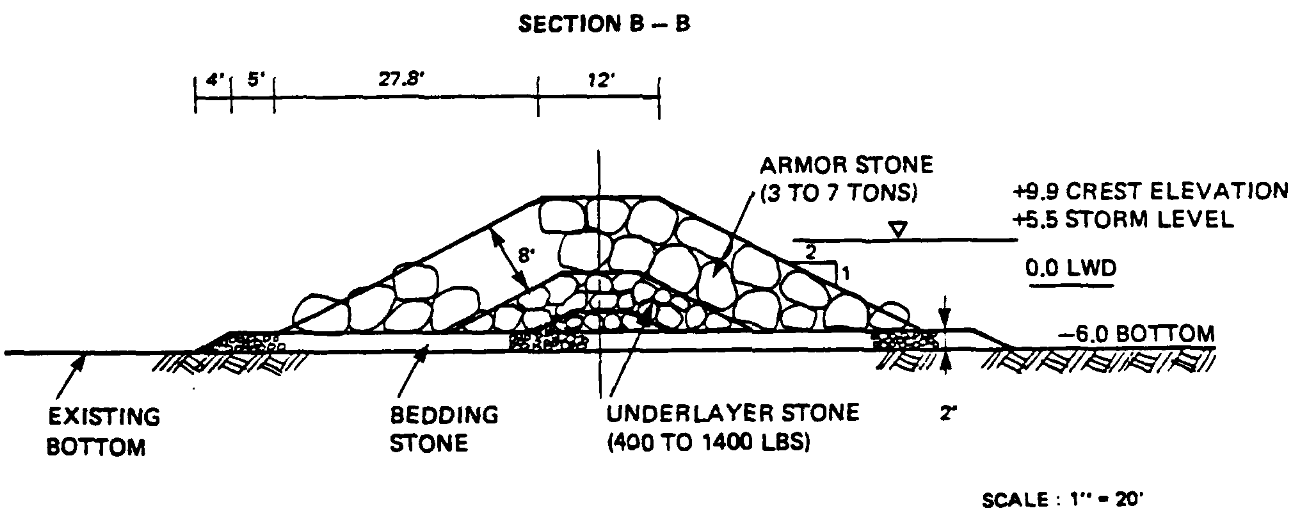
SIZE: 0.00015 W to 0.01W = 1.0 to 68 lbs
THICKNESS: ASSUME 2 FT. say 1 to 70 lbs



PLAN VIEW - TYPICAL GROIN

Scale: 1 inch = 40 feet





TYPICAL GROIN CROSS SECTIONS

10

ALTERNATIVE IV : GROINS WITH BEACH FILL – QUANTITIES

AT ROUNDHEAD - BEDDING LAYER

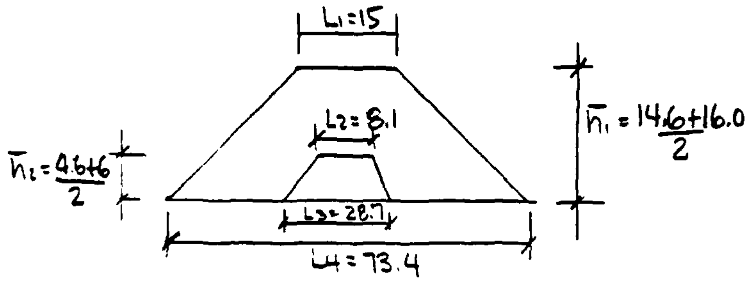
AVE. RADIUS $= \frac{46.5+43.7}{2} = 45.1'$ AT MIDSLOPE OF BLANKET

AREA $= \frac{1}{2}\pi\bar{R}^2 = 3195\ ft^2$

VOL $= 3195 \times 2 = 6390\ ft^3 = 237\ yd^3$

ARMOR LAYERS

FIND SURFACE AREA FOR AN AVERAGE 2 STONE THICK VOLUME



Volume of total truncated cone

$$V = \frac{1}{3}\pi\bar{h}_1\left(\left(\frac{L_1}{2}\right)^2 + \left(\frac{L_4}{2}\right)^2 + \frac{L_1 L_4}{4}\right)$$

$V = 26892\ ft^3$

Volume of underlayer cone

$$V = \frac{1}{3}\pi\bar{h}_2\left(\left(\frac{L_2}{2}\right)^2 + \left(\frac{L_3}{2}\right)^2 + \frac{L_2 L_3}{4}\right)$$

$V = 1556\ ft^3$

Volume of ARMOR LAYER $= \frac{1}{2}(26892-1556) = 12668\ ft^3$

SURFACE AREA FOR AVERAGE 10' THICK VOLUME $= 1267\ ft^2$

NUMBER OF UNITS

$$N_r = A\, n\, k_\Delta \left(1 - P/100\right)\left(\frac{w_r}{W}\right)^{2/3} = 1267\,(2)(1.15)(.63)\left(\frac{155}{12400}\right)^{2/3}$$

$N_r = 99$ units @ 12400 lbs/unit

OR 614 TONS OF 5.5 to 12.5 TON UNITS

Volume of UNDERLAYER $= \frac{1}{2}(1556) = 778\ ft^3$

SURFACE AREA FOR AVERAGE 4.6' THICK VOLUME $= 169\ ft^2$

$$N_r = 169\,(2)(1.15)(.63)\left(\frac{155}{1240}\right)^{2/3} = 61.2$$

$N_r = 61$ units @ 1240 lbs/unit

OR 38 TONS OF 750 to 2500 lbs UNITS.

TOTAL ROUNDHEAD QUANTITIES FOR 4 GROINS:

948 yd³ ≈ 1450 TONS BEDDING STONE @ 2.0 to 125 #

2450 TONS ARMOR STONE @ 5.5 to 12.5 TONS

150 TONS UNDERLAYER @ 750 to 2500 #

AT TRUNK

BEDDING LAYER

AVERAGE WIDTHS AT MID-SLOPE OF LAYER

@ BLUFF ; $\bar{W} = 4 \times 10 + 10 + 12 - 4 = 58'$

@ 6' CONTOUR 117 ft from BLUFF ; $\bar{W} = 4 \times 15.9 + 10 + 12 - 4 = 81.6'$

@ INTERFACE WITH ROUNDHEAD 221.5 ft from BLUFF; $\bar{W} = 4 \times 16.6 + 10 + 12 - 4 = 84$

WIDTH x THICK x LENGTH

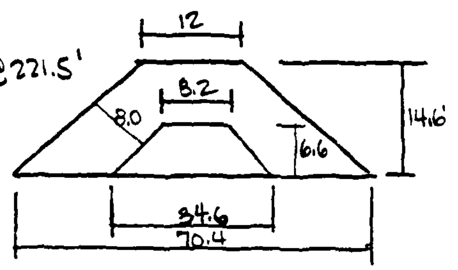
$$\text{Volume} = \frac{58+81.6}{2} \times 2 \times 117 + \frac{81.6+84.4}{2} \times 2 \times 104.5 = 33680 \text{ ft}^3$$

$$\text{Volume} = 1247 \text{ yd}^3$$

ARMOR LAYERS

CROSS SECTIONAL AREAS AT 0', 117' & 221.5' from BLUFF

@221.5'



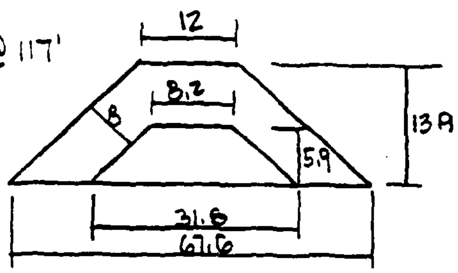
TOTAL AREA = $\frac{12+70.4}{2} \times 14.6 = 601.5$

SECOND AREA = $\frac{8.2+34.6}{2} \times 6.6 = 141.2$

ARMOR $\overline{\text{AREA}}$ = $601.5 - 141.2 = 460.3 \text{ ft}^2$

UNDERLAYER $\overline{\text{AREA}}$ = 141.2 ft^2

@ 117'



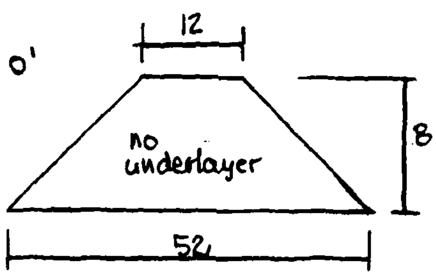
TOTAL AREA = $\frac{12+67.6}{2} \times 13.9 = 553.2$

SECOND AREA = $\frac{8.2+31.8}{2} \times 5.9 = 118.0$

ARMOR $\overline{\text{AREA}}$ = $553.2 - 118.0 = 435.2 \text{ ft}^2$

UNDERLAYER $\overline{\text{AREA}}$ = 118.0 ft^2

@ 0'



TOTAL AREA = $\frac{12+52}{2} \times 8 = 256 \text{ ft}^2$

ARMOR AREA = 256 ft^2

UNDERLAYER AREA = 0 ft^2 @ BLUFF

AT TRUNK

ARMOR LAYER VOLUME = $\frac{460.3 + 435.2}{2}(104.5) + \frac{435.2 + 256}{2}(117)$

= 87,225 ft^3

SURFACE AREA FOR AVERAGE 8' THICK VOLUME = $\frac{87225}{8}$ = 10903 ft^2

NUMBER OF UNITS $N_r = 10903\,(2)(1.15)(.63)\left(\frac{155}{6830}\right)^{2/3} = 1266$

OR 1266 (6830#/unit) = 4323 TONS OF 3 to 7 TON UNITS

UNDERLAYER VOLUME = $\frac{141.2 + 118.0}{2}(104.5) + \frac{118.0 + 0}{2}(117)$

= 20450 ft^3

SURFACE AREA FOR AVERAGE 3.8' THICK VOLUME = $\frac{20450}{3.8}$ = 5382 ft^2

NUMBER OF UNITS $N_r = 5382\,(2)(1.15)(.63)\left(\frac{155}{683}\right)^{2/3}$ = 2901

OR 2901 (.1 (6830)#/unit) = 990 TONS OF 400 to 1400 # UNITS

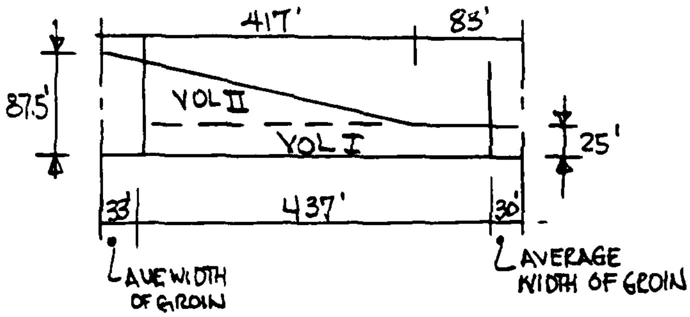
TOTAL TRUNK QUANTITIES FOR 4 GROINS:

5000 yd^3 ≈ 7500 TONS BEDDING STONE @ 1 to 70 lbs.

17300 TONS ARMOR STONE @ 3 to 7 TONS

3950 TONS UNDERLAYER STONE @ 400 to 1400 lbs

BEACH FILL



WIDTH OF FILL PER BAY

500 FT	℄ to ℄ GROINS
− 30 FT	AVERAGE WIDTH OF GROINS FOR 25' & 87.5' WIDE BEACHES
− 33 FT	
437 FT	

25' & 87.5' ARE WIDTHS OF BEACH FILL AT M.L.S. (+1.8)
TOTAL FILL EXTENDS FROM +4.0 FT AT THE UPSTREAM (EAST) END OF THE COMPARTMENT TO +8.0 FT DOWNSTREAM. SEE DIAGRAM PG. 4-14

BEACH FILL

PER SKETCH, CROSS SECTIONAL AREA OF FILL IS:

FOR 437 ft of 25 ft wide beach @ MLS

$25 \times \left[1.625/2 + 4 \times 1.625 + 1.2 + 0/2 \right] = 212.8\ ft^2$

FOR 417 - 33 = 384 ft of (87.5 - 25) ÷ 2 = 31.25 ft wide beach

$1/2 \times 25 \times \left[4.06/2 + 6 \times 4.06 + 3.6 + 2.6 + 1.6 + 0.6 + 0/2 \right] = 434.9\ ft^2$

TOTAL VOLUME OF FILL = 212.8 (437) + 434.9 (384)

= 259,995 ft^3 = 9630 yd^3

TOTAL FILL FOUR BAYS = 38520 yd^3 BEACH SAND

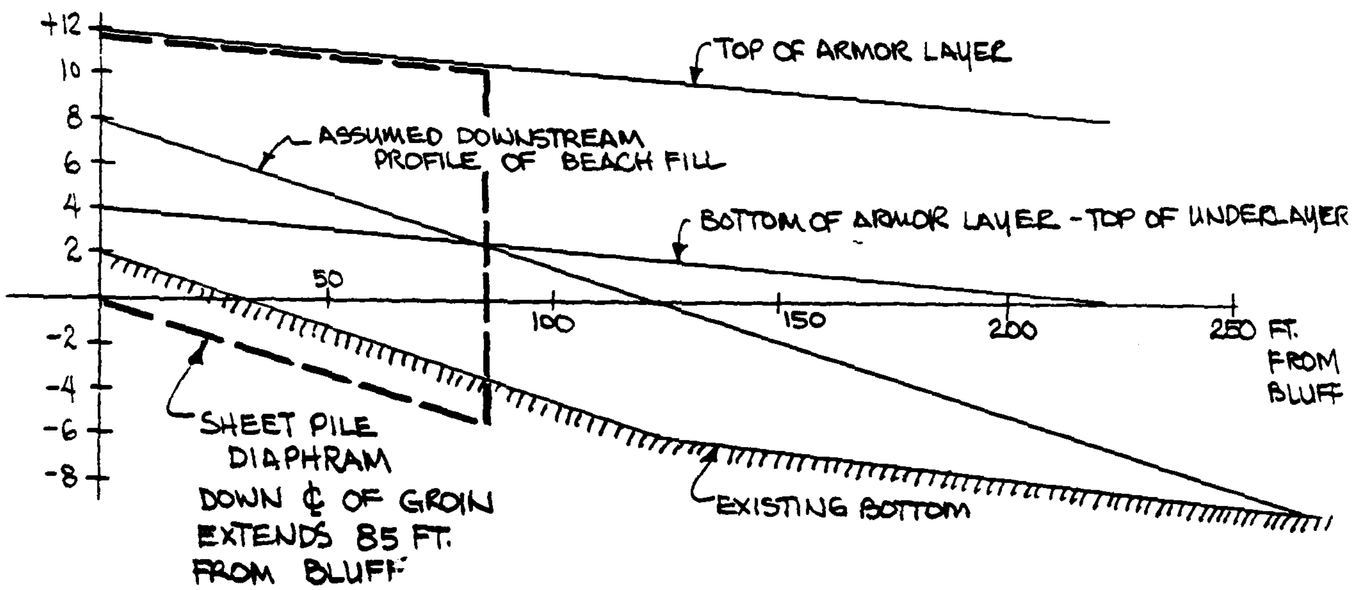
= 58250 tons

PERIODIC NOURISHMENT

ASSUMED AT 50 % OF 5400 = 2700 yd^3/yr.

DIAPHRAM

SHOULD EXTEND DOWN CENTERLINE OF GROIN FAR ENOUGH OFFSHORE TO PREVENT TRANSMISSION OF SAND THROUGH GROIN ARMOR LAYER. SEE SKETCH BELOW.



DIAPHRAM QUANTITY FOR FOUR GROINS

ASSUMING STEEL SHEET PILES PMA-22

LENGTH = 85 FT

AVERAGE HEIGHT = $\frac{12\text{ FT} + 16\text{ FT}}{2}$ = 14 FT

SQUARE FOOTAGE PER GROIN = 14×85 = 1190

TOTAL FOR FOUR GROINS = 4760 FT^2

SAY 4750 FT^2 TOTAL

COST OF EASEMENTS & ACCESS

SEE REVETMENT DESIGN PAGES FOR EXPLANATION OF

EASEMENTS ACQUIRED $17,750

PLUS 3 ACCESSES ON CITY PROPERTY

WITH STAGING & STOCKPILE AREAS

EXCEPT IN GROIN PLAN ACCESS DOWN TO THE BEACH

WILL BE REQUIRED AT EACH ACCESS POINT TO

REDUCE THE LENGTH OF MATERIAL RUNS AND

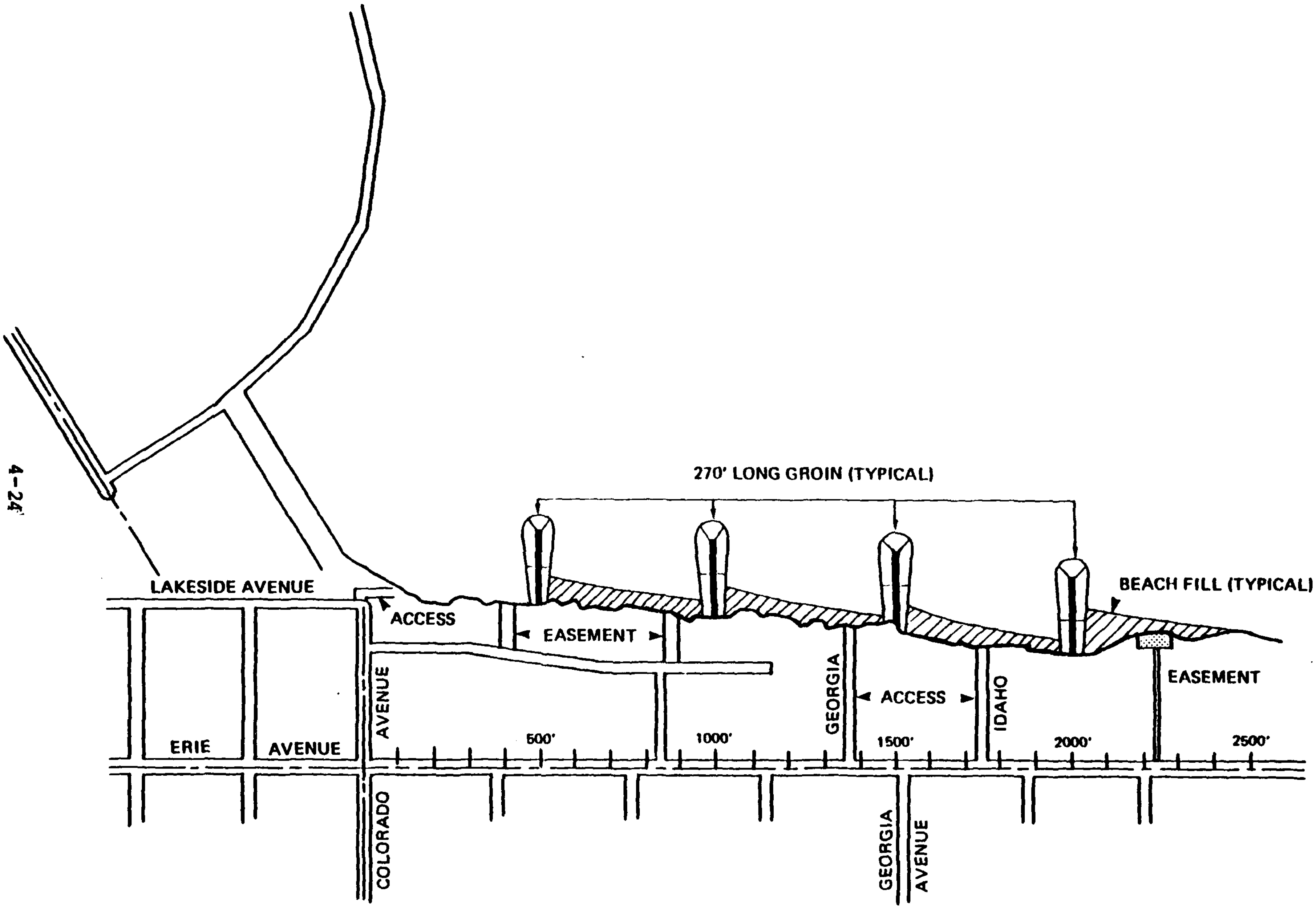
TEMPORARY FILL NEEDED

ASSUME CONSTRUCTION ROADS & AREAS COST $30,000

ACCESS AT 4 POINTS TO BE MAINTAINED FOR NOURISHMENT PURPOSES

METHODS:

1. CONSTRUCT ACCESS ROADS FROM BLUFF TO BEACH AT DESIGNATED LOCATIONS
2. DEPOSIT SAND FILL & COVER LAYERS FROM ACCESS POINTS TO GROIN ℄'S
3. PLACE MATERIALS IN QUANTITIES PER DESIGN DIMENSIONS CONTINUOUSLY ADVANCING OFFSHORE
4. USE TOP OF GROIN AS CONSTRUCTION ROADWAY
5. DEPOSIT BEACH SAND FILL PER DESIGN DIMENSIONS
6. REMOVE TEMPORARY ROADWAY USING THIS MATERIAL AS BACK FILL TO REPAIR RAMPS AT 5 ACCESS POINTS TO ORIGINAL BLUFF CONTOURS AND PROTECTIVE STATE.



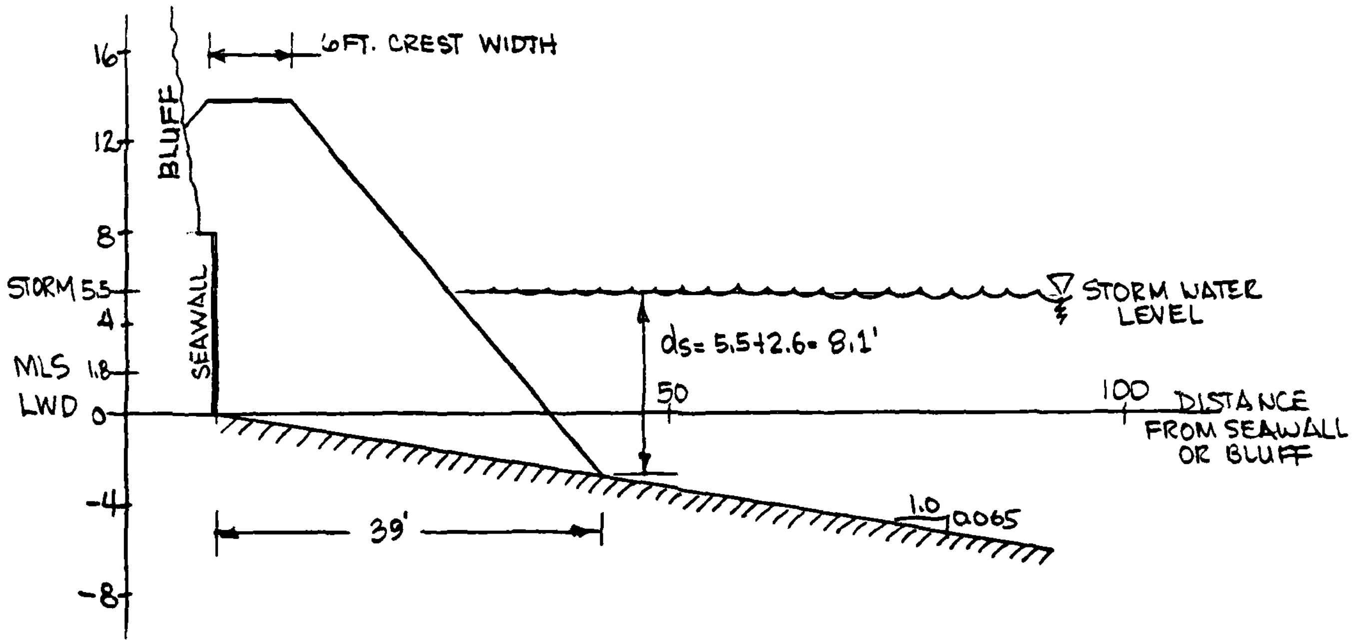
ALTERNATIVE IV GROINS WITH BEACH FILL

2

ALTERNATIVE V BLUFF REVETMENT

EXTENT OF REVETMENT SHOULD BE SUCH THAT IT PROTECTS THE DAMAGED AREA AS DETERMINED BY THE ACCRETION/EROSION CALCULATIONS. WE KNOW FROM PROFILE COMPARISONS THAT STATIONS 0 to 5+00 IN THE FILLET AREA ARE NOT ERODING THEREFORE THIS ZONE NEED NOT BE PROTECTED REVETMENT SHOULD EXTEND HOWEVER FROM STA 5+00 to STA 25+00.
TOTAL LENGTH 2000 FT.

AVERAGE CROSS SECTION AT BLUFF ASSUMING NEARSHORE SLOPE OF M= 0.065 IS:



FOR DESIGN CONDITIONS

LAKE LEVEL: FOR A 20 YR RECURRENCE INTERVAL = 574.1 (IGLD) = +5.5 (LWD)

WAVES: USE DIRECTION 2 APPROACH OF H_0 = 9.8', T = 7.2 sec, α_0 = 0

SLOPE: 1/2 to 1 WAVE LENGTH SEAWARD IS 1/50 OR 0.02 APPROX.

CREST WIDTH: USE MINIMUM NEEDED FOR DESIGN CROSS SECTION OR AS NECESSARY TO ALLOW A 12 FT. CONSTRUCTION ACCESS ON BEDDING LAYER AT MEAN LAKE STAGE.

FROM IRREGULAR WAVE THEORY

$\frac{d_s}{gT^2} = \frac{8.1}{32.2(7.2)^2} = 0.0049$ $K_R = 0.91$

$H_o' = H_o K_R = 8.92'$

$\frac{H_o'}{L_o} = \frac{8.92}{5.12(7.2)^2} = 0.034$ $\frac{d_s}{H_o'} = 0.92$

for $m = 0.02$ $H_s/H_o' = .61$ $H_s = 5.4'$

$H_{max}/H_o' = .76$ $H_{max} = 6.8'$

REGULAR WAVE THEORY FROM SPM FIGURE 7-4 SUGGESTS A BREAKING WAVE HEIGHT OF 7.6' FOR THESE CONDITIONS. THEREFORE USE HMAX AS Hb FOR CONSERVATISM CONSIDERING THE CURRENT INADEQUACIES OF IRREGULAR WAVE THEORY AS APPLIED TO EMPIRICAL EQUATIONS USED IN DESIGN.

$H_{b\,design} = 6.8'$ $H_o' = 8.92'$

ASSUMING A PERMEABLE RUBBLE MOUND REVETMENT WITH SIDE SLOPES 1:2 AND $H_o' = 8.92'$

$\frac{H_o'}{gT^2} = 0.0053$ from SPM fig 7-10 ($d_s/H_o' = 0.08$) $R/H_o' = 2.4$ } smooth impermeable slopes fronted by $m = 1:10$

from SPM fig 7-11 ($d_s/H_o' = 2.00$) $R/H_o' = 2.5$

this case $d_s/H_o' = 0.92$ ∴ $R/H_o' = 2.41$

apply correction factor figure 7-13 $k = 1.19$ for $\cot\theta = 2.0$

from figure 7-20 ($d_s/H_o' > 3$)

smooth 1:2 slope $R/H_o' = 1.95$

permeable rubble 1:2 slope $R/H_o' = 0.9$

ratio $\frac{rubble}{smooth} = \frac{.9}{1.95} \times \frac{R}{H_o'}_{smooth} \times k = \frac{.9}{1.95} \times 2.41 \times 1.19$ for 1:10 fronting slopes

from irregular wave theory

$m = 0.1$ $H_m/H_o' = 1.10$

$m = 0.02$ $H_m/H_o' = 0.76$

∴ for rubble, permeable, 1:2 slopes; where $d_s/H_o' = 0.92$ & $m = 0.02$

$$\frac{R}{H_o'} = \frac{.76}{1.10} \times \frac{.9}{1.95} \times 2.41 \times 1.19 = 0.91$$

RUNUP $R = .91 \times 8.92 = 8.1$ ft.

REVETMENT HEIGHT = R + STORM WATER LEVEL

= 8.1 + 5.5 = 13.6' ABOVE L.W.D.

- SKETCH AS SHOWN WITH REVETMENT AT ELEVATION +14.0 IS OK FOR RUNUP

- DESIGN OF ARMOR LAYER

$$W = \frac{w_r H^3}{K_D (S_r - 1)^3 \cot\theta}$$

$$W = \frac{155\ (6.8)^3}{3.5\ (2.48-1)^3\ 2.0}$$

$$W = 2150 \text{ lbs}$$

W = weight of armor unit in lbs.
wr = stone density assume 155 #/ft³
H = design wave height = 6.8'
K_D = stability coefficient of armor layer = 3.5 for breaking wave on structural trunk of random placed, rough angular quarrystone in 2 layers
S_r = specific gravity of armor stone = 155/62.4 = 2.48
$\cot\theta$ = side slope = 2.0

- ALLOWABLE GRADATION 0.9 W to 2.0 W OR
  1935 lbs to 4300 lbs
  say 1 to 2 1/4 TONS

- MINIMUM CREST WIDTH (BREAKWATER CROSS SECTION)

$$B = n_2 k_\Delta \left(\frac{W}{w_r}\right)^{1/3}$$

$$B_{min} = 3(1.15)\left(\frac{2150}{155}\right)^{1/3}$$

$$B_{min} = 8.3'$$

n_2 = number of stones in crest, minimum = 3
k_Δ = layer coefficient = 1.15 for 2 layers rough quarrystone
W = weight of individual armor unit
wr = stone density = 155 #/ft³

FOR REVETMENT B_{min} = 1/2 (8.3) = 4.2 FT ∴ 6 FT CREST IS ADEQUATE

- THICKNESS OF ARMOR LAYER

$$r = n_1 k_\Delta \left(\frac{W}{w_r}\right)^{1/3}$$

$$r = 2(1.15)\left(\frac{2150}{155}\right)^{1/3} = 5.5'$$

n_1 = number of stones in layer = 2 for this design

- EXTENT : $d_s < 1.5\,H$ ∴ EXTEND ARMOR TO BOTTOM

- UNDERLAYER STONE

  W MAX = 0.2 W = .2(2150) = 430 lbs } say 125 to 425#

  W MIN = 0.06 W = .06(2150) = 129 lbs }

  THICKNESS $r = n_1 k_\Delta \left(\frac{.1W}{w_r}\right)^{1/3}$ = 2.57 ft. for 2 stone layer

- BEDDING STONE

  WMAX = 0.01 W = 21.5 lbs } say 0.3 to 21 #

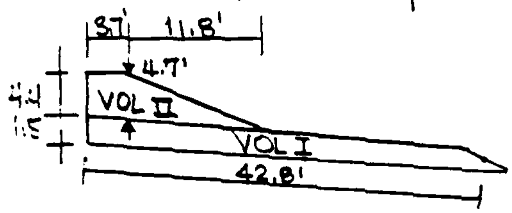
  WMIN = 0.00015 W = 0.32 lbs }

  THICKNESS USE 1.5 FT.

SEE FIGURE ON FOLLOWING PAGE FOR REVETMENT CROSS SECTION

REVETMENT QUANTITIES

- BEDDING & CORE LAYER



VOL I = 42.8×1.5 = 64.2 ft³/ft

VOL II = $3.7 \times \frac{4.4+4.7}{2} + \frac{4.7 \times 11.8}{2}$ = 44.6 ft³/ft

TOTAL VOLUME = 108.8 ft³/ft = 4.03 yd³/ft

for 2000 ft Volume = 8,060 yd³

≈ 12,100 TONS

- UNDERLAYER

  SURFACE AREA FOR AN AVERAGE 2 STONE THICK LAYER IS THE MID LENGTH OF THE LAYER × UNIT WIDTH

  $N_r = A\, n\, k_\Delta \left(1 - \frac{P}{100}\right)\left(\frac{w_r}{.1W}\right)^{2/3}$

  N_r = number of units in surface area A

  n = 2 stones in layer

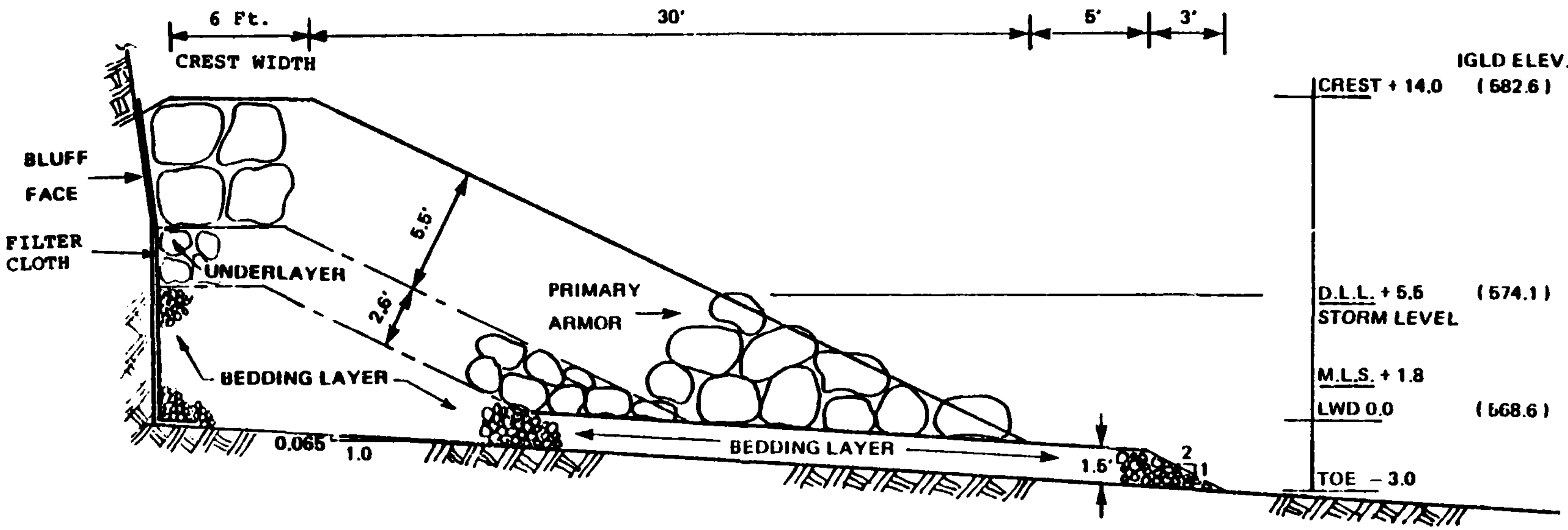
  from cross section as shown

  A = L×1ft = 20.2 ft²/ft

  $N_r = 20.2\,(2)(1.15)\left(1 - \frac{37}{100}\right)\left(\frac{155}{215}\right)^{2/3}$ = 23.53 units/ft

  Total number of units = 23.53 × 2000 = 47,060 units at .1W #/unit

  TONS OF UNDERLAYER NEEDED = 5,060 TONS



REVETMENT CROSS SECTION

- ARMOR

MIDLENGTH FROM CROSS SECTION = 32.0' $A = 32\ ft^2/ft$

$$N_r = 32(2)(1.15)(0.63)\left(\frac{155}{2150}\right)^{2/3} = 8.03 \text{ units/ft}$$

TOTAL NUMBER OF UNITS = 8.03 (2000) = 16,060 @ 2150#/unit

TONS OF ARMOR NEEDED = 17,250 TONS

- FILTER CLOTH LENGTH = 2000 FT, WIDTH = 16 FT; TOTAL 32,000 FT^2

CONSTRUCTION METHODS & EASEMENTS

FOR DELIVERY & TEMPORARY STOCKPILES OF MATERIALS ACQUIRE 3 EASEMENTS

VACANT LOT STA 4+20 APPROX		
PARCEL #9	46x93	$1380
VACANT LOT STA 8+90 APPROX		
PARCEL #20	44x93	$2190
A 20'x300 FT. ROAD TO A 50'x100' AREA ON		
PARCEL #42	50x50	$2450
PARCEL #43	50x50+20x300	$11730
TOTAL EASEMENTS		$17,750

ASSUMING PURCHASE PRICE OF LAND CONSTITUTES FAIR PRICE FOR EASEMENTS OVER 50 YR PROJECT LIFE

2 OTHER ACCESSES AT THE STREET ENDS OF GEORGIA (STA. 13+80 APPROX) and IDAHO (STA. 17+60 APPROX) CAN BE UTILIZED FOR INITIAL CONSTRUCTION TO DELIVER MATERIALS. IF NO STREET DAMAGE IS ASSUMED THESE ACCESSES COST $0.

MAIN ACCESS FOR HEAVY EQUIPMENT IS VIA COLORADO AVE STREET END AT SPENDING BEACH

THE AREA WEST OF THE SPENDING BEACH CAN BE USED AS THE MAJOR STAGING & STOCKPILE AREA FOR THE CONSTRUCTION

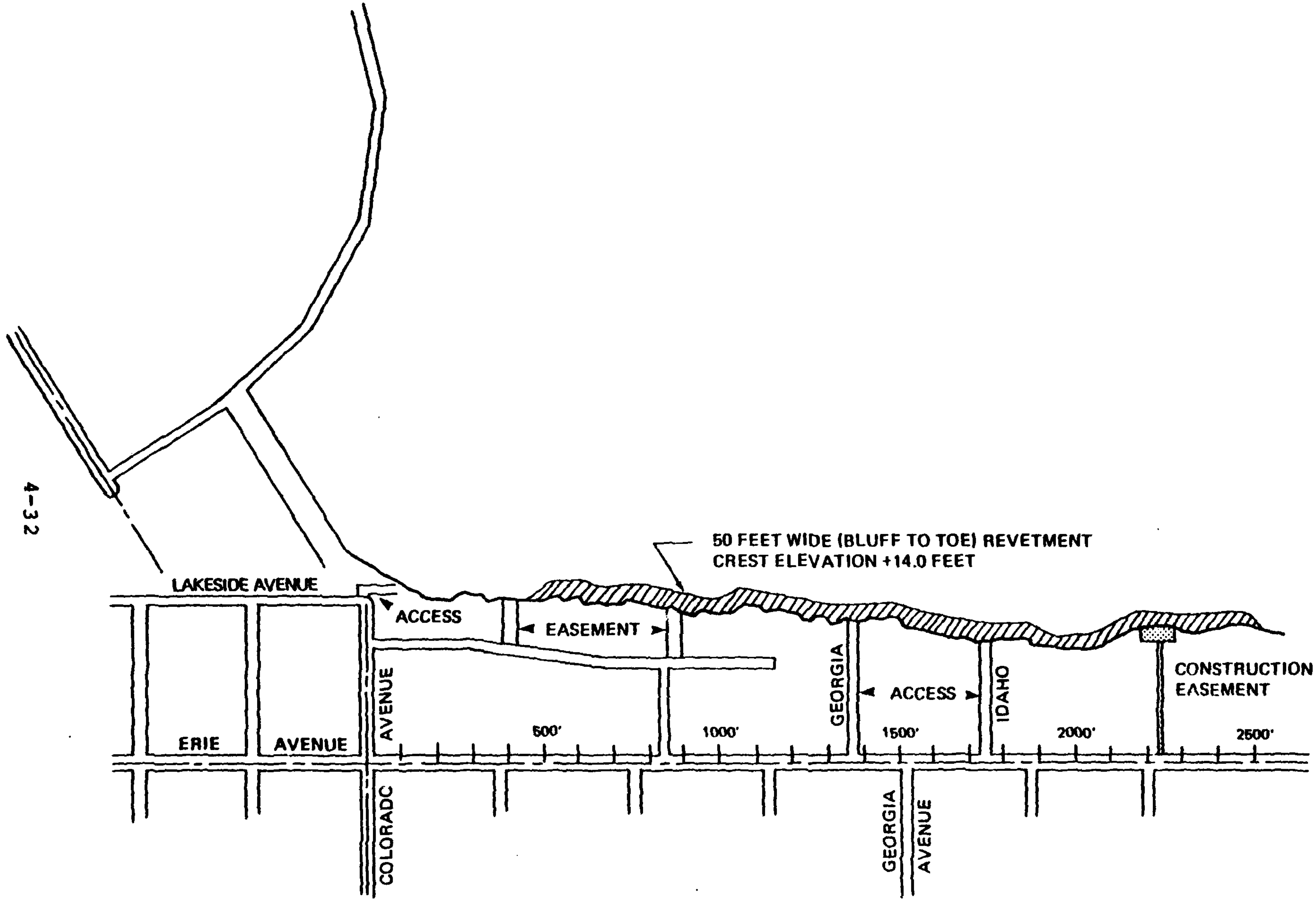
8

METHOD

AN OUTLINE OF A POSSIBLE CONSTRUCTION METHOD IS:

1. STARTING FROM COLORADO CONSTRUCT A TEMPORARY ROAD OUT OF BEDDING STONE TOWARDS STA. 5+00 KEEP THE WIDTH & ELEVATION OF THIS ROAD AS SMALL AS POSSIBLE
2. AFTER REACHING STA. 4+20 THE SUPPLY OF BEDDING STONE CAN COME FROM THIS ACCESS SO AS NOT TO CONTINUALLY RETURN TO THE COLORADO AVE. ACCESS. SUPPLY STONE AT 4+20 BY END DUMP OR CRANE REHANDLING.
3. FROM STA. 5+00 EAST BUILD UP BEDDING LAYER TO ELEVATION +6.0' FROM 12 FT WIDE ROAD
4. WHEN STA. 8+90 IS REACHED CONTINUE LAYING BEDDING LAYER SUPPLIED FROM THIS POINT STARTING AT STA. 5+00 WITH SUPPLY FROM STA. 4+20 EXTEND BEDDING LAYER INTO LAKE PER SPECS AND COVER WITH UNDERLAYER ARMOR SUPPLIED FROM COLORADO AVE. STAGING AREA
5. AS CONSTRUCTION PROGRESSES TO EAST, 4 PLACEMENTS FOLLOW BEHIND ONE ANOTHER UTILIZING THE 5 ACCESSES CREATED TO SUPPLY MATERIALS FOR EACH STAGE. THESE STAGES ARE:
   - A. CONSTRUCT BEDDING STONE ACCESS ROAD
   - B. EXTEND BEDDING STONE TO DESIGN DIMENSIONS
   - C. COVER & PROTECT BEDDING WITH UNDERLAYER ARMOR
   - D. COVER WITH ARMOR LAYER

FOR CONSTRUCTION ROADS & AREAS ASSUME A FIRST COST OF $20,000 TO COVER ROADS AT THE 3 EASEMENTS AND THE TEMPORARY BEDDING LAYER PLACED FROM STA. 0 to STA. 5+00.



A RNATIVE V REVETMENT PLAN

MATERIALS SURVEY FOR LORAIN HARBOR SECTION 111

General

A materials survey was performed in September 1980 to determine possible sources for the Lorain Harbor Section 111 Project. The survey consisted of a file search and communications with suppliers in which the following were considered: An analysis of the results of quarry investigations, an analysis of laboratory test results, the evaluation of available service records, and the determination of interest in producing required materials on the part of the quarry/pit operators.

Material Types and Gradations

Design

Three possible designs will be considered for the Lorain Harbor Section 111 beach erosion control project. They are: establishment of a feeder beach, beach restoration and groin compartmentation, and revetment.

The feeder beach plan involves the initial placement of sand in the eroded shore sector with periodic replenishment of sand in the form of a stockpile on the shoreline. This stockpile will serve as a source of sand and must be equivalent to 18,500 cubic yards initially and 5,400 cubic yards per year, with the sand being of suitable size characteristics.

The groin system with fill includes the construction of a sand beach with groin compartmentation. To maintain the 2,000-foot shore segment, 4 groins spaced 500 feet apart with a length of about 270 feet would be required. The material required for this alternative includes:

Item	Size	Quantity
Head Armor	5.5 - 12.5 tons	2,450 tons
Trunk Armor	3 - 7 tons	17,300 tons
Head Underlay	750 - 2,500 lbs.	150 tons
Trunk Underlayer	400 - 1,400 lbs.	3,950 tons
Head Bedding	2.0 - 125 lbs.	1,450 tons
Trunk Bedding	1 - 70 lbs.	7,500 tons
Sand (First Placement Only)		38,500 cubic yds.

The third alternative plan is a rubble revetment along 2,000 feet of shoreline. Beach revetment materials include:

Item	Size	Quantity
Armor	1 - 2.25 tons	17,250 tons
Underlayer	125 - 425 lbs.	5,060 tons
Bedding	0.3 - 21 lbs.	12,100 tons

Specific Gravity of Stone Materials

A specific gravity of 2.48 (155 pcf) was used to compute the stone sizes for the three stone types. A variation in specific gravity equal to ± 5 percent (2.36 to 2.60) is acceptable. It will be necessary to redesign stone sizes for any source used having a stone material whose specific gravity is not 2.48 $\pm$ 5 percent.

Material Quality

General

Quality requirements for each material type are discussed below. The bedding stone, armor stone, underlayer, and blanket and core have been subjected to the tests established by the Ohio River Division Laboratories, Cincinnati, OH. Test No. P-9, "Riprap and Breakwater Stone Evaluation," includes a suite of tests to determine stone durability.

Armor, Bedding, Underlayer Stone, and Blanket and Core

The stone to be used for this purpose will be free from significant cracks, seams, and overburden spoil. The sources which are suitable for this must not show significant breakdown in the freeze-thaw or wet-dry tests.

Material Sources

General

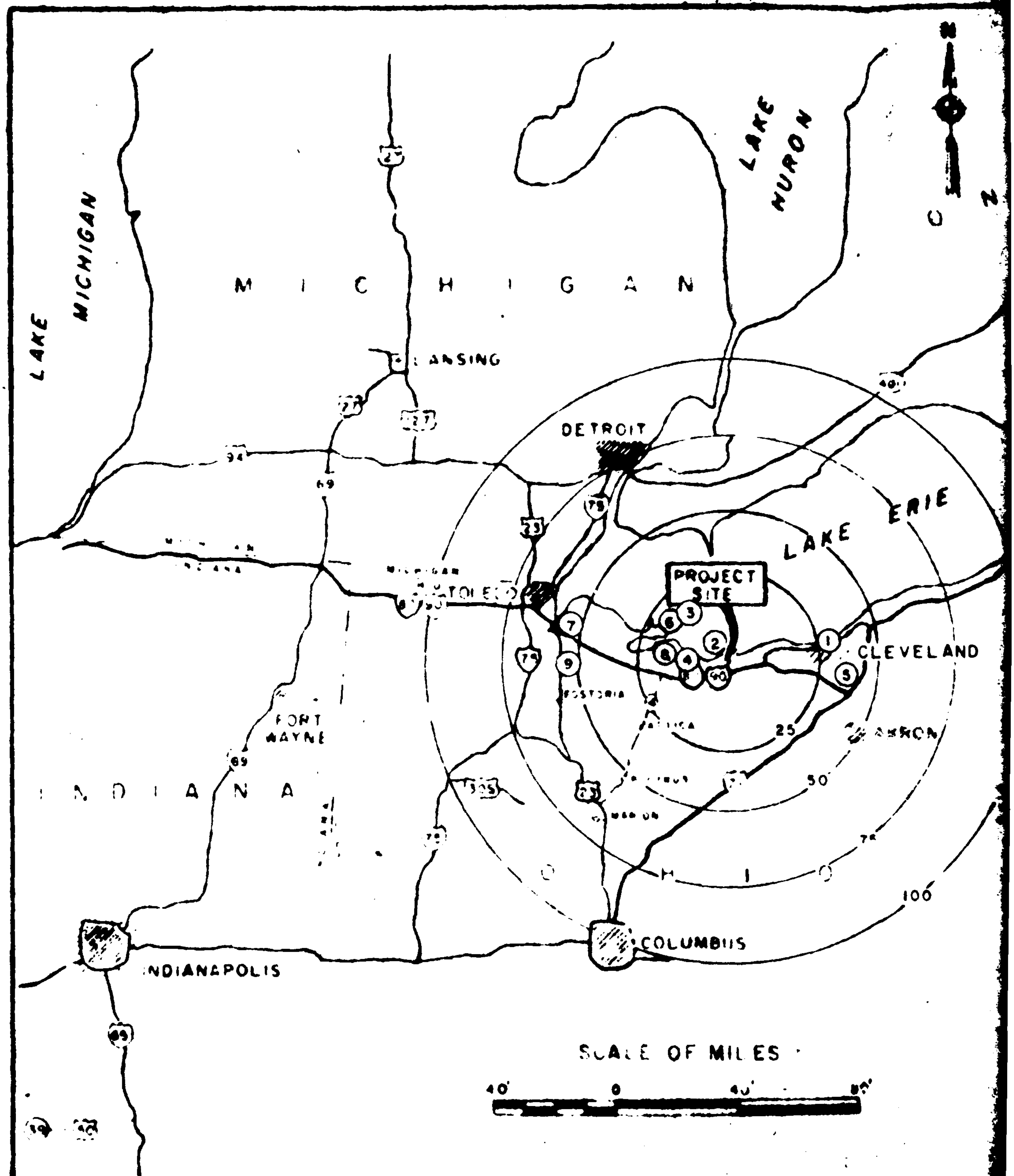
Armor, bedding, underlayer stone, blanket and core, and sand can be produced from the indicated sources listed in the "Possible Material Sources." It is possible that all the material from these sources is not suitable. The right will be reserved in the specifications to reject materials from certain localized areas, zones, strata, channels, or stockpiles when such materials are deemed unsuitable.

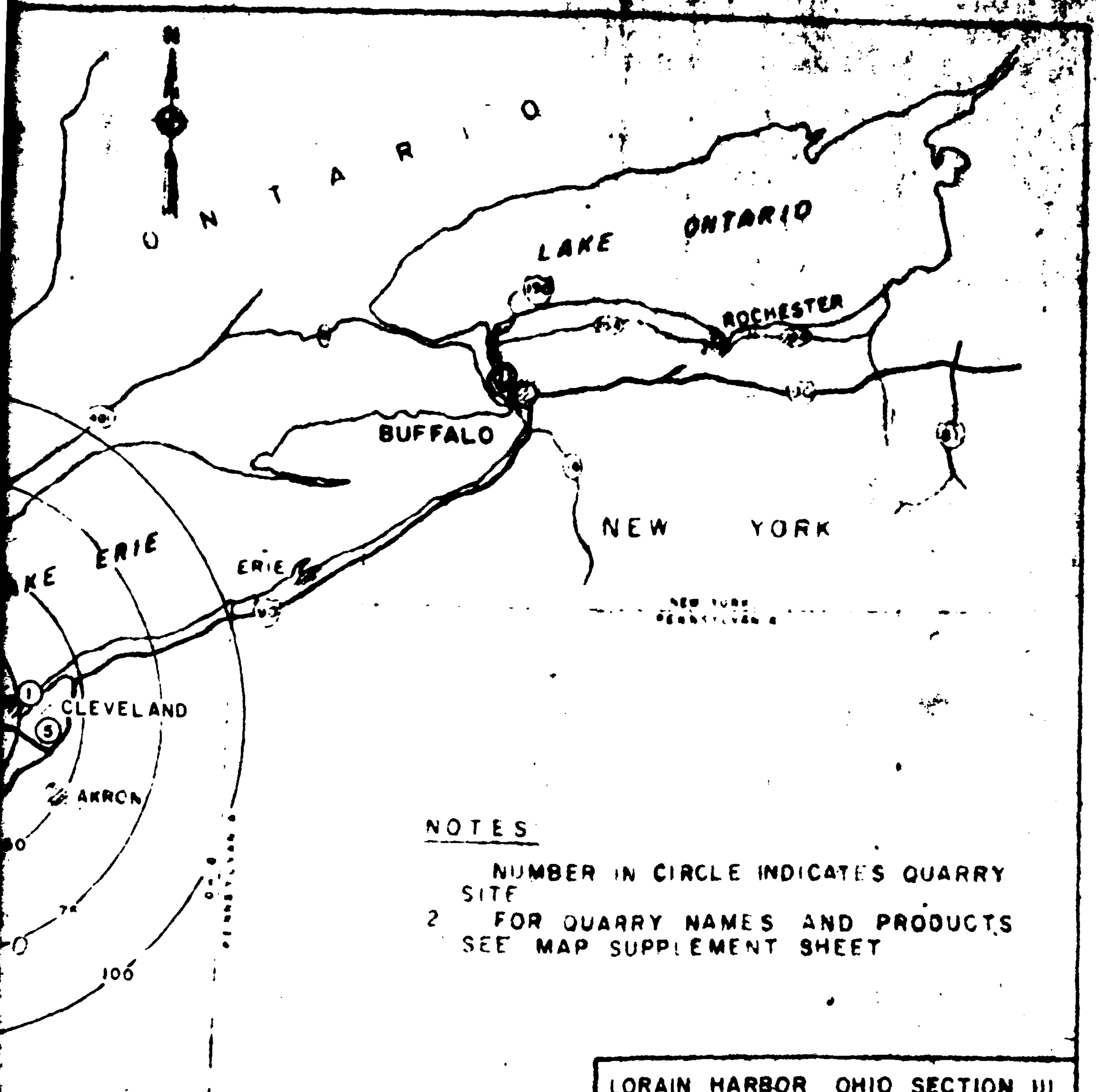
Selective quarrying will be required for the production of armor, bedding, underlayer, and blanket and core. The specifications will require that shale and other undesirable materials will be excluded by adequate processing.

Sources

Nine convenient sources are capable of producing the required material. They are all located within a 60-mile radius of the project and will be transported by barge or truck. It should be noted that although Cleveland Quarries is a viable source, the stone has an unusually low specific gravity (approximately 2.28). The stone, however, is of good quality and has been used in the construction of a number of breakwaters on the Great Lakes. Material source information for each material type relating number of possible sources and distances from the project site follows:

Armor Stone - 6 sources within a 60-mile radius.
Underlayer Stone - 7 sources within a 60-mile radius.
Bedding Stone - 7 sources within a 60-mile radius.
Beachfill Sand - 2 sources within a 40-mile radius.


LAKE MICHIGAN
MICHIGAN
LAKE HURON
LANSING
DETROIT
LAKE ERIE
PROJECT SITE
TOLEDO
CLEVELAND
FOSTORIA
AKRON
FORT WAYNE
INDIANA
OHIO
COLUMBUS
INDIANAPOLIS
25
50
75
100
SCALE OF MILES
40
0
40
80



NOTES

1 NUMBER IN CIRCLE INDICATES QUARRY SITE
2 FOR QUARRY NAMES AND PRODUCTS SEE MAP SUPPLEMENT SHEET

LORAIN HARBOR OHIO SECTION III
BEACH EROSION CONTROL PROJECT

LOCATION MAP
POSSIBLE MATERIAL SOURCES

U S ARMY ENGINEER DISTRICT, BUFFALO
TO ACCOMPANY DETAILED PROJECT REPORT

MAP SUPPLEMENT SHEET
SUMMARY OF POSSIBLE SOURCES FOR CONSTRUCTION MATERIALS

No.	SOURCE	QUARRY OR PIT LOCATION	[illegible]	ARMOR STONE, TYPES A1, A2, A3	UNDERLAYER STONE, TYPE B1, B2, B3	BEDDING, TYPES C1, C2, C3	BEACH FILL SAND TYPE D
1.	ERIE SAND AND GRAVEL CO.	CLEVELAND, OHIO	40				X
2.	ERIE SAND AND GRAVEL CO.	LORAIN, OHIO	2				X
3.	QUALITY QUARRIES	KELLEY'S ISLAND, OHIO	35	X	X	X	
4.	CLEVELAND QUARRIES	SOUTH AMHERST, OHIO	5	X	X	X	
5.	BOYA EXCAVATING CO.	VALLEY VIEW, OHIO	35	X	X	X	
6.	STANDARD SLAG CO.	MARBLEHEAD, OHIO	28	X	X	X	
7.	F. KRAEMER AND SONS, INC.	CLAY CENTER, OHIO	60	X	X	X	
8.	SANDUSKY CRUSHED STONE	SANDUSKY, OHIO	26		X	X	
9.	WOODVILLE LIME AND CHEMICAL CO.	WOODVILLE, OHIO	60	X	X	X	

C

12

4

NOTES:

ARMOR STONE (HEAD) TYPE A1 - 5.5-12.5 TONS
ARMOR STONE (TRUNK) TYPE A2 - 3-7 TONS
ARMOR STONE TYPE A3 - 1-2.25 TONS
UNDERLAYER (HEAD) TYPE B1 -0.37-1.25 TONS
UNDERLAYER (TRUNK) TYPE B2 - 0.2 -0.7 TONS
UNDERLAYER TYPE B3 - 0.06-0.2 TONS
BEDDING (HEAD) TYPE C1 - 2.0-125 LBS.
BEDDING (TRUNK) TYPE C2 - 1-70 LBS.
BEDDING TYPE C3 - 0.3-21 LBS.
SAND (BEACH SAND) TYPE D

X - DENOTES QUARRY IS CAPABLE OF PRODUCING THAT STONE.

LORAIN HARBOR, OHIO SECTION III
BEACH EROSION CONTROL PROJECT

SUMMARY OF POSSIBLE SOURCES

U.S. ARMY ENGINEER DISTRICT, BUFFALO
TO ACCOMPANY DETAILED PROJECT REPORT

3

POSSIBLE SOURCES FOR CONSTRUCTION STONE AND BEACH FILL

SOURCE	ROCK TYPE	PROPOSED USE	RADIAL DISTANC
BOYAS EXCAVATING CO. QUARRY AT VALLEY VIEW, OHIO	EUCLID SANDSTONE LENTIL OF THE BEDFORD SHALE	UNDERLAYER, BEDDING, ARMOR STONE	35 MI.
STANDARD SLAG CO. QUARRY AT MARBLEHEAD, OHIO OFFICE AT MARBLEHEAD, OHIO	LUCAS FORMATION (DOLOMITE)	UNDERLAYER, BEDDING, ARMOR STONE	28 MI.

ND BEACH FILL

USE	RADIAL DISTANCE	LABORATORY TEST RECORD			
		DATE TESTED	LABORATORY	PROJECT FOR WHICH TESTED	
,	35 MI.	JUNE 1974	ORD LAB LAB # 103/74.621C	OPERATION FORESIGHT PROJECT REPAIR EASTLAKE, OHIO (LARGE RIPRAP)	UNKN
		AUGUST 1976	ORD LAB LAB # 103/76.624B	CLEVELAND CONFINED DREDGE SPOIL DISPOSAL AREA NO. 14 (ARMOR STONE)	UNKN
		DECEMBER 1977	ORD LAB LAB # 103/77.623B	CLEVELAND CONFINED DREDGE SPOIL DISPOSAL AREA NO. 14 (ARMOR STONE)	1977
		APRIL 1979	ORD LAB LAB # 103/79.614B	CLEVELAND DIKED DISPOSAL AREA, SITE 14	UNKN
		MARCH 1980	ORD LAB LAB # 103/80.610B	CLEVELAND EAST BREAKWATER	UNKN
	28 MI.	DECEMBER 1968	ORD LAB LAB # 103/69.607C	CLEVELAND DIKED DISPOSAL AREA NO. 2 CLEVELAND HARBOR, OH. (CORE STONE AND ARMOR STONE)	1969
		MARCH 1972	ORD LAB LAB # 103/72.606C	CONFINED DREDGE SPOIL DISPOSAL PROGRAM (CORE, INTERMEDIATE, FILTER AND ARMOR STONE).	1973
					1974
		APRIL 1978	ORD LAB LAB # 107/78.611B	PRESQUE ISLE PROJECT	UNKN
		JULY 1978	ORD LAB LAB # 103/78.624B	CLEVELAND WEST BREAKWATER REHABILITATION PROJECT	UNKN

1 2

	SERVICE RECORD			
ESTED	DATE USED	PROJECT	EVALUATION	
REPAIR P)	UNKNOWN	OPERATION FORESIGHT PROJECT REPAIR EASTLAKE, OHIO	UNKNOWN	
SPOIL R STONE)	UNKNOWN	UNKNOWN	UNKNOWN	TH
SPOIL R STONE)	1977	OPERATION FORESIGHT PROJECT REPAIR EASTLAKE, OHIO	TOO EARLY TO EVALUATE	UN
REA,	UNKNOWN	UNKNOWN	UNKNOWN	SP US
	UNKNOWN	UNKNOWN	UNKNOWN	SP SU
AREA NO. 2 RE STONE	1969	CLEVELAND DIKED DISPOSAL AREA NO. 2 CLEVELAND HARBOR, OH (RIPRAP) STONE)	SATISFACTORY	A S L F
POSAL PRO- FILTER	1973-1974			S
	1974-1977	LORAIN DIKED DISPOSAL AREA, LORAIN HARBOR, OH (ARMOR, CORE, AND UNDERLAYER STONE)	TOO EARLY TO EVALUATE	
	UNKNOWN	UNKNOWN	UNKNOWN	
	UNKNOWN	UNKNOWN	UNKNOWN	

...TION	REMARKS
	THIS SANDSTONE IS WELL CEMENTED WITH NO "CURING EFFECT" NOTED.
...ATE	UNIT WEIGHT VARIES FROM 149.1 P.C.F. TO 152.2 (NEW PORTION OF QUARRY)
	SPECIFIC GRAVITY 2.395. MATERIAL APPEARS TO BE SUITABLE FOR INTENDED USE.
	SPECIFIC GRAVITY RANGES FROM 2.340 - 2.416. MATERIAL APPEARS TO BE SUITABLE FOR INTENDED USE.
	ALSO TESTED FOR FINE AND COARSE AGGREGATES FOR CONCRETE AND CELL FILL. SPECIFIC GRAVITY FOR FINE AGGREGATE IS 2.59; FOR COARSE AGGREGATE 2.62 LEDGE ROCK VARIES FROM 2.62 TO 2.75. SELF UNLOADING VESSELS AND BARGE FACILITIES AVAILABLE. ONLY UNITS 17 AND MH-1 ARE ACCEPTABLE FOR ARMOR STONE. ONLY CRUSHED STONE FROM LIFT 3 ACCEPTABLE FOR CONCRETE AGGREGATE.
...ATE	
	SPECIFIC GRAVITY 2.519 MATERIAL SUITABLE FOR INTENDED USE.
	SPECIFIC GRAVITY 2.521 -2.584. MATERIAL SUITABLE FOR INTENDED USE.

LORAIN HARBOR, OHIO SECTION III
BEACH EROSION CONTROL PROJECT

OHIO MATERIAL SOURCES
MATERIALS SURVEY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
TO ACCOMPANY DETAILED PROJECT REPORT

POSSIBLE SOURCES FOR CONSTRUCTION STONE AND BEACH FILL

SOURCE	ROCK TYPE	PROPOSED USE	RADIA DISTAN
QUALITY QUARRIES QUARRY AT KELLY'S ISLAND, OHIO	AMHERSTBURG AND LUCAS DOLOMITE	UNDERLAYER, BEDDING, ARMOR STONE	35 MI
CLEVELAND QUARRIES QUARRY AT SOUTH AMHERST, OHIO OFFICE AT SOUTH AMHERST, OHIO	BEREA SANDSTONE	UNDERLAYER, BEDDING, ARMOR STONE	5 MI.
ERIE SAND AND GRAVEL CO. STOCKPILE AT LORAIN, OHIO OFFICE AT ERIE, PA.	LAKE SAND	BEACH FILL	2 MI.

CH FILL

RADIAL DISTANCE	LABORATORY TEST RECORD			DA
	DATE TESTED	LABORATORY	PROJECT FOR WHICH TESTED	
35 MI.	JULY 1976	ORD LAB LAB # 103/76T.603B	CONFINED DREDGE SPOIL DISPOSAL PROGRAM DIKE 14 (ARMOR STONE)	1976
	DECEMBER 1977	ORD LAB LAB # 103/78.601B	CONFINED DREDGE SPOIL DISPOSAL PROGRAM DIKE 14 (ARMOR STONE)	
	SEPTEMBER 1978	ORD LAB LAB # 103/78.631B	CLEVELAND DIKE 14	UNKNOWN
5 MI.	AUGUST 1967	ORD LAB LAB # 103/68.604C	PILOT STUDY CONFINED DIKE DISPOSAL PROGRAM CLEVELAND HARBOR (RIPRAP)	UNKNOWN
	APRIL 1972	ORD LAB LAB # 103/72.606C	WELLSVILLE REHABILITATION PROJECT, WELLSVILLE, N.Y. (DERRICK STONE)	UNKNOWN
	APRIL 1976	ORD LAB LAB # 103/75.618B	CONFINED DREDGE SPOIL DISPOSAL AREA NO. 7, LORAIN HARBOR, OHIO	UNKNOWN
2 MI.	JULY 1973	ORD LAB LAB # 101/74.305C	VERMILION HARBOR, OH, DETACHED BREAKWALL (F.A. FOR CONCRETE CAP)	1973
	1977		LAKEVIEW PARK BEACH EROSION CONTROL PROJECT (BEACH FILL)	1977
	1980	ORD LAB LAB # 103/80.622B	1980 BEACH REPLENISHMENT PROJECT AT LAKEVIEW PARK PROJECT (BEACH FILL)	1980

ED	DATE USED	PROJECT	EVALUATION	
		SERVICE RECORD		
	1976	CONFINED DIKE DISPOSAL SITE 14	TOO EARLY TO EVALUATE	
			CURRENTLY BEING TESTED	UNITS K
	UNKNOWN	UNKNOWN	UNKNOWN	SAMPLES FOUND S SEAM.
SAL)	UNKNOWN	UNKNOWN	UNKNOWN	UNIT WE SERVICE DISTRIC
CT.)	UNKNOWN	UNKNOWN	UNKNOWN	
AREA	UNKNOWN	UNKNOWN	UNKNOWN	SPECIFI CURING
)	1973	VERMILION HARBOR, OH, DETACHED BREAKWALL (CONCRETE CAP)		SPECIFI
ROL	1977	LAKEVIEW PARK BEACH EROSION CONTROL PROJECT (BEACH FILL)	EXCELLENT	
	1980	1980 BEACH REPLENISHMENT PROJECT AT LAKEVIEW PARK PROJECT	TOO EARLY TO EVALUATE	

...TION	REMARKS
...TE	
...STED	UNITS KI-L2-I UPPER + LOWER + KI-LIA-I ONLY ACCEPTABLE FOR ARMOR STONE.
	SAMPLES RANGE FROM 2.392 - 2.411 SPECIFIC GRAVITY. UNITS KI-L2 WERE FOUND SUITABLE AND UNITS KI-L2-5 EXHIBITED BREAKAGE ALONG STYLOLITIC SEAM.
	UNIT WEIGHT AVERAGES ABOUT 143.5 P.C.F. THIS SANDSTONE HAS A GOOD SERVICE RECORD. IT HAS BEEN USED ON SEVERAL OUTER BREAKWALLS IN THIS DISTRICT. HOWEVER, IT WILL FAIL MOST DURABILITY TESTS.
	SPECIFIC GRAVITY VARIES FROM 2.28 TO 2.33. MINIMUM OF 100 DAYS CURING REQUIRED.
	SPECIFIC GRAVITY IS 2.63. LOW ALKALI CEMENT REQUIRED FOR CONCRETE.
...TE	

LORAIN HARBOR, OHIO SECTION III
BEACH EROSION CONTROL PROJECT

OHIO MATERIAL SOURCES
MATERIALS SURVEY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
TO ACCOMPANY DETAILED PROJECT REPORT

POSSIBLE SOURCES FOR CONSTRUCTION STONE AND BEACH FILL

SOURCE	ROCK TYPE	PROPOSED USE	RADIA DISTAN
ERIE SAND AND GRAVEL CO. STOCKPILE AT CLEVELAND, OHIO OFFICE AT ERIE, PA.	LAKE SAND	BEACH FILL	40 MI
E. KRAEMER AND SON, INC. QUARRY AT CLAY CENTER, OHIO OFFICE AT CLAY CENTER, OHIO	NIAGARAN DOLOMITE	ARMOR, UNDERLAYER AND BEDDING STONE	60 MI.
SANDUSKY CRUSHED STONE CO. QUARRY AT PARKERTOWN, OHIO OFFICE AT PARKERTOWN, OHIO	DELAWARE AND COLUMBUS DOLOMITE	UNDERLAYER AND BEDDING STONE	26 MI.
WOODVILLE LIME AND CHEMICAL CO. QUARRY AT WOODVILLE, OHIO OFFICE AT WOODVILLE, OHIO	NIAGARAN DOLOMITE	ARMOR, UNDERLAYER BEDDING STONE	60 MI.

BEACH FILL

E	RADIAL DISTANCE	LABORATORY TEST RECORD			DA
		DATE TESTED	LABORATORY	PROJECT FOR WHICH TESTED	
	40 MI.	MAY 1978	ORD LAB LAB # 101/78.310B	CLEVELAND HARBOR, CONFINED DIKE DISPOSAL SITE, AREA NO. 14	
		AUGUST 1979	ORD LAB LAB # 101/79.310B	CLEVELAND DIKE 14	
		MARCH 1980	ORD LAB LAB # 101/80.308B	CLEVELAND EAST BREAKWATER	
	60 MI.	MARCH 1972	ORD LAB LAB # 103/72.606C	CONFINED DREDGE SPOIL DISPOSAL PROGRAM (ARMOR STONE)	UNKNOWN
	26 MI.	MARCH 1972	ORD LAB LAB # 103/72.606C	CONFINED DREDGE SPOIL DISPOSAL PROGRAM (FINE AND COARSE AGGREGATES FOR CONCRETE, CELL FILL AND RIPRAP)	1973-197
		FEBRUARY 1977	ORD LAB LAB # 101/77.310B	CONFINED DREDGE SPOIL DISPOSAL DIKE AT LORAIN (CONCRETE AGGREGATE)	UNKNOWN
	60 MI.	OCTOBER 1970	ORD LAB LAB # 101/71.320C	FREMONT, OHIO LOCAL FLOOD PROTECTION (RIPRAP)	1971
		SEPTEMBER 1970	ORD LAB LAB # 101/71.312C	FREMONT, OHIO LOCAL FLOOD PROTECTION (FINE AND COARSE AGGREGATES FOR CONCRETE, GRANULAR FILL, BASE COURSE, BEDDING AND FILTER)	1971

TESTED	SERVICE RECORD DATE USED	PROJECT	EVALUATION	
D DIKE				SA PR AL
				SA AL
				SA AL
OSAL	UNKNOWN	UNKNOWN	UNKNOWN	UN AVA TO
OSAL PRO- EGATES RIPRAP)	1973-1974	SANDUSKY RIVER LOCAL FLOOD PROTECTION PROJECT. FREMONT OH. (RIPRAP)	TOO EARLY TO EVALUATE	ONL 162 2.6 AVA
SAL DIKE TE)	UNKNOWN	UNKNOWN	UNKNOWN	
ROTEC-	1971	FREMONT OHIO LOCAL FLOOD PROTECTION (RIPRAP)	TOO EARLY TO EVALUATE	AVE OF FRO
ROTEC- GATES BASE	1971	FREMONT, OHIO LOCAL FLOOD PROTECTION PROJECT (CONCRETE FLOOD WALLS)	TOO EARLY TO EVALUATE	SPE FIN FRO VARI 3.3 COA REQ TO

	REMARKS
UATION	
	SAMPLE APPEARS SUITABLE HOWEVER 11% SOFT AND/OR WEATHERED GRAINS MAY PRODUCE SURFACE DEFECTS IN EXPOSED CONCRETE. RECOMMENDED USE OF LOW ALKALI CEMENT DUE TO PRESENCE OF 6% CHERT.
	SAMPLE APPEARS SUITABLE FOR INTENDED USE ALTHOUGH THE USE OF LOW ALKALI CEMENT IS RECOMMENDED.
	SAMPLE APPEARS SUITABLE HOWEVER DUE TO THE PRESENCE OF 14% CHERT, LOW ALKALI CEMENT IS RECOMMENDED.
	UNIT WEIGHT VARIES FROM 167 P.C.F. TO 169 P.C.F. RAIL FACILITIES AVAILABLE. COARSE AGGREGATE FOR CONCRETE WILL REQUIRE TESTING PRIOR TO APPROVAL.
ATE	ONLY MATERIAL IN LIFTS 3 AND 5 IS ACCEPTABLE. UNIT WEIGHT VARIES FROM 162.2 P.C.F. TO 169.7 P.C.F. SPECIFIC GRAVITY FOR FINE AGGREGATES IS 2.62: FOR COARSE AGGREGATES 2.65: FOR RIPRAP 2.69: RAIL FACILITIES AVAILABLE.
ATE	AVERAGE WEIGHT IS 165 P.C.F. RAIL FACILITIES AVAILABLE. QUARRY CAPABLE OF PRODUCING LARGE ARMOR STONE; HOWEVER, ARMOR STONE WOULD BE OVERSIZE FROM NORMAL PRODUCTION BLASTING.
ATE	SPECIFIC GRAVITY FOR FINE AGGREGATE VARIES FROM 2.68 TO 2.70. FM VARIES FROM 3.05 TO 3.30. BOTH FINE AND COARSE AGGREGATES WILL REQUIRE TESTING PRIOR TO APPROVAL.

LORAIN HARBOR, OHIO SECTION III
BEACH EROSION CONTROL PROJECT

OHIO MATERIAL SOURCES
MATERIALS SURVEY

U S ARMY ENGINEER DISTRICT, BUFFALO
TO ACCOMPANY DETAILED PROJECT REPORT

APPENDIX 5

ECONOMIC ANALYSIS

APPENDIX 5

ECONOMIC ANALYSIS

TABLE OF CONTENTS

EFFECTS OF BLUFF RECESSION

Bluff recession rates have been calculated in the Problem Identification Appendix of this report. By using long term averaging of bluff line changes over the period 1937 to 1973, a pre-dike bluff recession rate has been quantified for the 2500 feet of shoreline in the study area. This 2500 feet has been broken down into smaller increments based upon sections of shore which remained stable or which receeded during the 1968 to 1973 period. These calculations resulted in the pre-dike recession rates shown in the table on the following page.

For the post-dike period, aerial photographs of the study area were compared to determine the position of the bluffline in 1978 and 1980. This type of analysis is subject to various inaccuracies which are listed in the Problem Identification Appendix. The most serious drawback is the small time frame over which these average recession rates were obtained. Two years is considered to be an insufficient time period for this analysis because it doesn't cover high and low periods of lake level. Therefore, the rates obtained may be biased toward excessive recession in this a high lake level period. Unfortunately, there is no other data available to be used in predicting a post-dike bluff recession rate at this time.

The predicted post-dike recession rate per shoreline section is also presented in the following table.

Shoreline Increments*	Pre-Dike Rate	Post-Dike Rate
0 to 50	0.4 ft/yr.	0.0 ft/yr.
50 to 450	1.2	0.0
450 to 950	1.2	0.2
950 to 1950	0.8	1.5
1950 to 2350	0.7	2.9
2350 to 2500	0.0	1.1

*Refers to distance east of the Colorado Avenue centerline measured along the north side of Erie Avenue. (See pgs 1-30 & 1-34)

A determination was made early in this study, that not all stretches within the study area were suffering from increased erosion attributable to the dike. In fact, the impoundment calculations in Appendix 1 of the report reveal that the first 800 ft. east of the dike spending beach is accreting as littoral sediments create a fillet behind the dike structures. This accretion is mostly below water level at this time and is only evident from a pre and post dike offshore profill comparison. The fact remains that any accretion constitutes a benefit from the existence of the dike. This beneficial effect is evidenced by a post-dike recession rate of 0.0 calculated for the first 450 feet of shore and a much reduced rate of 0.2 for the stretch 450 to 950 ft. east of Colorado Avenue when compared to the pre dike rates of 0.4 and 1.2 ft/year for the same increments of shoreline.

The effects of the dike on bluff recession must therefore be broken into two components for the purposes of this Section 111 mitigation study. These are:

1. The beneficial effects of the dike on areas identified as accreting per Appendix 1 which are: 0 to 800 ft and 2400 to 2500 ft. east of Colorado Avenue.

2. The adverse effects of the dike on areas identified as eroding per Appendix 1 which are: 800 to 2400 ft. east of Colorado Avenue.

Since the objective of the Section 111 is to mitigate damages related to erosion attributable to the Dike Disposal structure, only those areas suffering adverse effects "damages" can be taken into account in mitigation measures. The remaining shoreline is ignored based upon the beneficial effect that the dike has on these areas. These lengths of shoreline will be termed the beneficial "impact" area and the effects will be calculated separately in this study to obtain a complete picture of dike effects.

PRE AND POST DIKE DAMAGES

Within the damaged area identified as 800 to 2400 ft east of Colorado Avenue, three types of losses occur as a result of shoreline and bluff erosion:

1. loss of property as the bluffline receeds
2. loss of structures when the bluffline receeds to a point where the setback distance reaches zero
3. losses in extra costs incurred to maintain private protective structures.

The three components of loss will be estimated for pre and post dike recession rates based upon the procedures listed below:

Property loss estimate

1. From the master list of 45 parcels in the study area (which may be threatened by bluff recession) choose those parcels which lie within the damaged area 800 to 2400 ft east of Colorado Avenue.
2. According to the location of the parcel along the baseline, determine the bluff recession rate from the table in the previous section.

3. From the master list determine the property value in $\$/Ft.^2$ per parcel and the property frontage in ft.
4. Calculate the area of property loss per parcel by multiplying the appropriate annual recession rate by the parcel frontage.
5. Determine the annual value lost per parcel by multiplying the area lost by its value in $\$/Ft^2$.
6. Total all property value lost over the area in question to determine annual property value lost.
7. Perform these calculations for both pre and post-dike recession rates.

MARKET VALUE FOR PARCELS IN THE STUDY AREA

Parcel Number	Market Value		Lot Size (Front x Depth)	Land Value $/Ft^2
	Land	Structure		
1	3970	0	50x141	.56
2	3060	0	43x116	.61
3	5285	17850	43x95	1.29
4	5355	14420	43x99	1.26
5	1140	0	43x72	.37
6	1180	0	46x72	.36
7	5040	20320	47x91	1.18
8	5220	26620	46x97	1.17
9	1380	0	46x93	.32
10	5040	23400	46x92	1.19
11	5990	15070	42x101	1.41
12	6545	26340	42x119	1.31
13	6545	21460	42x119	1.31
14	6630	24760	43x118	1.31
15	6720	20040	44x112	1.36
16	6545	22500	43x112	1.36
17	6720	35950	43x120	1.30
18	6250	24610	43x102	1.43
19	6250	27070	44x97	1.46
20	2190	0	44x93	.54
21	3680	18150	30x97	1.27
22	3680	15590	30x95	1.29
23	4240	24760	30x98	1.44
24	5990	26930	42x100	1.43
25	5930	36310	40x106	1.40
26	5990	35470	40x108	1.39
27	6250	33970	40x115	1.36
28	21820	40500	98x117	1.90
29	20550	32110	96x100	2.14
30	20000	36850	55x148	2.46
31	19600	33970	55x135	2.64
32	19600	42540	55x132	2.70
33	17270	24680	45x132	2.91
34	4710	0	120x66	.59
35	12970	56700	120x66	1.64
36	21050	103145	57x154	2.40
37	22640	67710	57x304	1.31
38	39660	64450	118x307	1.10
39	25200	62840	60x304	1.33
40	24550	67390	58x304	1.39
41	2740	0	17.75x304	.51
42	3600	81360	118x310	.98
43	49950	75700	118x307	1.38
44	22860	27600	60x302	1.26
45	22860	22800	60x302	1.26

NOTES: 1) Market value & lot size are based upon Corps of Engineers August 1980 Survey of Lorain County records, office of the County Treasurer, Elyria, Ohio.

2) Land value is based upon: land market value ÷ appraised lot size in feet^2.

Structural loss estimate

1. From the 1980 Corps of Engineers Survey, measure the distance from the structure to the nearest point of bluff approach. List this as distance to bluff.
2. Determine whether the structure will be lost in the 50 year study period by dividing the distance to bluff by the bluff recession rate. The resulting number is the number of years to structure loss. If the years to loss is greater than 50, the structure is not lost during the study period.
3. Determine the present value of structural loss assuming the total market value of the structure is lost in the year indicated. This assumes that for all structures, no market value decrease or increase occurs over the study period.
   i.e. Present Value of Loss = Market Value X Present Worth Factor (i = 7 1/8%)
4. Determine the average annual damage due to structural loss by amortization of the present value of loss.
5. Total the average annual damages for all parcels to obtain the total average annual damage due to structural loss.
6. Perform these calculations for both pre and post-dike recession rates.

Losses to maintain private protective structures.

These loss estimates are calculated using procedures and assumptions as shown on the following pages.

PRE AND POST DIKE IMPACTS

Within the impact area identified as 0 to 800 and 2400 to 2500 ft east of Colorado Avenue, similar calculations and procedures as listed above were performed.

CALCULATION OF COSTS TO MAINTAIN PRIVATE PROTECTIVE STRUCTURES DURING PRE & POST DIKE PERIODS

ASSUMPTIONS:

1) IN THE AREA 0' to 800' & 2400' to 2500' EAST OF ℄ COLORADO AVE PRE DIKE PERCENTAGE OF PRIVATE STRUCTURAL PROTECTION TO SHORELINE IS $\frac{705}{900}$ = 78% BASED UPON THE 1980 CORPS OF ENGINEERS SURVEY CHECKED VS. THE 1980 AERIAL PHOTOS. THIS SHOULD BE AN APPROXIMATION OF THE LEVEL OF PROTECTION THAT PRIVATE PARTIES ARE ABLE TO MAINTAIN. THE 1980 SURVEY, ALTHOUGH TAKEN IN THE POST DIKE PERIOD SHOULD REPRESENT STRUTURES BUILT PRIOR TO 1974 UNDER PRE DIKE CONDITIONS

2) IN THE AREA 800' to 2400' EAST OF COLORADO AVE PRE DIKE PERCENTAGE OF PRIVATE STRUCTURAL PROTECTION TO AMOUNT OF SHORELINE IS $\frac{685'}{1600'}$ = 43% BASED UPON CORPS 1980 SURVEY.

3) FOR POST DIKE PERIOD ASSUME THAT IN THE AREA 00' to 800' & 2400' to 2500' (ACCRETION ZONES) ONCE THE EXISTING STRUCTURE DETERIORATE NO NEW STRUCTURES WILL BE BUILT BECAUSE OF THE ADDED PROTECTION AFFORDED
IN THE AREA 800 to 2400, BECAUSE OF THE INCREASED EROSION RATE CAUSED BY THE DIKE, THE ENTIRE STRETCH WILL NEED TO BE PROTECTED

4) DUE TO INCREASED EROSION RATE IN THE AREA 800 to 2400 THE PRIVATE STRUCTURES WILL HAVE TO BE REPLACED MORE OFTEN THAN DURING PRE DIKE PERIOD. FROM THE STRUCTURAL SURVEY INFORMATION (PROVIDED IN THIS REPORT APPENDIX 1) IT WAS ESTIMATED THAT A PRE DIKE STRUCTURE

MIGHT LAST ABOUT 25 YEARS ON THE AVERAGE, SINCE THE WEIGHTED AVERAGE PRE DIKE EROSION RATE IN ZONE STA 950 to 2350 IS 0.8 ft/yr $\left(\frac{.18 \times 1000 + .17 \times 400}{1400} = 0.8 \right)$ BASED UPON DDNR 1937 to 1973 DATA; AND, THE POST DIKE RATE FOR THIS ZONE IS 1.9 ft/yr $\left(\frac{1.5 \times 1000 + 2.9 \times 400}{1400} = 1.9 \right)$ BASED UPON AERIAL PHOTOGRAPHY 1978 – 1980 DATA. THE RECESSION RATE HAS INCREASED BY A FACTOR OF 2.5 AND ASSUMING THAT THE REPLACEMENT FREQUENCY OF STRUCTURES WILL INCREASE PROPORTIONATELY; THEN THE POST DIKE PRIVATE STRUCTURES MUST BE REPLACED @ 25 ÷ 2.5 = 10 YRS INTERVALS.

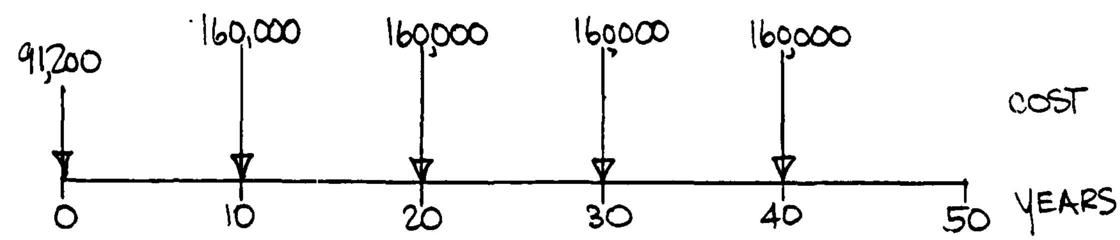
ESTIMATES: DAMAGES 800' to 2400' EAST OF COLORADO AVE.

POST DIKE REPLACEMENT COSTS

LENGTH – WHOLE LENGTH PROTECTED ≈ 1600 ft

COST – ASSUME $100/LINEAR FT BASED UPON COSTS OF OTHER PRIVATE STRUCTURES INSTALLED IN THIS AREA

FREQUENCY – EVERY 10 YRS STARTING AT YEAR 10 PLUS 57% X 1600 FT TO PROTECT AREAS NOT NOW PROTECTED



COST EVERY 10 YRS = 1600 FT × 100 $/FT

COST NOW = $160,000 × .57 = 91,200

ASSUMING NO FUTURE COST ESCALATIONS IN EITHER PRE OR POST DIKE CALCULATIONS

AD-A120 366 CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT F/G 13/2
DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT. SECTION 1--ETC(U)
NOV 81

UNCLASSIFIED NL

4 OF 4
AD A
120366

END
DATE
FILMED
11-82
DTIC

ANNUAL DAMAGES - POST DIKE

1. BRING ALL COSTS TO PRESENT

91,200		→	91,200
160,000	PWF ($i = 7\frac{1}{8}, n = 10yr$)	→	80,392
160,000	PWF ($i = 7\frac{1}{8}, n = 20yr$)	→	40,393
160,000	PWF ($i = 7\frac{1}{8}, n = 30yr$)	→	20,295
160,000	PWF ($i = 7\frac{1}{8}, n = 40yr$)	→	10,197
	TOTAL	=	242,477

2. ANNUALIZE PRESENT COST

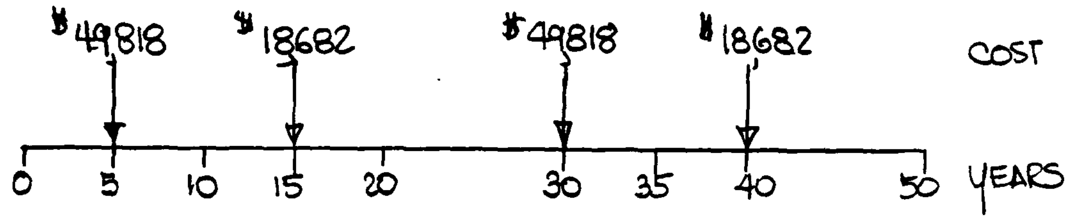
$$\$242{,}477 \times CRF\,(i = 7\tfrac{1}{8},\ n = 50\,yr) = \$17{,}850$$

PRE DIKE REPLACEMENT COSTS

LENGTH - 685 FT OUT OF 1600 FT PROTECTED

COST - $100 /LINEAR FT

FREQUENCY - EVERY 25 YRS AFTER CONSTRUCTION.
OF 22 STRUCTURES IN ZONE 800' to 2400', ONLY 6 WERE IN GOOD OR FAIR CONDITION IN 1980. OF THESE 5 WERE BUILT IN 1968 to 1974. ASSUME THEY HAVE 10 YR LIFE AND MUST BE REPLACED 15 YRS HENCE. ASSUME OTHER 16 STRUCTURES REPLACED IN 5 & 30 YRS HENCE.



COST AT YEAR 5 & 30 REPLACE 16/22 STRUCTURES

$$\frac{16}{22} \times 685\ FT \times 100\ \frac{\$}{FT} = \$49818$$

COST AT YEAR 15 & 40 REPLACE 6/22 STRUCTURES

$$\frac{6}{22} \times 685\ FT \times 100\ \frac{\$}{FT} = \$18{,}682$$

ANNUAL DAMAGES PRE DIKE

1. BRING ALL COSTS TO PRESENT

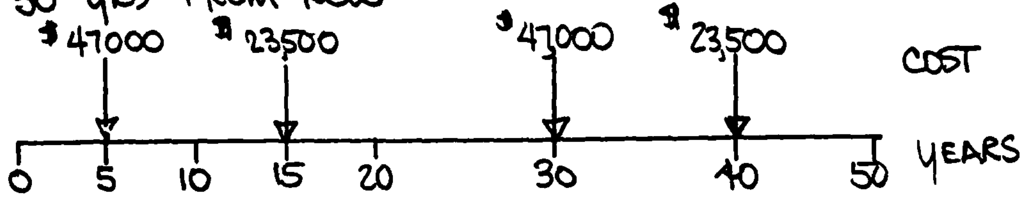
49818 PWF (i=7⅛, n=5) → 35313
18682 PWF (i=7⅛, n=15) → 6654
49818 PWF (i=7⅛, n=30) → 6319
18682 PWF (i=7⅛, n=40) → 1191
TOTAL = 49477

2. ANNUALIZE PRESENT COST

$49,477 × CRF (i=7⅛, n=50) = $3,642

ESTIMATES: IMPACTS 0 to 800' & 2400' to 2500' EAST OF COLORADO
POST DIKE REPLACEMENT COSTS ARE ZERO BECAUSE THESE AREAS ARE PROTECTED BY THE ACCRETION CAUSED BY THE DIKE.
THE EXISTING STRUCTURES WILL BE ALLOWED TO DETERIORATE AT A MUCH REDUCED RATE AND NO NEW STRUCTURES BUILT.
POST DIKE ANNUALIZED COSTS = $0

PRE DIKE REPLACEMENT COSTS
LENGTH - 705 FT OUT OF 900 FT ARE PROTECTED
COST - $100 /LINEAR FOOT
FREQUENCY - OF THE 12 STRUCTURES IN THIS AREA ONLY 5 ARE CONSIDERED FAIR OR GOOD; 1 BUILT IN 1956 IS FAIR 4 OTHERS BUILT IN 1968 to 1973 ASSUME ARE 10 YRS OLD & MUST BE REPLACED 15 YRS HENCE (& AT 40 YRS). OF THE 8 REMAINING STRUCTURES ASSUME THEY WILL BE REPLACED 5 YRS HENCE AND THEREAFTER 30 YRS FROM NOW



COSTS AT YEARS 5 & 30 REPLACE 8/12 STRUCTURES

$\frac{8}{12} \times 705' \times 100\ \$/FT = \$47{,}000$

COSTS AT YEARS 15 & 40 REPLACE 4/12 STRUCTURES

$\frac{4}{12} \times 705 \times 100\ \$/FT = \$23{,}500$

ANNUAL IMPACTS - PRE DIKE

1. BRING ALL COSTS TO PRESENT

47000 PWF ($i = 7\frac{1}{8}, n = 5$)	→	33,315
23500 PWF ($i = 7\frac{1}{8}, n = 15$)	→	8370
47000 PWF ($i = 7\frac{1}{8}, n = 30$)	→	5962
23500 PWF ($i = 7\frac{1}{8}, n = 40$)	→	1498
TOTAL	=	49145

2. ANNUALIZE PRESENT COST

$\$49{,}145 \times CRF(i = 7\frac{1}{8}, n = 50) = \$3618$

SUMMARY

The tables which follow summarize the calculations and estimates performed to determine damages and impacts at pre and post-dike recession rates.

These tables should only be used for economic comparison over a 50 year period for damages or benefits accruing from the various alternatives under study in this report. As mentioned previously, the post-dike recession rate is highly suspect as to its accuracy in predicting events 50 years from now. This has wide ranging implications on the post-dike calculations because all losses depend heavily on these recession rates.

ANNUAL AVERAGE DAMAGE AT PRE DIKE RECESSION RATE

		ANNUAL PROPERTY LOSS					ANNUAL STRUCTURAL LOSS				
		1	2	3	4	5	6	7	8	9	10
DISTANCE EAST OF COLORADO AVENUE	PARCEL NUMBER	RECESSION RATE FT/YR	FRONTAGE FT.	ANNUAL AREA LOST 1x2	VALUE $/FT^2	ANNUAL VALUE LOST $ 3x4	DISTANCE TO BLUFF	YEARS TO LOSS 6÷1	STRUCTURE VALUE $	PRESENT WORTH OF DAMAGE 8 x PWF	ANNUAL DAMAGE $ 9 x CRF
800	18	1.2	43	51.6	1.42	73	33	27	24610	3838	283
	19	1.2	44	52.8	1.46	77	26	22	27070	5955	438
	20	1.2	44	52.8	0.54	29		Vacant	0	0	0
950	21	1.2	30	36.0	1.26	45	15	12	18150	7947	585
	22	0.8	30	24.0	1.29	31	17	21	15590	3674	270
	23	0.8	30	24.0	1.44	35	13	16	24760	8232	606
	24	0.8	42	33.6	1.43	48	14	17	26930	8358	615
	25	0.8	40	32.0	1.40	45	18	22	36310	7988	588
	26	0.8	40	32.0	1.39	44	28	35	35470	3189	235
	27	0.8	40	32.0	1.36	44	21	26	33970	5675	418
	28	0.8	98	78.4	1.90	149	32	40	40500	2581	190
	29	0.8	96	76.8	2.14	164	57	Not Lost	32110	0	0
	30	0.8	55	44.0	2.46	108	32	40	36850	2349	173
	31	0.8	55	44.0	2.64	116	30	38	33970	2485	183
	32	0.8	55	44.0	2.70	119	25	31	42540	5037	371
	33	0.8	45	36.0	2.91	105	115	Not Lost	24680	0	0
	34	0.8	120	84.0	0.59	50		Vacant	0	0	0
	35	0.8	120	12.0	1.64	20	49	Not Lost	56700	0	0
	36	0.8	57	45.6	2.40	109	48	Not Lost	103145	0	0
1900	37	0.8	57	45.6	1.31	60	130	Not Lost	67710	0	0
	38	0.7	118	82.6	1.10	91	160	Not Lost	64450	0	0
	39	0.7	60	42.0	1.38	58	150	Not Lost	62840	0	0
	40	0.7	58	40.6	1.39	56	90/180	Not Lost	67390	0	0
	41	0.7	17.75	12.4	0.51	6		Vacant	0	0	0
	42	0.7	118	82.6	0.98	81	190	Not Lost	81360	0	0
2400	43	0.7	118	82.6	1.38	114	65/95	Not Lost	75700	0	0

ANNUAL VALUE OF PROPERTY LOSS $1,877

ANNUAL VALUE OF STRUCTURAL LOSS $4,955

ANNUAL DAMAGE DUE TO PRIVATE PROTECTIVE WORKS $3,642

TOTAL ANNUAL DAMAGE $10,474

ANNUAL AVERA DAMAGE AT POST DIKE RECESSION RATE

		ANNUAL PROPERTY LOSS					ANNUAL STRUCTURAL LOSS				
		1	2	3	4	5	6	7	8	9	10
DISTANCE EAST OF COLORADO AVENUE	PARCEL NUMBER	RECESSION RATE FT/YR	FRONTAGE FT.	ANNUAL AREA LOST 1x2	VALUE $/FT²	ANNUAL VALUE LOST $ 3x4	DISTANCE TO BLUFF	YEARS TO LOSS 6÷1	STRUCTURE VALUE $	PRESENT WORTH OF DAMAGE 8 x PWF	ANNUAL DAMAGE $ 9 x CRF
800	18	0.2	43	8 6	1.42	12	33	Not Lost	24610	0	0
	19	0.2	44	8.8	1.46	13	26	Not Lost	27070	0	0
	20	0.2	44	8.8	0.54	5		Vacant	0	0	0
950	21	0.2	30	6.0	1.26	8	15	Not Lost	18150	0	0
	22	1.5	30	45.0	1.29	58	17	11	15590	7312	538
	23	1.5	30	45.0	1.44	65	13	9	24760	13327	981
	24	1.5	42	63.0	1.43	90	14	9	26930	14495	1067
	25	1.5	40	60.0	1.40	84	18	12	36310	15898	1170
	26	1.5	40	60.0	1.39	83	28	19	35470	9593	706
	27	1.5	40	60.0	1.36	82	21	14	33970	12961	954
	28	1.5	98	147.0	1.90	279	32	21	40500	9544	703
	29	1.5	96	144.0	2.14	308	57	38	32110	2348	173
	30	1.5	55	82.5	2.46	203	32	21	36850	8684	639
	31	1.5	55	82.5	2.64	218	30	20	33970	8576	631
	32	1.5	55	82.5	2.70	223	25	17	42540	13202	972
	33	1.5	45	67.5	2.91	196	115	Not Lost	24680	0	0
	34	1.5	120	84.0	0.59	50		Vacant	0	0	0
	35	1.5	120	96.0	1.64	157	49	33	56700	5850	431
	36	1.5	57	85.5	2.40	205	48	32	103145	11401	839
1900	37	1.5	57	85.5	1.31	112	130	Not Lost	67710	0	0
	38	2.9	118	342.2	1.10	376	160	Not Lost	64450	0	0
	39	2.9	60	174.0	1.38	240	150	Not Lost	62840	0	0
	40	2.9	58	168.2	1.39	234	90/180	31/Not Lost	67390	3990	294
	41	2.9	17.75	51.5	0.51	26		Vacant	0	0	0
	42	2.9	118	342.2	0.98	335	190	Not Lost	81360	0	0
2400	43	2.9	118	342.2	1.38	472	65/95	22/33	75700	12232	900

ANNUAL VALUE OF PROPERTY LOSS $4,135

ANNUAL VALUE OF STRUCTURAL LOSS $10,998

ANNUAL DAMAGE DUE TO PRIVATE PROTECTIVE WORKS $17,850

TOTAL ANNUAL DAMAGE $32,983

ANNUAL AVERAGE IMPACT AT PRE DIKE RECESSION RATE

		ANNUAL PROPERTY LOSS					ANNUAL STRUCTURAL LOSS				
		1	2	3	4	5	6	7	8	9	10
DISTANCE EAST OF COLORADO AVENUE	PARCEL NUMBER	RECESSION RATE FT/YR	FRONTAGE FT.	ANNUAL AREA LOST 1x2	VALUE $/FT^2	ANNUAL VALUE LOST $ 3x4	DISTANCE TO BLUFF	YEARS TO LOSS 6÷1	STRUCTURE VALUE $	PRESENT WORTH OF DAMAGE 8 x PWF	ANNUAL DAMAGE $ 9 x CRF
00	1	0.4	50	20.0	0.56	11		Vacant	0	0	0
	2	1.2	43	51.6	0.61	31		Vacant	0	0	0
	3	1.2	43	51.6	1.29	67	22	18	17850	5171	381
	4	1.2	43	51.6	1.26	65	20	17	14420	4475	329
	5	1.2	43	51.6	0.37	19		Vacant	0	0	0
	6	1.2	46	55.2	0.36	20		Vacant	0	0	0
	7	1.2	47	56.4	1.18	66	13	11	20320	9531	[illegible]
	8	1.2	46	55.2	1.17	65	16	13	26620	10880	[illegible]
450	9	1.2	46	55.2	0.32	18		Vacant	0	0	0
	10	1.2	46	55.2	1.19	66	28	23	23400	4805	[illegible]
	11	1.2	42	50.4	1.41	71	35	29	15070	2048	151
	12	1.2	42	50.4	1.31	66	35	29	26340	3579	263
	13	1.2	42	50.4	1.31	66	40	33	21460	2214	163
	14	1.2	43	51.6	1.31	68	35	29	24760	3364	248
	15	1.2	44	52.8	1.36	72	36	30	20040	2542	187
	16	1.2	43	51.6	1.36	70	53	44	22500	1089	80
800	17	1.2	43	51.6	1.30	67	30	25	35950	6433	474
2400	44	0.0	60	0	1.26	0	35	Not Lost	27600	0	0
2500	45	0.0	60	0	1.26	0	38	Not Lost	22800	0	0

ANNUAL VALUE OF PROPERTY LOSS $907

ANNUAL VALUE OF STRUCTURAL LOSS $4,133

ANNUAL IMPACT ON PRIVATE PROTECTIVE WORKS $3,618

TOTAL ANNUAL IMPACT $8,658

ANNUAL AVERAGE IMPACT AT POST DIKE RECESSION RATE

		ANNUAL PROPERTY LOSS					ANNUAL STRUCTURAL LOSS				
		1	2	3	4	5	6	7	8	9	10
DISTANCE EAST OF COLORADO AVENUE	PARCEL NUMBER	RECESSION RATE FT/YR	FRONTAGE FT.	ANNUAL AREA LOST 1x2	VALUE $/FT^2	ANNUAL VALUE LOST $ 3x4	DISTANCE TO BLUFF	YEARS TO LOSS 6÷1	STRUCTURE VALUE $	PRESENT WORTH OF DAMAGE 8 x PWF	ANNUAL DAMAGE $ 9 x CRF
00	1	0.0	50	0	0.56	0		Vacant	0	0	0
	2	0.0	43	0	0.61	0		Vacant	0	0	0
	3	0.0	43	0	1.29	0	22	Not Lost	17850	0	0
	4	0.0	43	0	1.26	0	20	Not Lost	14420	0	0
	5	0.0	43	0	0.37	0		Vacant	0	0	0
	6	0.0	46	0	0.36	0		Vacant	0	0	0
	7	0.0	47	0	1.18	0	13	Not Lost	20320	0	0
	8	0.0	46	0	1.17	0	16	Not Lost	26620	0	0
450	9	0.0	46	0	0.32	0		Vacant	0	0	0
	10	0.2	46	9.2	1.19	11	28	Not Lost	23400	0	0
	11	0.2	42	8.4	1.41	12	35	Not Lost	15070	0	0
	12	0.2	42	8.4	1.31	11	35	Not Lost	26340	0	0
	13	0.2	42	8.4	1.31	11	40	Not Lost	21460	0	0
	14	0.2	43	8.6	1.31	11	35	Not Lost	24760	0	0
	15	0.2	44	8.8	1.36	12	36	Not Lost	20040	0	0
	16	0.2	43	8.6	1.36	12	53	Not Lost	22500	0	0
800	17	0.2	43	8.6	1.30	11	30	Not Lost	35950	0	0
2400	44	1.1	60	66.0	1.26	83	35	32	27600	3051	225
2500	45	1.1	60	66.0	1.26	83	38	35	22800	2050	151

ANNUAL VALUE OF PROPERTY LOSS $257

ANNUAL VALUE OF STRUCTURAL LOSS $376

ANNUAL IMPACT ON PRIVATE PROTECTIVE WORKS $0

TOTAL ANNUAL IMPACT $633

SUMMARY OF DAMAGES & BENEFICIAL IMPACT

ANNUAL BENEFICIAL IMPACT 0 to 800 & 2400 to 2500 Ft. east of Colorado Avenue.

At Pre Dike Recession Rates (ODNR 1937-1973)

Lost Property	907	
Structural Losses	4133	
Protective Structure Costs	3618	
TOTAL	$8658	say $8700

At Post Dike Recession Rates (1978-1980 Aerials)

Lost Property	257	
Structural Losses	376	
Protective Structure Costs	0	
TOTAL	$633	say $650

IMPACT: Dike has reduced annual average damages by $8050.

ANNUAL DAMAGES 800 to 2400 Ft east of Colorado Ave.

At Pre Dike Recession Rates

Lost Property	1877	
Structural Losses	4955	
Protective Structure Costs	3642	
TOTAL	$10474	say $10,500

At Post Dike Recession Rates

Lost Property	4135	
Structural Losses	10998	
Protective Structure Costs	17850	
TOTAL	$32983	say $33,000

IMPACT: Dike is responsible for an increase in annual average damages of $22,500.

NOTE: These computations use a "worst case" approach to the impact of the dike on the study shoreline. The actual impact could be much less depending upon the effects of lake levels and failing private structures which could not be quantified at this time.

A comparison of pre and post dike damages over a 50 year period reveals that:

	PRE-DIKE DAMAGES	POST DIKE DAMAGES	DIKE INDUCED DAMAGES
Structures Lost	13	16	3
Land Lost	1.4 acres	3.1 acres	1.7 acres
Total Damage	$10,500/yr	$33,000/yr	$22,500 yr

At a glance this may seem misleading in that the loss of only 3 structures and 1.7 acres of land would cause $22,000 damage per year. But the mechanics of the computation would reveal that the difference lies not only in which structures are lost, but when they are lost. Post dike structures are lost sooner (at the faster recession rate) and therefore incur higher annualized damages. Also the higher costs to maintain private protective structures at the post dike rate contribute greatly to the dike induced damage costs ($17,850/yr vs $3,642/yr).

COST/BENEFIT ANALYSIS

Alternative I - No Action

Costs

A. First Cost - None

B. Annual Damages - The difference between post and pre-dike damages in the following categories (only in damaged area 800 to 2400 ft east of Colorado Ave):

1. private property losses
2. structural losses
3. increases in replacement and maintenance of private protective works

Damages @ Post Dike Rate	1. private property	4,135
	2. structures (homes)	10,998
	3. private structures	17,850
	Total	$32,983
@Pre Dike Rate	1. private property	1,877
	2. structures (homes)	4,955
	3. private structures	3,642
	Total	$10,474

Benefits

A. Annualized Annual Benefits - N/A

NET AVERAGE ANNUAL DAMAGES AS A RESULT OF NO ACTION
$22,500

Alternative II - Land Acquisition Plan

Costs

A. First Costs

1. Acquisition of all land and structures in the damaged area determined to be 800 to 2400 feet east of ℄ Colorado Avenue (including moving expenses, increased interest costs, etc.)
2. Demolition and removal of structures in affected area.
3. Relocation of utility services within the affected area which are necessary to provide continued service at another location (assumed part of cost 2 above).

B. Annualized Costs

1. Amortization of first costs
2. No maintenance or inspection costs (assuming land is left to erode)

Benefits

A. Annualized Benefits

1. Savings to private property owners on shore protective works that they would have had to maintain to protect property at the prevailing (post dike) erosion rate.
2. Saving by municipalities on the protection of street ends and utilities.
3. Intangible benefit - alleviation of concern.
4. No recreational benefit assumed on acquired land.

ALTERNATIVE II ACQUISITION PLAN COST/BENEFIT ANALYSIS

FIRST COST ITEMS	
Acquisition of Properties	1,410,000
Moving Expenses	40,500
Replacement Housing Costs	179,000
Demolition Costs	140,500
TOTAL FIRST COSTS	$1,770,000
SUPERVISION & ADMINISTRATION OF PLAN	
@ 15% of First Costs	265,500
Overhead on S&A @ 27%	71,700
Other Expenses @25% Of S&A	66,300
TOTAL	$2,173,500

ANNUALIZED COSTS

Amortization of Total First Costs
@ i = 7 1/8%/yr for 50 yrs CRF= .07361
2,173,500 x .07361 = $159,991 say $160,000

ANNUALIZED BENEFITS

1&2) Savings on Private Protective Structures @ $17,900/yr
3) Intangible Benefit - Alleviation of Concern

TOTAL $17,900

BENEFIT/COST RATIO 17900/160000 B/C = 0.11

Alternative III - Feeder Beach Plan

Costs

A. First Costs

1. First placement of fill in amount equivalent to erosion since dike completion-18,500 yd^3. In three equal placements this fill should provide initial stability to the shoreline.
2. Easements for access.

B. Annualized Costs

1. Amortization of first costs.
2. Periodic placement of fill assumed as an annual placement of 5400 yds.
3. Yearly inspection for needed fill quantities.

Benefits

A. Annualized Benefits

1. Reduction in annual damages (from 800 to 2400 ft east of Colorado Avenue)by returning the shoreline from a post-dike recession rate to its former pre-dike rate. Includes savings to property not lost, structures not lost and private protection not built over the 50 year life of the project.
2. Since this plan returns the shoreline to its original pre-dike eroding rate, no property value enhancement can be claimed for this alternative.
3. Intangible benefit arises from the construction of a temporary beach when the fill is placed. Since this is short lived, no reactional benefit will be assumed. An additional intangible benefit may be assumed from the growth of the fillet east of the dike spending beach. This fillet will probably grow with the intro-

duction of additional quantities of nourishment into the littoral zone updrift but its size and projection above the waterline are unknown at this time.

ALTERNATIVE III FEEDER BEACH PLAN COST/BENEFIT ANALYSIS

FIRST COST ITEMS

A	18500 yd^3 Fill @9.90/Yd	183,150
B	Easement For Access	14,200
C	Construction Road & Staging Area	5,000
D	Subtotal A+B+C	$202,350
E	Contingencies @15% of D	30,350
F	Subtotal D+E	$232,700
G	Engineering & Design @10% of F	23,300
H	Supervision & Administration	
I	Supervision & Inspection @6% of F	14,000
J	Overhead on G @20% of G	4,700
K	Overhead on I @27% of I	3,800
L	Indirect Labor @25% of G+I	9,300
M	Total First Cost F+G thru L	$287,800

ANNUALIZED COSTS

1.	Amortization of Total First Costs (i = 7 1/8 n = 50 yrs) First Cost X CRF (.07361)	21,200
2.	Periodic Fill Placement Averaging Annually 5400 yd^3 @9.90/yd	53,500
3.	Yearly Inspection Costs	500
	Total Annual Costs	$75,200

ANNUALIZED BENEFITS

1.	Reduction in Damages from a Post to a Pre Dike Recession Rate $32,983 - $10,474 = $22,500 See Damage Section	$22,500

BENEFIT/COST RATIO 22500/75200 B/C = 0.30

Intangible benefit of temporary beaches is not taken into account in this B/C analysis

Alternative IV-Groin System with Fill

Costs

A. First Costs

1. Construction cost of 4 groins spaced 500 ft. apart.
2. Construction cost of placement of 58,250 tons of fill from 500 to 2500 ft east of Colorado Avenue in 4 equal compartments.
3. Easements for access.

B. Annualized Costs

1. Amortization of first costs
2. Annual maintenance costs
3. Annual inspection costs
4. Periodic nourishment costs (assumed annual).

Benefits

A. Annualized Benefits

1. Prevention of all dike attributable damages due to increased erosion rate; plus, partial (assumed 70 percent) prevention of natural damages at pre-dike erosion rate.
2. Intangible benefits
   A. alleviation of concern of homeowners in the affected area.
   B. enhanced property values (depends upon proof of higher utilization of property which cannot be proven at this time).
3. No recreational benefits are assumed.
   A. the elevation of the fill would not support a recreational beach.
   B. the demand for beach usage in this area does not warrant additional expenditures to make the area suitable for a beach usage.
   C. Other areas in the vicinity with upgraded facilities exist.

ALTERNATIVE IV: GROIN SYSTEM WITH FILL COST/BENEFIT ANALYSIS

	FIRST COST ITEMS	
A	1450 Tons Bedding Stone @$14.25/Ton	20,650
B	2450 Tons Armor Stone @$36.50/Ton	89,400
C	150 Tons Underlayer @$20.50/Ton	3,100
D	7500 Tons Bedding Stone @$20.00/Ton	150,000
E	17300 Tons Armor Stone @$31.50/Ton	544,950
F	3950 Tons Underlayer @$43.50/Ton	171,800
G	58250 Tons Beach Fill @$6.55/Ton	381,500
H	4750 Square Feet Diaphram @$14.50/SF	68,900
I	Easements for Access	17,750
J	Construction Roads & Areas	30,000
K	Subtotal	1,478,000
L	Contingencies @20% of K	295,600
M	Subtotal K + L	1,773,600
N	Engineering & Deisgn @12% of M	212,800
O	Supervision & Administration	
P	Supervision & Inspection @6% of M	106,400
Q	Overhead on N @20%	42,600
R	Overhead on P @27%	28,700
S	Indirect Labor @25% of N + P	79,800
T	Total First Costs M + N thru S	2,243,900
	ANNUALIZED COSTS	
1.	Amortization of Total First Costs (i = 7 1/8, n = 50 yrs) Total First Costs x CRF (.07361)	165,200
2.	Annual Maintenance 2% of First Cost + Contingencies (2% of M)	35,500
3.	Annual Inspection Cost	1,000
4.	Periodic Nourishment Cost Averaging Annually 2700 yd^3 @9.90/yd	26,700
	Total Annualized Costs	228,400

ALTERNATIVE IV COST/BENEFIT ANALYSIS

ANNUAL BENEFITS*

1. Partial prevention of damages in eroding zone 800 to 2400 ft. east of Colorado Avenue. Benefit from prevention of dike attributable damages is $22,500 annually. Pre-dike (natural erosion conditions) damages preventable amount to $10,500 annually. Benefit from this plan is estimated to be 22,500 + 0.7 (10,500) = $29,850 annually.

*Intangible benefits are not included.

BENEFIT/COST RATIO

B/C = 29850/228400 = 0.13

Alternative V - Revetment

Costs

A. First Costs

1. Construction of a rubble mound revetment to protect the shoreline from future erosion from 500 to 2500 ft east of Colorado Ave.
2. Easements for construction access.

B. Annualized Costs

1. Amortization of first costs
2. Annual maintenance costs
3. Annual inspection costs.

Benefits

A. Annualized Benefits

1. Prevention of all damages to property, structures, and private protective structures had they continued to erode at the post-dike rate.
2. Intangible benefits
   A. alleviation of concern
   B. enhanced property values
   c. aesthetic enhancement of bluff
3. No recreational benefit assumed.

ALTERNATIVE V REVETMENT PLAN COST/BENEFIT ANALYSIS

	FIRST COST ITEMS	
A	12,100 Tons Bedding Stone @$25.00/Ton	302,500
B	5,060 Tons Underlayer Stone @$45.00/Ton	227,700
C	17,250 Tons Armor Stone @$35.00/Ton	603,750
D	32,000 Square Feet Filter Cloth @$0.80/SF	25,600
E	Easements for Access	17,750
F	Construction Roads & Areas	20,000
G	Subtotal A thru F	1,197,300
H	Contingencies @20% of G	239,500
I	Subtotal G + H	1,436,800
J	Engineering & Design @12% of I	172,400
K	Supervision & Administration	
L	Supervision & Inspection @5% of I	71,800
M	Overhead on J @20%	34,500
N	Overhead on L @27%	19,400
O	Indirect Labor @25% of J&L	61,100
P	Total First Costs I+J thru O	1,796,000
	ANNUALIZED COSTS	
1.	Amortization of Total First Costs (i = 7 1/8, n = 50 yrs) Total First Costs x CRF (.07361)	132,200
2.	Annual Maintenance of Structure 2% of First Cost + Contingencies (2% of I)	28,700
3.	Annual Inspection Cost	1,000
	Total Annualized Costs	161,900
	ANNUALIZED BENEFITS*	
1.	Prevention of all damages at post dike recession rate in eroding zone 800 to 2400 ft. east of Colorado Avenue	33,000
	BENEFIT/COST RATIO 33000/161,900	B/C = 0.20

*Intangible Benefits not included

ESTIMATED IMPLEMENTATION COSTS

	PLAN NO. II ACQUISITION	PLAN NO. III FEEDER BEACH	PLAN NO. IV GROIN & FILL	PLAN NO. V REVETMENT
	($)	($)	($)	($)
FIRST COSTS	2,173,500	287,800	2,243,900	1,796,000
ANNUALIZED COSTS				
Interest & Amortization of First Costs	160,000	21,200	165,200	132,200
Maintenance & Other	0	54,000	63,200	29,700
TOTAL	160,000	75,200	228,400	161,900
ANNUALIZED BENEFITS	17,900	22,500	29,850	33,000
Benefit/Cost Ratio	0.11	0.30	0.13	0.20

IMPLEMENTATION RESPONSIBILITY

Alternative I - In the No Action Plan there are no monetary outlays made by the federal government. The residents in the damaged area however suffer an estimated $22,500 per year in losses to private property, structures and protective works because of the presence of the dike disposal structure. This is a worst case estimate based upon the assumption that all the excess post dike recession is caused by the dike disposal structure. With the meager data available, this point cannot be clarified at this time.

Alternative II - The Land Acquisition Plan removes the endangered residents from the eroding area and therefore constitutes a complete solution to the erosion problem. As such, costs of this alternative must be shared between local interests and the federal government. The maximum federal financial responsibility is limited by law to only those costs to mitigate erosion attributable to federal navigation works. The remaining costs must be assumed by non-federal interests such as at the state or local level. The cost apportionment is shown in the following table based upon maximum federal contributions toward the feeder beach plan - alternative III. The Federal government will pay the present worth value of the feeder beach plan towards the first cost of the Land Acquisition Plan.

Alternative III - Since the Feeder Beach Plan mitigates only the erosion attributable to the dike disposal structure it is eligible for 100% federal funding. This makes alternative III the base case for financial comparisons since it represents the maximum federal financial responsibility for this study.

Alternative IV - The Groin System with Fill Plan prevents natural as well as dike attributable erosion and as such exceeds the federal responsibility under Section 111 provisions.

Implementation must therefore be based on a cost sharing plan with local interests. Again, Alternative III the Feeder Beach Plan represents the maximum *federal financial* responsibility and local interests must make up the difference in first and annual costs before this plan could be implemented.

Alternative V - The Revetment Plan also exceeds the federal responsibility for mitigation under Section 111 provisions. As in the case of the groins with fill plan,the feeder beach alternative sets the guidelines for maximum federal responsibility and local interests must cost share the remainder prior to plan implementation.

Maximum Federal Responsibility as set by Alternative III is:
for Plans IV and V

- $287,800 toward either plans' first cost; and
- $54,000 toward maintenance, periodic nourishment, and inspection on an annual basis.

for Plan II

- $1,021,600 toward the plan first cost;

The maximum federal financial responsibility developed in this section is a worst case approximation based upon the post dike recession rates calculated for the period 1978 thru 1980. Those post dike recession rates in excess of pre-dike rates were attributable solely to the influence of the dike disposal structure when in fact high lake levels, failing private protective structures, and refracted wave ray focusing may contribute to this increased rate. Since the influence of these factors could not be clearly identified given the limited data base, this worst case approach was adopted to define the upper limit of federal responsibility.

The table on the next page summarizes the implementation responsibility for each alternative.

IMPLEMENTATION RESPONSIBILITY

	PLAN NO. II ACQUISITION	PLAN NO. III FEEDER BEACH	PLAN NO. IV GROIN & FILL	PLAN NO. V REVETMENT
FIRST COST				
Federal	1,021,600*	287,800	287,800	287,800
Non- Federal	1,151,900	0	1,956,100	1,508,200
Total	$2,173,500	$287,800	$2,243,900	$1,796,000
ANNUALIZED COSTS				
Federal	75,200	75,200	75,200	75,200
Non-Federal	84,800	0	153,200	86,700
Total	$160,000	$75,200	$228,400	$161,900
ANNUALIZED BENEFITS	$17,900	$22,500	$29,850	$33,000
BENEFIT/COST RATIO	0.11	0.30	0.13	0.20

* First Cost Amounts exceeding one million dollars require Congressional authorization prior to project approval.

APPENDIX 6

INVENTORY OF CULTURAL RESOURCES

CULTURAL RESOURCES

INTRODUCTION

The report contained in this appendix presents the results of a cultural resources survey performed in the project area in 1974. This survey was performed as part of the Diked Disposal Site No. 7 Project, Lorain, Ohio. This report also represents an assessment of the project area for the Lorain Harbor Section III Report, as the impact areas for both projects coincide. While the specific impact predictions contained in this report pertain only to the dike disposal site (impact predictions for the Lorain Harbor Section III Report are contained in the main report), the site location data and historical overview apply to the Lorain Harbor Section III Report as well.

INVENTORY OF CULTURAL RESOURCES

DIKED DISPOSAL SITE NO. 7
LORAIN HARBOR, OHIO

CONTRACT NO. DACW49-75-C-0063

DEPARTMENT OF THE ARMY
BUFFALO DISTRICT, CORPS OF ENGINEERS

GAI CONSULTANTS, INC.
MONROEVILLE, PENNSYLVANIA 15146

TABLE OF CONTENTS

LIST OF FIGURES

SCOPE OF CULTURAL RESOURCES RESEARCH

The purpose of this research effort by the Buffalo District, Corps of Engineers was to compile an inventory of all resources of cultural value or importance within or adjacent to the land and water areas of proposed Site No. 7 Diked Disposal Area in Lorain Harbor, Ohio. The research consisted of a literature search and field surveys to determine the presence or absence of cultural resources by which the project area has been fashioned or which may be affected adversely, damaged, or destroyed by the proposed project. Figure 1 is an overview of the general project area, while Figure 2 is a plan view of moored dredge and discharge pipeline locations by which the proposed project work would be implemented. The potential impact of the diked disposal area on the existing cultural resources was considered to be of prime importance; however, a broader area adjacent to the main project area was also taken into consideration as a means of placing the potential impact on all of the cultural resources into a sufficiently broad perspective to allow for an objective evaluation.

The field survey of the project zone and adjacent areas in the harbor and along Black River was undertaken by Dr. Don W. Dragoo, Curator of Anthropology, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania during the week of June 16-20, 1975. The immediate project zone was observed

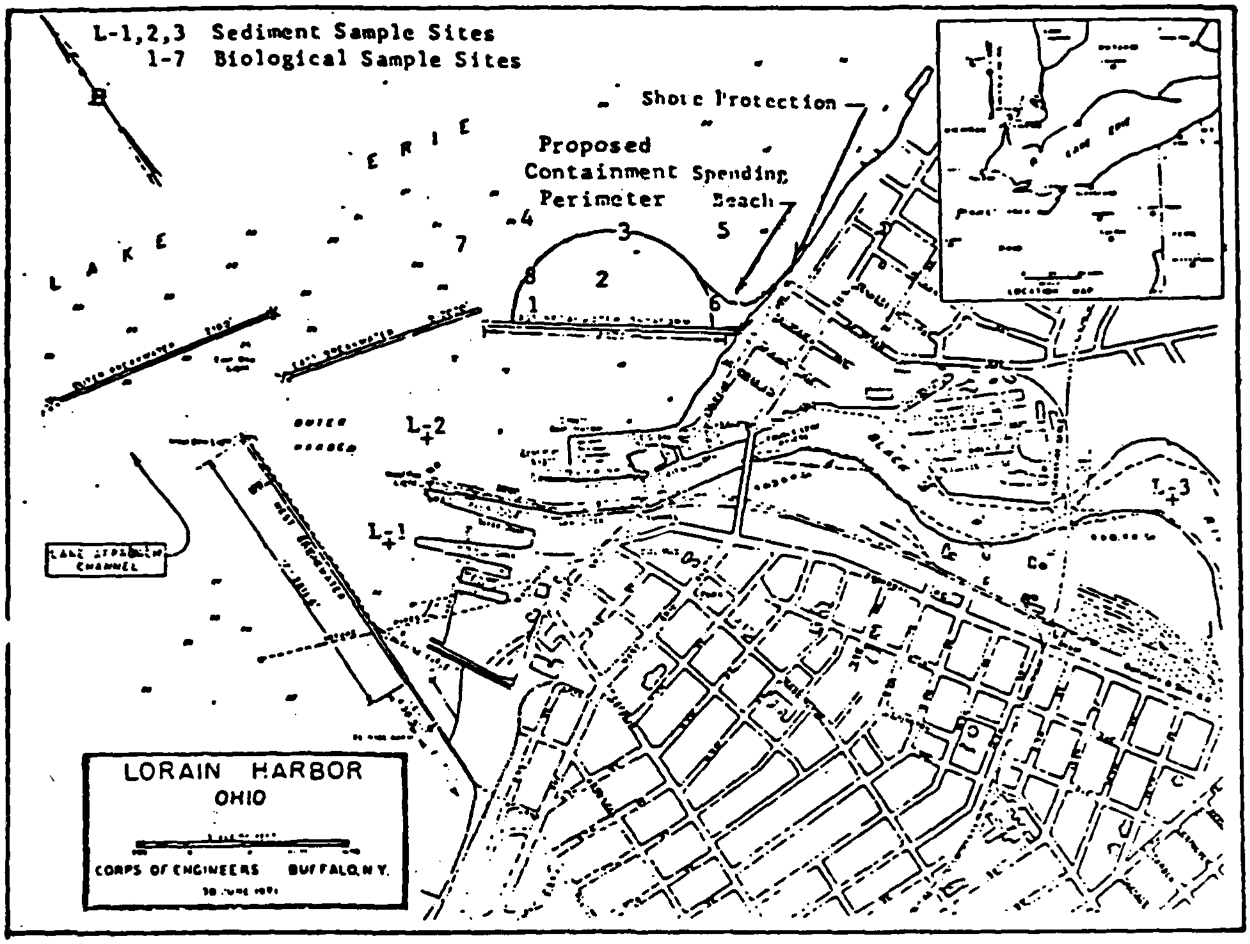


Figure 1. Project Location

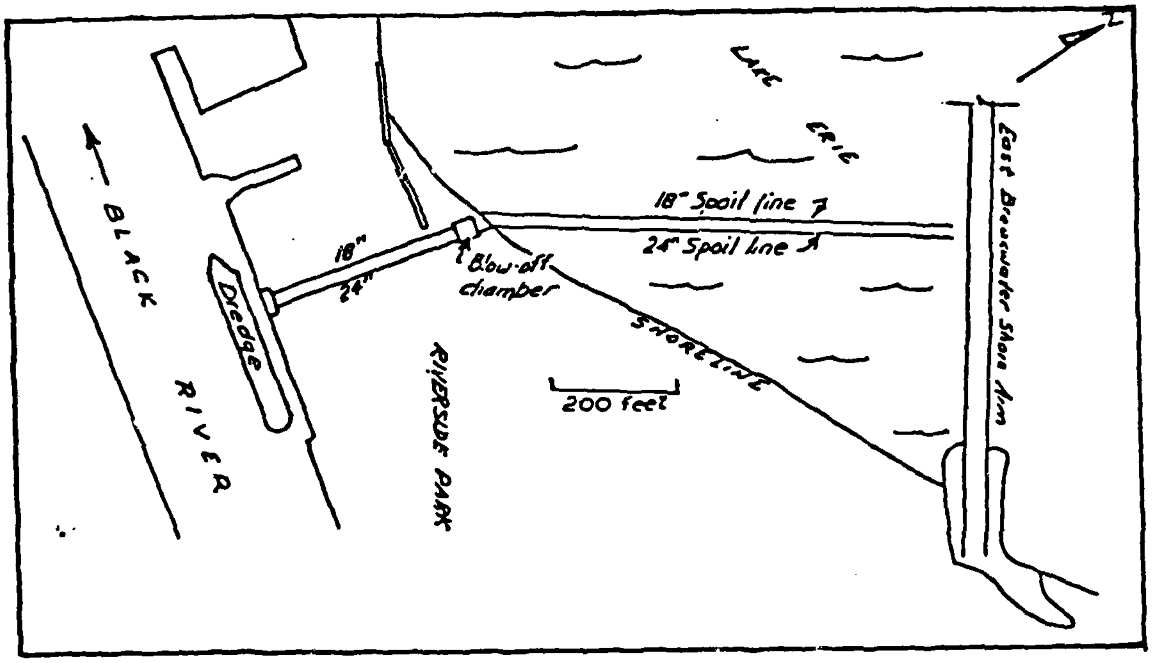


Figure 2. Plan View Showing Location of Moored Dredge and Discharge Pipelines.

for the remains of any significant archaeological or cultural features mentioned in the literature and a field search was made for any additional sites that could have escaped mention or previous recording. It was determined by both records and direct observations that the water areas of the harbor adjacent to the project have been extensively modified and disturbed by dredging and the construction of breakwaters. No remains of historical significance that would qualify for inclusion on the Historical Register are known to be present in the water areas in or surrounding the project zone. Although scattered debris of shipping activities and the remains of a wreck are known to be present, salvage of these items would not warrant the high cost of recovery as they are of minor historic value and similar or like items are still in existence or present in museums such as the Great Lakes Historical Museum at Vermilion, Ohio. A magnetometer survey could probably locate some items on the floor of the harbor, but it would be exceedingly difficult to justify on historical or cultural grounds the high cost of such a survey, or the underwater salvage of the material once it is accurately located.

During the field survey, all land areas and the shoreline discussed in this report were carefully checked and observed for any evidence of the archaeological and historic sites known to have been present according to the historic records and literature. Intervening areas were also field checked for possible remains (particularly prehistoric) not recorded in the literature. Land around Lorain Harbor has been subjected to extensive modifications and disturbances in recent times, and most of the areas known to have been the location of archaeological or historic cultural resources are now covered by present-day buildings, streets, railroads, docks, and factories which preclude the direct observation of the underlying soils. However, in such cases, it is probable that all earlier remains were destroyed during the construction of the foundations for these features since the remains of the earlier structures were on or immediately below the surface. Of all the areas mentioned in this report, only a small portion of Riverside Park appears to be open land. Surface observation and soil checks of this area indicated that there had been recent soil disturbances and no evidence for prehistoric or early historic features or cultural debris was found. Industrial waste such as slag cinders from the steel mills is to be found scattered over much of the area along the Black River where it has been used for fill in the railroad yards of the Baltimore and Ohio Railroad. Dredging has modified and altered the natural configuration of the banks of the Black River throughout the project area. Retaining walls and riprap cover large sections of the river bank.

CULTURAL RESOURCES

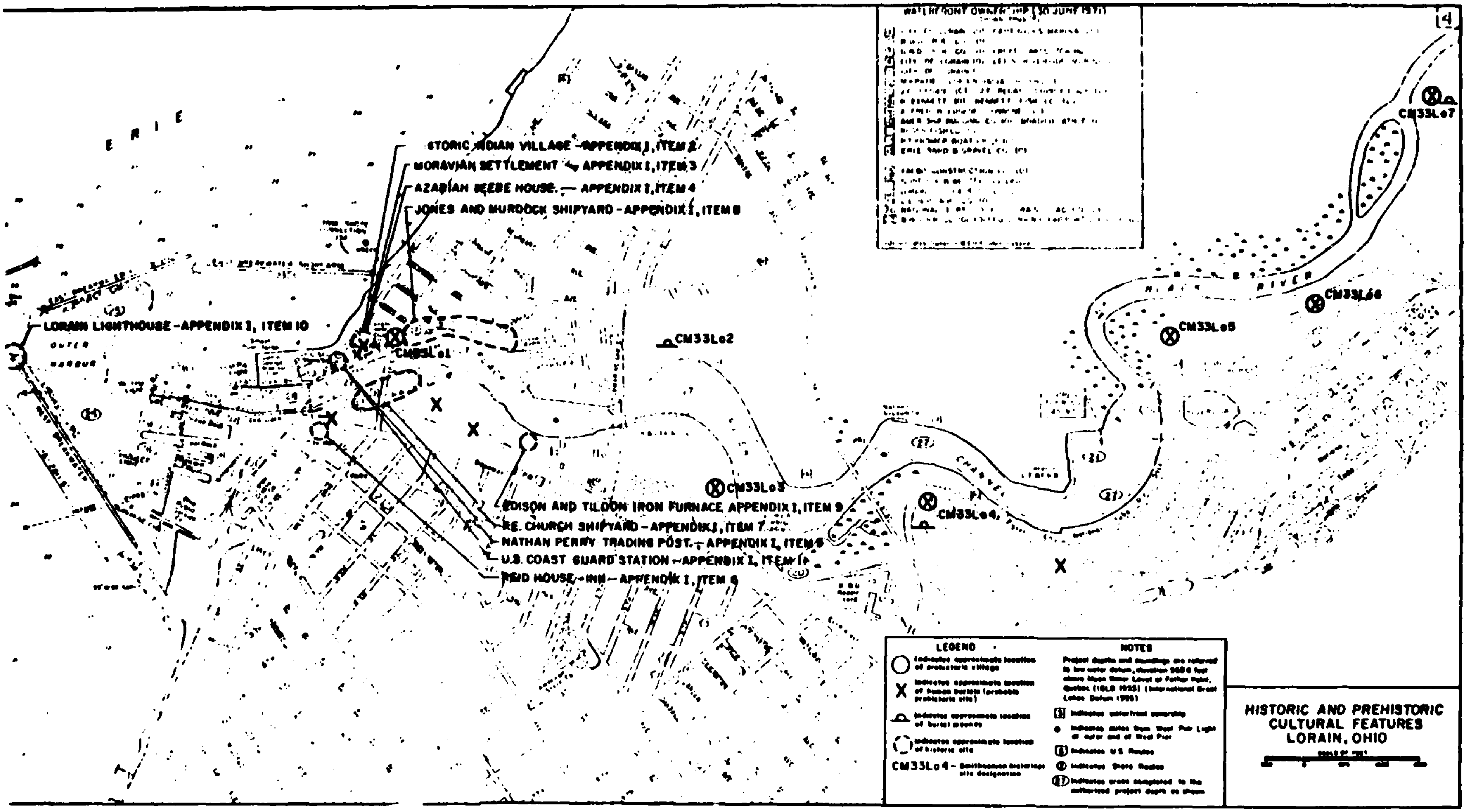
This inventory was compiled from a comprehensive review of existing archaeological and historical literature and records of the city of Lorain and Lorain County in the Lorain County Historical Society, Elyria Public Library, Ohio State Historical Society, and Carnegie Museum of Natural History Library (Pittsburgh, Pennsylvania). Co-ordination of pertinent material research was conducted through the staffs of these institutions and the U. S. Coast Guard Station, Lorain, Ohio. The current status of all potentially identifiable cultural resources was field checked to confirm the literature research. The accounts of cultural resources known to have existed or which have been found to be still present are listed chronologically within their respective categories.

Prehistoric

The prehistoric cultural resources of the lower Black River and the Lorain Harbor area are not widely known because of the lack of scientific research conducted in the Lorain area in recent times. A summary of Lorain County prehistoric archaeology was published by Colonel Raymond C. Vietzen in 1967 (Ref. 6). According to Vietzen's report, considered to be an authentic account, the earliest prehistoric occupation of the Black River area dates from about

7000 B.C. with the presence of Archaic cultures. Earlier Paleo-Indian remains appear to be absent, or at least unknown, in the area immediately adjacent to Lake Erie and the project area. From 7000 B.C., there appears to have been continuous occupation of the Lorain County area and the Black River drainage basin by various American Indian cultural groups including various Archaic peoples 7000-1000 B.C., the Adena 1000 B.C.-A.D. 100, Hopewell 100 B.C.-A.D. 600, and Late Woodland and Late Prehistoric A.D. 600-1650. The last Indian group believed to have occupied the area in prehistoric times was the Erie, but other contemporary groups may have also been living in the area. Current knowledge of the Late Prehistoric cultures of northern Ohio indicates that the setting was very complex, probably involving several groups. One of these may have been the Erie which supposedly were destroyed by the Iroquoian peoples living to the east in present-day New York State.

The most important reference to prehistoric sites in the lower Black River and Lorain Harbor area is found in a map on file at the Lorain County Historical Society, Elyria, Ohio. Attributed to P. Bungart, this map shows the location of archaeological sites known to have been present prior to or about 1897. Approximate locations of those sites nearest the present project are shown on Figure 3. Six villages and three burial mounds are shown. The burial mounds undoubtedly



E R I E
STORIC INDIAN VILLAGE - APPENDIX I, ITEM 2
MORAVIAN SETTLEMENT - APPENDIX I, ITEM 3
AZARIAH BEEBE HOUSE - APPENDIX I, ITEM 4
JONES AND MURDOCK SHIPYARD - APPENDIX I, ITEM 8
LORAIN LIGHTHOUSE - APPENDIX I, ITEM 10
OUTER HARBOR
CM33Lo1
CM33Lo2
CM33Lo3
CM33Lo4
CM33Lo5
CM33Lo6
CM33Lo7
EDISON AND TILLDON IRON FURNACE APPENDIX I, ITEM 9
F.E. CHURCH SHIPYARD - APPENDIX I, ITEM 7
NATHAN PERRY TRADING POST - APPENDIX I, ITEM 5
U.S. COAST GUARD STATION - APPENDIX I, ITEM 1
REID HOUSE - INN - APPENDIX I, ITEM 6
BLACK RIVER
CHANNEL
WATERFRONT OWNERSHIP (30 JUNE 1971)
LEGEND
Indicates approximate location of prehistoric village
Indicates approximate location of human burials (probable prehistoric site)
Indicates approximate location of burial mounds
Indicates approximate location of historic site
CM33Lo4 - Smithsonian historical site designation
NOTES
HISTORIC AND PREHISTORIC
CULTURAL FEATURES
LORAIN, OHIO

FIGURE 3

belonged to the Adena and Hopewell cultures of 1000 B.C.-A.D. 600 (Ref. 2, pp. 1-315). Village sites adjacent to the mounds probably belonged to the same cultures, but later occupations may have also been present on the same areas. Most of the village sites can be attributed to later groups of the Late Prehistoric Period (A.D. 1000-1650). Some objects and a human skeleton on display at the Lorain County Historical Society appear to belong to the Late Prehistoric Period.

Several places on the Bungart map are marked as areas where human burials were found. Such recognizable human skeletal remains are generally associated with Late Prehistoric village sites when they are found in flat areas unassociated with burial mounds. Thus, it appears likely that prehistoric villages, or possibly early historic Indian settlements, were also present in these areas.

All sites shown on the Bungart map were within the present-day Lorain city limits. Village CM 33 Lo 1 was partially situated within the area (marked as Riverside Park on Figure 2) of the proposed pumpout pipeline from the dredge to the disposal area. A surface survey of this area, however, produced no evidence that any significant portions of this village remain intact. Recent disturbances in the area by construction of streets, buildings, and other urban infrastructure has modified the area since prehistoric times to the extent that the site is not visible today. In view of the fact that some remains of this village may have escaped detection or destruction, it is important that work crews be cautioned to watch for buried cultural debris and human bones during construction of the pipeline for spoil across this area. In the event that such items are uncovered, observation and salvage by a competent archaeologist could be a means of preserving the remains.

All of the other sites shown on Figure 3 appear to have been destroyed since the river banks and immediately adjacent lands have been thoroughly disturbed throughout the lower portion of the Black River. All of the remaining site areas on the Bungart map are now covered by industrial plants, roads, railroads, or storage areas for raw materials. No trace of any of the marked sites could be found during the field survey, and it is unlikely that any significant portions of them remain intact.

It is our considered judgment, therefore, that no important prehistoric sites will be adversely affected by constructing the proposed Site No. 7 Diked Disposal Area. As indicated, the only possible surviving remains would be those of site CM 33 Lo 1 in the Riverside Park area, and if such remains are detected, a program of immediate, limited salvage would be warranted to recover and study such remains. Since the greater portion of the site evidently has already been destroyed, and it is unlikely that extensive knowledge will ever be gained of the site's total configuration and cultural importance, the site would not meet the criteria for inclusion on the National Register.

Additional information of some research value pertaining to the prehistory of the Black River area is contained in the following publications. The work described in these reports was done many years ago, and it is suggested that the conclusions drawn therein may not always conform to more recent ideas concerning the prehistory of northern Ohio.

Brinton, Daniel Garrison

1884 On the cuspidiform petroglyphs, or so-called birdtrack rock sculptures of Ohio. Philadelphia Academy of Natural Sciences, Proceedings, 1884, Vol. 36, pp. 275-277.

Galbraith, John H.

1915 Ohio cave dwellers. Ohio State Archaeological and Historical Quarterly, Vol. 26, p. 540.

Greenman, Emerson F.

1935 Seven prehistoric sites in northern Ohio. Ohio State Archaeological and Historical Quarterly, Vol. 44, pp. 220-237.

Newberry, John S.

1874 Ancient earth-works in Lorain County. Geological

Survey of Ohio, Report, II, Pt. 1, pp. 223-224.

Newberry, John S.

1889 Ancient mining in North America. American Antiquarian, Vol. 11, pp. 164-167.

Vietzen, Raymond C.

1946 Prehistory of the Black River Valley. Ohio Indian Relic Collectors Society, Bulletin, Vol. 15, pp. 6-9.

Wittlesey, Charles

1850 Notice of two ancient skulls and other bones found in a cave near Elyria, Lorain, Ohio. American Association for the Advancement of Science, Proceedings, Vol. 5, pp. 16-18.

1875 The rock inscriptions, Amherst, Lorain County, Ohio. Scientific Monthly: A Magazine Devoted to the Natural Sciences, Vol. I, No. 2, pp. 55-58.

Early Historic Indian Cultural Resources

When European settlers arrived in the Black River area near present-day Lorain, Ohio, the land was claimed by the Seneca Indians, the major western tribe of the Iroquois, whose traditional homeland was in present-day western New York state. During the latter half of the 17th century, the Iroquoian peoples spread westward around the southern shore of Lake Erie and across northern Ohio, eliminating the Erie and other groups of northern Ohio who had claimed this territory throughout the preceding Late Prehistoric Period (A.D. 1000-1650). Archaeological evidence does not indicate that the Iroquoian peoples established major villages in northern Ohio during the late 1600's and most of the 1700's, but they did establish small settlements and camps that enabled them to control the area for hunting and participation in the fur trade.

The 1700's were a period of great stress for all of the Eastern Indian tribes. Colonial settlements of their homelands forced many of these tribes, such as the Delaware and splintered groups from other tribes, to resettle across the Allegheny Mountains in the Upper Ohio Valley by the early 1700's. By the mid-1750's, the struggle between France and Britain for the Upper Ohio River country again forced the Indian to seek new homes farther West in Ohio. Among the groups who entered northern Ohio and contested for living space with the Iroquois (mostly Senecas) were the Delaware, Wyandots, Hurons, and Shawnees.

The first documented evidence of the presence of these people in the Black River area is found in the story of Colonel James Smith who was captured by the Indians in 1755 while cutting a wagon road through the Allegheny Mountains in Pennsylvania. The Indians took Smith to a French fort and then moved on to the Black River area where they settled for a time. Smith was adopted by the tribe, but later escaped and joined the regular British Army.

The first European to visit the Lorain area, however, may have been a Frenchman named Louis Vagard. A stone in the shape of an Indian idol with the inscription: "Louis Vagard, La France, 1533" was found by a farmer in southern Lorain County, but the authenticity of this stone may be questioned (Ref. 4, p. 89). Other French and English traders undoubtedly visited the area, but history has not recorded their passing.

Archaeological evidence of the historic Indian groups living in the Black River area of Lorain County is practically nonexistent according to Colonel Raymond C. Vietzen, a long-time resident and student of the area's prehistory and early history (Ref. 4, p. 7). The archaeological field survey conducted as part of this project confirmed the apparent lack of evidence of historic Indian remains in Lorain as stated by Vietzen.

Early Historic Settlement of Black River and Lorain, Ohio

The area of Lorain County was originally encompassed in a land grant made to the Connecticut Colony by the British consisting of a narrow corridor of land about seventy-five miles wide and extending from ocean to ocean. The French claims to this area were eliminated at the end of the French and Indian War (1754-63). In 1786, Connecticut gave up its claims to this vast tract of land to the Federal government, but in so doing, reserved for the citizens of Connecticut a strip of land extending 120 miles westward from the Pennsylvania boundary and about fifty miles southward from the southern shore of Lake Erie. Known as Connecticut's Western Reserve, the land was sold to settlers through the Connecticut Land Company with the exception of the westernmost 25 miles (now Huron County) which was set aside for the citizens of Connecticut shore towns who had suffered fire and other damages at the hands of the British forces during the Revolutionary War. Many of these people from New England were soon to become the main occupants of Lorain County and were to play an important part in the future development of northern Ohio (Ref. 5).

The earliest attempted permanent settlement in Lorain County was made at the mouth of the Black River in 1787. In April of that year, a group of Moravians under the leadership of their minister, David Zeisberger, moved with several Christian Indians of the Delaware tribe from a campsite on the Cuyahoga River to the mouth of the Black River. They began the task of building a permanent settlement there, but their hopes were soon dashed. A few days after they had set to work building cabins, a message from the chief of the Delawares, living then in that part of Ohio, ordered the new settlers to leave the Black River area. The new settlement was abandoned, and the Moravians moved westward to the Sandusky River region (Ref. 1, p. 330-333). Little evidence of this first, short-lived settlement has survived. It is now impossible to precisely locate the site of this village, but available information suggests that it was near the present-day Riverside Park.

After the unsuccessful Moravian settlement, it was 1807 before settlers again arrived to claim this land. In the meantime, the Indians had relinquished their claims to the area by the treaty of Fort Industry in 1805. The first family to settle in Black River (later to be changed to Charleston and then Lorain) was that of Azariah Beebe, who came from Vermont in 1807. Beebe built his log cabin on the east bank at the mouth of the Black River and sent word for his wife and employer's son, Nathan Perry, Jr., to join him. Nathan Perry, Sr., soon built a trading post on the east bank of the Black River in the same area now occupied by the U. S. Coast Guard Station and traded with the various Indian tribes during the next three years after which time the Indians began to move westward (Ref. 1, p. 330-331).

By 1810, Nathan Perry, Sr., and the Beebes had left the area and Daniel Perry, an uncle of Nathan, moved into the house built by the Beebes. Other families began to move into the area that same year, and the small trading post settlement began to grow. Among the new arrivals were Jacob Shupe, Joseph Quigley, George and Andrew Kelso, Ralph Lyon, and a Mr. Seely. In 1811, John S. Reid, Quartus and Aretus Gilmore, and William Martin joined the residents.

John S. Reid was a carpenter by trade, and with the help of other members of the settlement, constructed a large blockhouse in 1812 on the corner of what is now Broadway and First Street in Lorain. This blockhouse served as the Reid home, tavern and inn, post office, and office for the justice of the peace. Reid was named the first postmaster and justice of the peace and held these positions from 1812 to 1827. James Reid and later his son, Conrad, were to dominate the political life of this area for many years.

Over the next several years, the settlement grew slowly but steadily. It was not, however, until July 16, 1834 that a map presented to the county recorder to file for public record marked the settlement's emergence as a corporate town. A notation on the map stated: "A town plat at the mouth of Black River in the township of Black River in Lorain County and the State of Ohio: scale, 250 chains to the inch. Survey May 10, 1834. Commencing at a stone planted at the north corner of public square from which plat is surveyed." It was not until two years later that the town council chose the name Charleston in the hope it would attract new settlers and Eastern railroad and canal promoters.

Unfortunately, the change of name failed to attract many new settlers, and the hoped for railroad and canal did not materialize. The Ohio legislature had granted a franchise to a group of railroad promoters in 1834 to build and operate a railroad from Painesville to Sandusky which would have passed through the Charleston townsite. However, the state-subsidized promoters, known as the Ohio Railroad Company, collapsed, costing Ohio $249,000 and Charleston its link with Ohio commerce. The town was destined to slumber until the railroad finally arrived in 1872 (Ref. 7, pp. 288-291 and Ref. 4, pp. 88-92).

Apparently, none of the structures associated with the early settlement have survived. More recent construction around the mouth of the Black River has presumably erased all traces of the pioneer cabins and the Reid blockhouse. It is concluded that construction at the proposed Site No. 7 Diked Disposal Area will in no way further disrupt any remains of these early structures.

Early Commerce and Industry - 1807-1872

With the removal of the Indians from northern Ohio, the trading post at the mouth of the Black River turned to serving the settlers that slowly had begun to arrive in the area. The industrial life of Black River did not begin for another ten years until the area around its mouth became the focus for boat and shipbuilding. The first vessel constructed was the General Huntington launched by F. E. Church in 1819 at a shipyard on the west bank of the Black River, just opposite the present-day location of the American Shipbuilding Company. In 1820, Augustus Jones and William Murdock, who had been shipbuilders on the Connecticut River, received land grants on the east bank near the mouth of the Black River and began building sailing vessels with shipbuilders from the east who had been put out of work there during the War of 1812 when the British destroyed the Connecticut shipyards. The first ship launched at the Jones and Murdock shipyard was the sloop William Tell in 1828.

Shipyards were soon established along both the east and west banks of the Black River and also along the lake shore. The village of Black River was well suited for shipbuilding, since the river afforded a good harbor and fine timber was present in the forest surrounding the village and lining the shores of the Black River. Many of the early shipbuilders became ship owners, and fleets of schooners sailed in and out of the Black River carrying the commerce from the area, which consisted mainly of grain from the rich farm lands of Lorain County.

The era of wooden shipbuilding continued at the mouth of the Black River until 1873. One hundred and twenty-three major vessels as well as about forty scows were constructed during this period. The list of these major vessels is given in Appendix II of this report.

The building of the first steamboats, Bunker Hill and Constellation in 1837, led to the formation of the Black River Steamboat Association. When the Bunker Hill was launched from the J. N. Jones Shipyard, it was necessary to tow it to Cleveland in order to equip it with the boiler and fittings. The Constellation was completed at Black River by hauling the steam machinery by oxen from Pittsburgh. These first ships had been constructed under the controlling interest of parties in Buffalo and Cleveland; but the formation of the Black River Steamboat Association enabled the local businessmen to control the building of future craft. In 1838, the Association launched its first vessel, the Lexington.

From its inception in 1819, shipbuilding was to remain Black River's major industry until the coming of the railroad in 1872. The population of Black River expanded very slowly throughout the period, and the ship workers often left the area during the summer as the community was infested with malaria and typhoid during these hot months. The village lacked public sanitation, and the undrained marshland along the river was a breeding ground for mosquitoes. After 1853, many of the farmers who had previously hauled their products to the mouth of the Black River for shipment by boat, now took their grain to the railroad in Elyria.

After shipbuilding, the only other notable industry in Black River was fishing. The waters of Lake Erie off the mouth of the Black River were especially noted for perch, pike, herring, pickerel, whitefish, and lake trout. Fishing had been important in the area from the beginning of the settlement, but it did not assume substantial proportions in the economy of Black River until the late 1860's and early 1870's.

The first iron furnace in the Black River settlement was erected in 1860 on the west bank of the river at what is now the foot of Eighth Street. The owners of the furnace were S. O. Edison and Dr. Philo Tilden, while William McKinley, father of the President, was furnaceman and bookkeeper for the company. The company operated in Black River until 1871 when the plant burned to the ground. It was never rebuilt, and Edison moved his operation to Saginaw Bay, Michigan, where it became known as S. O. Edison & Company. The location of the Black River furnace was later occupied by the Ranney Fish Company.

The iron furnace had been one of the few bright spots in the economy of Black River (Charleston) during the 1860's. With its destruction by fire in 1871, the earlier loss of the grain trade to the railroads at Elyria, and the decline of the wooden shipbuilding industry, Black River entered the

1870's in a state of economic uncertainty. Many of the merchants had departed, the warehouses were parcelled out among the local farmers for barns and fences, the hotels were empty, and the corporate organization was abandoned. Black River, or Charleston, was a town in name only.

The field survey for the locations of the above mentioned cultural features of the 1807-1872 period indicates that there are obviously no significant remains of these historical resources intact today. All have been obliterated over the years by more recent construction and activities at and around the mouth of the Black River. There is now no evidence of the early shipyards that once spread along the lake front east of the mouth of the Black River in the area to be occupied by the proposed Site No. 7 Diked Disposal Area. Decay and the wave action of Lake Erie have destroyed the old launch ramps, and stone and concrete riprap presently face the shore line in an effort to stem further erosion.

Sources for the above information and additional details may be found in the following items:

Boynton, W. W.

1876 The Early History of Lorain County Tract No. 83, pp. 301-366, Western Reserve Historical Society, Cleveland, Ohio.

Upton, Harriet Taylor

1910 History of the Western Reserve. Vol. 1, pp. 223-

262. The Lewis Publishing Company, Chicago.

Metcalf, George P.

1967 Lorain County, Ohio - A short history. Pathways of the Pioneers, Vol. 2, No. 2, Lorain County Historical Society, Elyria, Ohio.

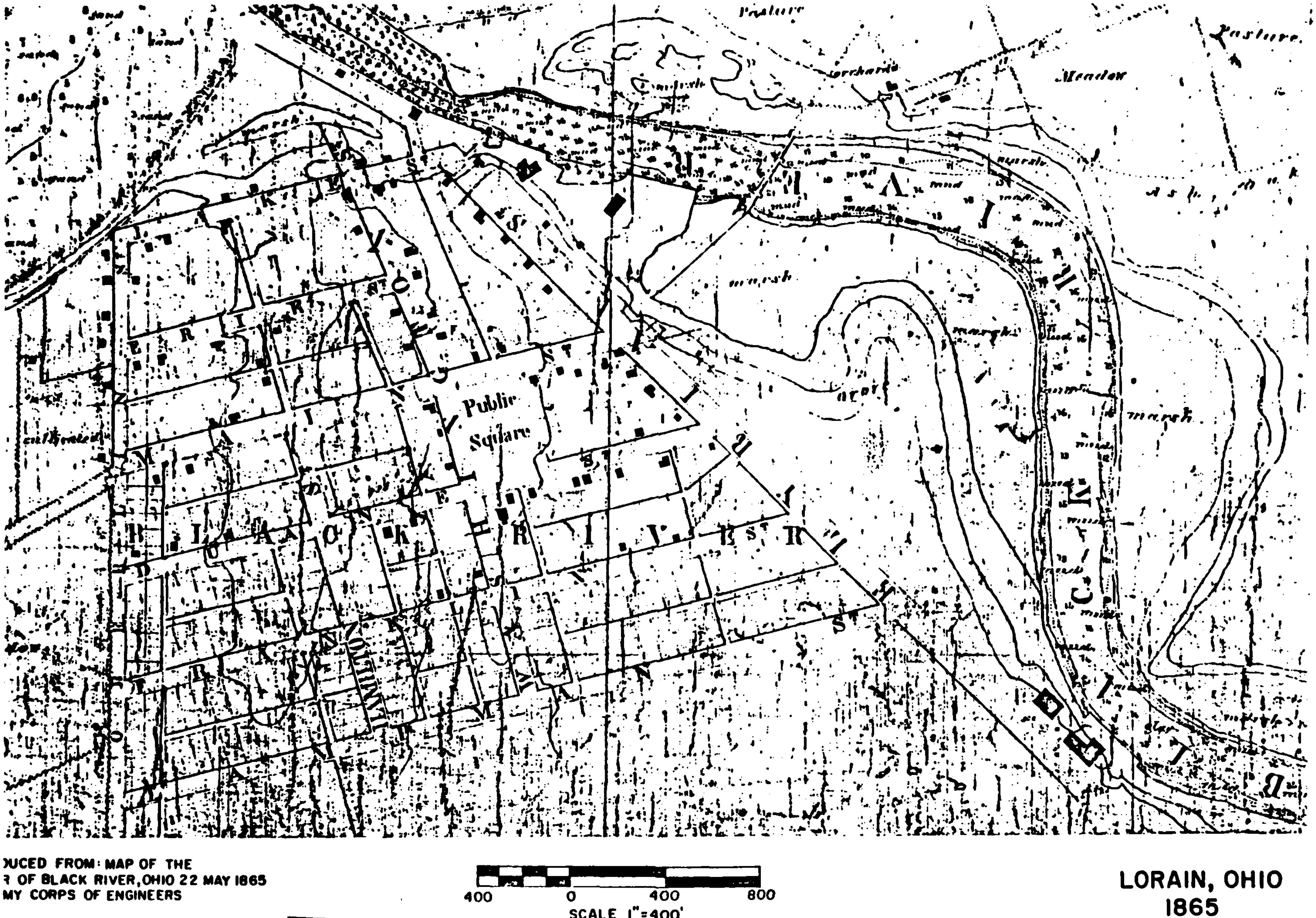
Wright, G. Frederick

1916 A standard history of Lorain County, Ohio, Vol. 1, The Lewis Publishing Co., Chicago.

Lorain County Sesquicentennial 1824-1974, pp. 88-98, American Multi-Service, Elyria, Ohio.

The Development of Modern Lorain, Ohio 1872-1975

Black River (Charleston) was on the verge of becoming a ghost town when several businessmen realized the importance of the Black River harbor as a lake port for the export of coal from southern Ohio. The railroad was opened to Black River (Charleston) in 1872 by the Cleveland, Tuscarawas Valley and Wheeling Railroad, later renamed the Cleveland, Lorain, and Wheeling Railroad and now part of the Baltimore and Ohio Railroad system. At that time, there were less than 500 inhabitants in Black River, and the plat map of the village shows only a few blocks of structures situated on both the east and west side of the river near the harbor (Ref. 3). Figure 4 shows the project vicinity in 1865, which was identical to that shown on the 1872 map.



DUCED FROM: MAP OF THE
R OF BLACK RIVER, OHIO 22 MAY 1865
MY CORPS OF ENGINEERS

LORAIN, OHIO
1865

FI

The coming of the railroad revived Black River. In 1874, an application was made to the Lorain County commissioners for incorporation as a village under the name of Charleston. The U. S. Post Office Department refused to approve the name, however, because there was another Charleston, Ohio. The name Lorain was then chosen by the town council, and the village was officially incorporated as Lorain, Ohio, in 1876. The population of the village began to grow rapidly, and by 1880, there were 1,595 inhabitants, more than triple the 1870 count. Lorain had finally achieved importance and a stable economic foundation.

Since 1880, the following major events have shaped the growth and development of Lorain into the major industrial city of today. (See Ref. 7 and Ref. 4 for further discussion.)

a. During the late 1870's and early 1880's, John Gawn established the first large-scale commercial fishery. Other companies were formed about 1889 with the partnership of the Kolbe Brothers and Ranney Company followed soon by T. W. Smith, which was later merged with the A. Booth Company. In 1901, the Reger and Warner Company was formed. The commercial fishing activities of these companies were to become the most extensive on Lake Erie. After 1960, commercial fishing on Lake Erie was greatly reduced because of pollution from lake front cities and industries and the increased population of the lamprey eel which could enter the Great Lakes more readily through the St. Lawrence Seaway, which opened in 1959. Today, perch are the most valuable commercial fish found in the waters off Lorain's harbor.

b. Following the coming of the railroad in 1872, new small industries were established in Lorain. Among these were the planing mills of Brown Brothers and Company and E. Slaight and Sons, and the Lorain Stove Company.

c. In 1881, the Nickel Plate Railroad extended its route through Lorain providing direct access to cities and towns east and west.

d. The Haydenville Brass Works moved from Haydenville, Massachusetts to Lorain in 1881, the town's first basic industry not based on water transportation since the destruction of the iron furnace in 1871. By 1883, the brass factory was the town's largest employer, and the population of the town doubled within a period of sixteen months. The brass factory remained in business until 1903.

e. The most important event in the growth of Lorain was the decision in 1894 to move the Johnson

Company, manufacturers of steel rails for traction lines, from Johnstown, Pennsylvania to Lorain, Ohio. As a condition to this move, the city of Lorain agreed to straighten and dredge the Black River to make it navigable to the Johnson Company plant, which was to occupy a large tract of land south and east of the mouth of the Black River. The Johnson steel mill began operation on April 1, 1895, and Lorain began its emergence as an important steel-producing center. The plant operated as the Johnson Company until the company was reorganized and the name changed to Lorain Steel Company in 1898. With the reorganization came an expansion of manufacturing facilities and improvements in methods. The Lorain Steel Company was soon taken over by the National Tube Company, which in turn became a subsidiary of the newly organized United States Steel Corporation. Since that time, there has been continued expansion and development of the steel-making facilities with over 10,000 people now employed in this industry in Lorain. There can be little doubt that the steel industry was the spark that saved Lorain from obscurity and made it the important industrial center that it is today.

f. With the arrival of the steel industry, there was also a revival of shipbuilding. In 1897, the Cleveland Shipbuilding Company organized and built a shipyard on the east side of the Black River opposite the location of the early shipyard. Here, in 1898, was launched the first steel ship built on the Great Lakes. Christened the Superior City, it was then the largest ship on the Great Lakes. In 1899, the American Shipbuilding Company gained control of the Lorain shipyard and has continued its operation to this day. Ships built here include ore carriers, passenger ships, railroad care ferries, tankers, self-unloaders, tugs, barges, and ocean-going freighters. During both World Wars I and II, many ships were constructed at Lorain. The company has pioneered in the design and construction of the largest and fastest ore carriers on the Great Lakes. After World War II, the Wilfred Sykes built at this yard was known as the "Queen of the Lakes." For the past several years, the American Shipbuilding Company has been constructing giant ore carriers over 850 feet long.

g. Since the arrival of the railroad in 1872, the shipment of coal and other goods from Lorain has been important in the commerce of the area. The Baltimore and Ohio Railroad has long maintained extensive terminals on the west bank of the Black River and on the lake front. Beginning with the dredging of the river in 1894, there have been continued improvements to the harbor facilities and navigability of the Black River upstream to the steel mills. Although constant improvements had been made to Lorain Harbor by the U. S. Government since 1828, the modern development began with the passage of the River and Harbor Act of June 3, 1996, which authorized the survey of the harbor area at the mouth of Black River. Subsequent acts of 1899, 1907, 1910, 1917, 1930, 1935, 1945, 1960, and 1965 authorized and provided for improvements which included the construction of breakwaters and the dredging of the harbor area and the Black River. The harbor is naturally deep and one of the best in the Great Lakes. A western and an eastern sea wall protects the harbor from storms. Key features are shown on Figure 4. According to records at the U. S. Coast Guard Station at Lorain, the first beacon of record in the harbor was during the Civil War. There probably was an earlier one, but no record exists of it today.

The Lorain Beacon Building was built in 1898, and James Connolly was the light keeper for the U. S. Light House Service. The present light house, built in 1909, along with the Coast Guard Station, represent the oldest extant public structures in the entire city.

From the above listed major structures and events came other benefits to the growth and development of Lorain as a major industrial city. Steel, shipbuilding, and lake commerce have provided a stable economic base for the area since 1894. Attendant to these developments have been a steady growth in population and the establishment of many small businesses, churches, schools, and public facilities necessary to sustain the continued well-being of the population.

DISCUSSION AND CONCLUSIONS

The focus of major economic activity in Lorain has always been the Black River and the lake harbor at its mouth. As new industries came into existence or old industries modernized, earlier structures were destroyed. Obviously, improvements or expansion could not be accomplished in such a restricted area without destruction of these older features. As a result, modern-day Lorain today has little remaining evidence of its days as the struggling village of Black River and Charleston. Present-day Lorain is a city whose rise to prominence has occurred within the past one hundred years, its greatest development having taken place since 1900. Since the arrival of the railroad in 1872, the steel mills in 1894, and the return of the shipyards in 1897, Lorain has become a small industrial giant whose activities have erased the evidence of the lean days prior to 1872.

Two natural disasters have also contributed to the loss of Lorain's links to its past. Following several days of rain in 1913, the Black River turned into a raging torrent, rising fifteen feet above its banks and sweeping ships and structures into Lake Erie. On June 28, 1924, Lorain was hit by a tornado that stands as one of the greatest natural disasters recorded in the Eastern United States. Seventy-eight people were killed and more than 1,000 injured. The downtown area and the harbor were almost completely devastated. Nearly 200 business places were wrecked, 500 homes completely destroyed, and 1,000 more houses partially destroyed. Much of the downtown area around the mouth of the Black River had to be rebuilt.

In the literature search and field survey conducted as part of this effort, no significant sites, buildings, or features of Lorain's early history or prehistory were found intact around or near the mouth of the Black River. However, the status of those items deemed of prehistoric or historic significance in relation to the proposed Site No. 7 Diked Dredge Disposal Area is indicated in Appendix I.

The only feature of the area adjacent to the proposed disposal area that is considered to be of historic interest and worthy of preservation by the people of Lorain, acting through the Lorain County Historical Society, is the lighthouse in Lorain Harbor. This structure, built in 1909, was scheduled for replacement during the 1960's, but public concern and pressure have so far spared the structure. The fight to save the lighthouse now centers on the problem of financial responsibility for its care and maintenance. Present action in this matter is being undertaken by the Great Lakes Historical Society and Museum of Vermilion, Ohio. The lighthouse has been nominated for inclusion on the National Register of Historic Places, and final action is pending. (See Appendix III for references concerning the Lighthouse.)

Although the lighthouse is of relatively recent construction and lacks most of the qualifications for inclusion on the National Register, the structure is of historical interest as an example of the period and the growing importance of Lorain as a major Great Lakes port. It, and the companion U. S. Coast Guard Station, are the only structures remaining from the period of Lorain development at the turn of the 20th century. In this respect, the U. S. Coast Guard Station should also be considered culturally integral to the lighthouse. Since the former is still in active use, the problem of its preservation has not yet arisen.

The construction of the proposed Site No. 7 Diked Disposal Area will not affect the lighthouse since it is outside the range of any activities that would be associated with building the pipeline or the containment area. A temporary adverse visual effect would accrue to the U. S. Coast Guard Station during the period for the construction of the pipeline, but there would be no permanent adverse effect following the completion of the pipeline installation. There would be no basic changes in the appearance of the area or the activities currently associated in and around Lorain Harbor once the pipeline is in operation.

Except for the remote possibility that some remains of prehistoric site CM 33 Lo 1 may still exist, as mentioned previously, there are no historic, prehistoric, or existing cultural resources that can be expected to be, directly or indirectly, adversely affected by the proposed project. There are no remaining cultural resources other than the lighthouse and the U. S. Coast Guard Station that could possibly qualify for inclusion on the National Register. In the event evidence for prehistoric site CM 33 Lo 1 would be encountered during the excavation for the pipeline, only immediate archaeological salvage and recording of items and features directly in the path of the pipeline would appear to be warranted. The highly disturbed nature of the soil of this area by many activities since the prehistoric occupation makes the probability of significant features existing intact very low.

Historically, the early Black River community and the present-day city of Lorain have depended upon the harbor and the navigability of the Black River for economic stability. The construction of the proposed Site No. 7 Diked Disposal Area can only add to that stability and the cultural well-being of the community. In addition to serving the need for dredge disposal, it is anticipated that there may be additional protective benefits to the lighthouse, U. S. Coast Guard Station, and more recent structures as the design features of the disposal area will serve as added buffers to wave erosion and destructive winds coming off Lake Erie over the harbor area.

LIST OF REFERENCES

1. Boynton, W. W., The Early History of Lorain County, 1876, Western Reserve Historical Society, Cleveland, Ohio pp. 330-333.

2. Dragoo, Don W. "Mounds for the Dead," Annals of Carnegie Museum, Vol. 37, 1963, Pittsburgh, Pennsylvania, pp. 1-35.

3. Lake, D. J., Atlas of Lorain County, Ohio, 1874, Titus, Simmons and Titus, Philadelphia, Pennsylvania.

4. Lorain County Susquicentennial 1824-1974, 1974, American Multi-Service, Elyria, Ohio.

5. Upton, Harriet Taylor, History of the Western Reserve, Vol. 1, 1910, Lewis Publishing Company, Chicago.

6. Vietzen, Colonel Raymond C. "Lorain County's Indians," Pathways of the Pioneers, Vol. 2, No. 3, 1967, Lorain County Historical Society, Elyria, Ohio.

7. Wright, Frederick G., A Standard History of Lorain County, Ohio, Vol. 1, 1916, Lewis Publishing Company, Chicago, pp. 288-291.

Appendix I: Significant Former and Presently Extant Historic and Prehistoric Cultural Resources, Lorain Harbor, Ohio.

1. Prehistoric archaeological sites consisting of at least five villages, three burial mounds, and two burial areas as recorded on Plate 3. All of these sites appear to have been destroyed.
2. Historic Indian village on the east shore of the Black River near its mouth. No evidence remains of this village.
3. Structures (houses) of the first permanent settlement by the Moravians at the mouth of the Black River in 1787. No intact remains of this settlement exist today.
4. House of Azariah Beebe built at the mouth of the Black River in 1807. No remains of this house exist today.
5. The Nathan Perry trading post in the area now occupied by the U. S. Coast Guard Station. Built about 1807-1808. No remains. Destroyed by later buildings.
6. John S. Reid home and blockhouse containing also the post office, tavern, inn, and office for the first justice of the peace. Built in 1812 at what

is now the corner of First Street and Broadway. No remains, replaced by later streets and structures.

7. F. E. Church shipyard located on the west side of the Black River just above the mouth in 1818-1819. No remains.

8. A. Jones and W. Murdock shipyard built near the mouth of the Black River in 1820. No remains of this shipyard exist today. Replaced by later structures.

9. The Edison and Tildon iron furnace built on the west bank of the Black River at the foot of 8th Street. Burned to the ground in 1871. Area later occupied by Ranney Fish Company.

10. The Lorain Lighthouse is still in existence. The Great Lakes Historical Society is trying to have it preserved as a major historic landmark.

11. The U. S. Coast Guard Station is still in existence and in use. This structure and the lighthouse are the only major features in the harbor area not altered extensively or replaced since early in the 1900's.

Appendix II: Ships constructed at Lorain (Black River) during the golden age of wooden shipbuilding. List based on G. Frederick Wright, A Standard History of Lorain County, Ohio, pp. 305-308, 1916.

Name	Year	Builder
General Huntington	1819	F. Church
Schooner Ann	1821	F. Church
Young Amaranth	1825	F. Church
Nucleus	1827	William Wilson
Sloop William Tell	1828	Captain A. Jones
Schooner President No. 1	1829	Captain A. Jones
Steamer General Graciot	1831	Captain A. Jones
Schooner White Pigeon	1832	W. and B. B. Jones
Schooner Globe	1832	Captain A. Jones
Brig John Henzie	1833	W. and B. B. Jones
Schooner Nancy Dousman	1833	Captain A. Jones
Brig Indiana	1834	W. Jones; A. Gilmore
Schooner Florida	1834	W. and B. B. Jones
Schooner Juliette	1834	W. and B. B. Jones
Sloop Lorain	1834	Ed Gillmore, Jr.
Schooner St. Joseph	1835	F. N. Noyes
Schooner Texas	1836	J. Hamblin
Schooner Erie	1836	F. N. Jones
Brig Ramsey Crooks	1836	G. W. Jones
Brig North Carolina	1834	J. Hamblin
Steamer Bunker Hill	1837	F. N. Jones
Steamer Constellation	1837	A. Gillmore
Steamer Lexington	1838	F. N. Jones
Sloop Randolph	1837	Captain A. Jones
Schooner Algonquin	1839	G. W. Jones
Schooner Tom Corwin	1840	G. W. Jones
Schooner Marion	1841	Captain Thomas Cobb
Schooner President No. 2	1841	F. N. Jones
Schooner George Watson	1841	G. W. Jones
Brig Rosa	1841	F. N. Jones
Brig Hoosier	1842	F. N. Jones
Brig Alert	1842	F. N. Jones
Schooner Equador	1842	F. N. Jones
Schooner Acorn	1842	Captain Thomas Cobb
Schooner Trenton	1843	W. S. Lyons
Schooner Endora	1843	T. Cobb
Schooner Andover	1844	William Jones
Schooner Farmer (rebuilt)	1844	D. Rogers
Schooner Magnolia	1845	W. S. Lyons
Schooner John Erwin	1845	Cobb & Burnell
Schooner Thomas G. Colt	1846	William Jones

Appendix II (Cont'd.)

Name	Year	Builder
Schooner W. A. Adair	1845	T. H. Cobb
Steamer H. Hudson	1846	Jones & Company
Brig Emerald	1844	Joseph Keating
Brig Concord	1846	W. S. Lyons
Schooner Palestine	1847	J. Keating
Schooner T. L. Hamer	1847	W. S. Lyons
Schooner Rambler	1847	Benjamin Flint
Schooner Samuel Strong	1847	Captain T. Cobb
Propeller Delaware	1847	Cobb. Burnell & Co.
Propeller Ohio	1848	S. D. Burnell
Schooner Vincennes	1846	W. S. Lyons
Brig Eureka	1847	S. D. Burnell
Schooner Asia	1848	Captain T. Cobb
Brig A. R. Cobb	1841	Captain T. Cobb
Brig Mahoning	1848	William Jones
Schooner Florence	1848	W. S. Lyons
Propeller Henry Clay (rebuilt)	1851	William Jones
Schooner T. P. Handy	1849	William Jones
Schooner Meridian	1848	William Jones
Schooner Abagail	1848	Lyons & Fox
Bark Buckeye State	1852	Mr. Hubbard
Schooner J. Reid	1852	W. S. Lyons
Schooner Winfield Scott	1852	William Jones
Schooner Main	1852	W. S. Lyons
Schooner Hamlet	1852	William Jones
Schooner H. C. Winslow	1853	William Jones
Schooner W. F. Allen	1853	Jones & Co.
Schooner City	1853	D. Rogers
Schooner Cascade	1853	William Jones
Schooner H. E. Mussey	1853	Benjamin Flint
Schooner Wings of the Morning	1854	Jones & Co.
Schooner Peoria	1854	A. Gillmore
Propeller Dick Pinto	1854	G. W. Jones
Schooner G. L. Newman	1855	B. Flint
Schooner Drake	1855	Jones & Co.
Bark Lemuel Crawford	1855	Jones & Co.
Schooner Kyle Spangler	1856	William Jones
Schooner Leader	1856	Lyons & Gillmore
Schooner W. H. Willord	1856	Charles Hinman
Schooner John Webber	1856	Charles Hinman
Schooner Grace Murray	1856	William Jones
Schooner L. J. Farwell	1856	William Jones
Bark David Morris	1857	William Jones
Schooner Return	1855	D. Fox

Appendix II (Cont'd.)

Name	Year	Builder
Schooner Herald	1857	William Jones
Schooner Freeman	1855	William Jones
Schooner Ogden	1857	William Jones
Bark Levi Rawson	1861	William Jones
Bark William Jones	1862	Jones & Co.
Schooner Alice Curtis	1858	Edwards
Propeller Queen of the Lakes	1855	William Jones
Brig Audubon	1855	William Jones
Schooner John Fretter	1853	Charles Hinman
Schooner E. F. Allen	1862	A. Gillmore
Bark Franz Sigel	1862	G. W. Jones
Bark Orphan Boy	1862	William Jones
Conrad Reid	1862	H. D. Root
H. D. Root	1863	H. D. Root
Minerva	1863	William Jones
William H. Chapman	1865	H. D. Root
Schooner Fostoria	1865	W. S. Lyons
Pride	1866	H. D. Root
W. S. Lyons	1866	W. S. Lyons
Bark Summer Cloud	1864	Lester Smith
Schooner Lillie Fox	1866	D. Fox
Kate Lyons	1866	William Jones
Bark P. S. Marsh	1867	G. W. Jones
Schooner H. C. Post (rebuilt)	1866	Thomas Wilson
General Q. A. Gillmore	1867	Thomas Wilson
H. G. Cleveland	1867	William Jones
Clough	1867	D. Fox
Vernie Blake	1867	H. D. Root
Thomas Wilson	1868	Thomas Wilson
Brig E. Cohen	1867	H. D. Root
Thomas Gawn	1872	John Squires
Barge Sarah E. Sheldon	1872	Quelos & Peck
Mary Groh	1873	H. D. Root
Steamer Charles Hickox	1873	H. D. Root
Steam Barge Egyptian	1873	Quelos & Peck
Schooner Our Son	1875	H. Kelley
Schooner Sumatra	1873	Quelos & Peck
Schooner Three Brothers	1873	H. D. Root

Appendix III: Bibliography and References for the History of the Lorain Lighthouse Station.

BIBLIOGRAPHY

1. The Lorain Daily News: November 22, 1905
2. " " " " : December 26, 1908
3. " " " " : January 4, 1909
4. The Lorain Journal: July 26, 1939
5. " " " : August 2, 1945
6. " " " : July 18, 1950
7. " " " : October 16, 1950
8. " " " : June 5, 1953
9. " " " : September 23, 1953
10. " " " : August 4, 1960
11. " " " : October 1, 1960
12. " " " : July 12, 1965
13. " " " : August 7, 1965
14. " " " : July 31, 1965
15. Chronicle Telegram-Elyria: May 10, 12, 1966
16. " " " : November 10, 1965
17. " " " : December 30, 1965
18. " " " : August 4, 1965
19. " " " : August 17, 1965
20. " " " : September 17, 1965
21. " " " : January 6, 1966

Appendix III (Cont'd.)

22. Chronicle Telegram-Elyria: September 2, 1966

23. " " " : July 31, 1971

REFERENCES

1. The U. S. Coast Guard Station, Lorain Ohio.

2. The Lorain County Historical Society, Elyria, Ohio.

3. The Great Lakes Historical Society, Vermilion, Ohio.

4. The Lorain Journal microfilm records.

5. The Lorain Public Library newspaper clipping file on U. S. Coast Guard Station.

6. The Lorain County Recorders Office, Elyria, Ohio.

7. The Lorain County Treasurers Office, Elyria, Ohio.

8. The Lorain City Engineers Office, Lorain, Ohio

   a. Map file number X-16

   b. Map file number Y-75 (A Coast Guard Plot Plan #101218 for the Lorain Lifeboat Station.

APPENDIX 7

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Artificial Reef Conference. Proceedings - Center for Marine Research, Texas A&M University, College Station. TAMU-SG-74103. 1974.
2. Fraleigh, P.C., J.C. Burnham, G.H. Gronau, T.L. Kovacik. 1979. Maumee Bay Environmental Quality Study, 1977. Final Report. Toledo-Lucas County Port Authority, Toledo Edison Co.
3. Goodyear, C.C. 1980. U.S. Fish and Wildlife Service, Great Lakes Fishery Laboratory, Ann Arbor, Mich. Personal Communication. July 7.
4. Hartman, W.L. 1973. Effects of exploitation, environmental changes and new species on the fish habitats and resources of Lake Erie. Tech. Report 22, Great Lakes Fishery Commission.
5. Herdendorf, C.E. 1980. Center for Lake Erie Area Research, Ohio State University. Personal Communication. July 7.
6. Hubbs, C.L. and K.F. Lagler. 1947. Fishes of the Great Lakes Region. Cranbrook Inst. Science, Bloomfield Hills, Mich. 186 pp.
7. Jaycock, R. Lorain Harbormaster. Personal Communication. July 23.
8. Johnson, P. Naturalist, Lorain County Parks. Personal Communication. July 7.
9. Krieger, K.A. and P.J. Crerar. 1980. Limnological surveillance of the nearshore zone of Lake Erie in central and eastern Ohio. Part II: benthos. Preliminary report. U.S. Environmental Protection Agency, Region V, Great Lakes National Program Office, Chicago, Ill.

10. Lorain County Regional Planning Commission. 1974. Regional Housing Study, Report No. 19. Elyria, Ohio.

11. Lorain County Regional Planning Commission. 1976. New Lorain, Report #1, Elyria, Ohio.

12. Lorain County Regional Planning Commission. 1977. New Lorain, Report #2, Elyria, Ohio.

13. Lorain Port Authority, Undated, Port of Lorain, City of Lorain, Lorain, Ohio.

14. Lorain Port Authority (Stanley Consultants), Lorain Marina Feasibility Study. 1980. City of Lorain, Lorain, Ohio.

15. Muth, K. 1980. U.S. Fish and Wildlife Service, Sandusky Biological Station. Personal Communication. July 8.

16. National Audubon Society. 1974. 74th Christmas Bird Count. American Birds 28(2): 584pp.

17. Newman, D.L. 1969. A field book of birds of the Cleveland region. Cleveland Museum of Natural History. 52pp

18. Ohio Department of Natural Resources, Division of Wildlife, 1980. Commercial Fish Landings, Lake Erie, 1979. Publ. 200 (R380). 16pp.

19. ______________________ 1974. Endangered Wild Animals in Ohio. Publ. 316 (974). 3pp.

20 ______________________ 1979. Lake Erie Fisheries Investigations. Dingell - Johnson Project. F-35-R-17. Study II. 56pp.

21. Pistis, C. 1980. Michigan Sea Grant Program, Grand Haven, Mich. Personal Communication. July 8.

22. Pribanic, M. 1980. President, Polish Fisherman's Club, Lorain, Ohio. Personal Communication. August 6.

23. Sweeney, R.A. 1978. Aquatic disposal field investigations, Ashtabula river disposal site, Ohio. Tech. Report D-77-42. Dredged Material Research Program, U.S. Army Corps of Engineers, Washington, D.C.

24. Trautman, M.B. 1957. The Fishes of Ohio. Ohio State University Press, Columbus. 683pp.

25. Trifiletti, J. City of Lorain, Parks and Recreation Department. Lorain, Ohio. Personal Communication

26. U.S. Army Corps of Engineers. 1975. Final Environmental Impact Statement. Diked Disposal Site No. 7, Lorain Harbor, Ohio. Buffaol District Office.

27. U.S. Fish and Wildlife Service. 1980. Commercial Fish Production from Lake Erie, 1979. Sandusky Biological Station. 22pp.

28. ________________________ 1980. List of endangered and threatened wildlife and plants. Title 50, Chapter 1, part 17. Federal Register, p. 33768-33781. May 20.

29. Van Meter, H.D. and M.B. Trautman. 1970. An annotated list of the fishes of Lake Erie and its tributary water exclusive of the Detroit River. Ohio Jour. Sci. 70(2): 65-78.

30. Wolfert, D.R., W.D.N. Busch and H.D. Van Meter. 1978 Seasonal abundance of fish in an inshore area of southcentral Lake Erie, 1974-75. Admin. Report. U.S. Fish and Wildlife Service, Sandusky Biological Station. 16pp.

LME

8