New York City
Department of City Planning

Waterfront Revitalization Program/
Environmental Assessment Program

August, 1989

Arverne Urban Renewal Area
Queens, New York

Flooding and Erosion Report

ARVERNE URBAN RENEWAL AREA
QUEENS, NEW YORK
FLOODING AND EROSION REPORT

Prepared for:

New York City Department of City Planning
Waterfront Revitalization Program/Environmental
Assessment Program
22 Reade Street
New York, New York 10007

The preparation of this report was financially aided through Federal grant number NA 82-AA-D-CZ068 from the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration under the Coastal Zone Management Act of 1972, as amended.

Prepared by:

Dresdner, Robin & Associate Inc.:
Lead Consultants;
Marine Sciences Research Center,
State University of New York at
Stony Brook;
Olko Engineering, Inc.;
Edwards and Kelcey Engineers, Inc.; and
Gruzen Samton Steinglass Architects, Planners

AUGUST, 1989

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INTRODUCTION

The Arverne Urban Renewal Area (URA) is a 308-acre site owned by the City of New York. It consists primarily of vacant land, with scattered businesses, institutions and residences. Arverne is located on the ocean-side of the Rockaway Peninsula between the Edgemere and Hammels neighborhoods and west of Far Rockaway. The City has offered 278 acres of the URA for development as a residential community. The 30-acre difference between the URA and the offering site consists primarily of existing residential properties to be retained on site and a proposed light industrial area which has been excluded from the current offering site, hereonin referred to as the Site (see Figure A-1).

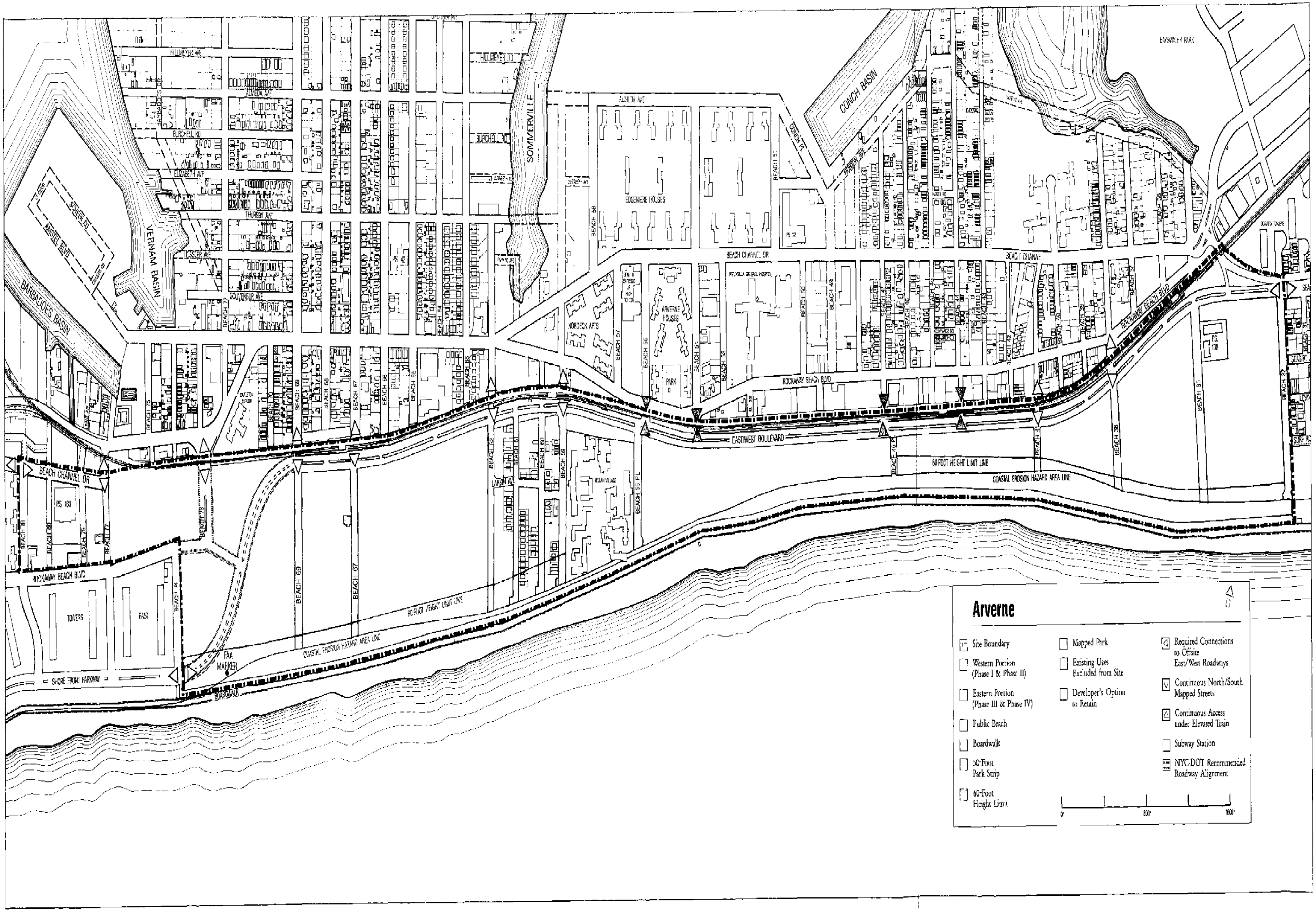
In general, the Site is bounded on the north by Beach Channel Drive and Rockaway Freeway, to the east by Beach 32nd Street, to the west by Beach 81st and Beach 74th Streets, and to the south by the existing boardwalk. Figure A-1 shows the boundaries of the Site. The boundaries of the URA are shown in Figure A-1a.

CONTEXT OF THE STUDY

The City is seeking to develop a residential community at the Arverne Urban Renewal Area which is appropriately designed to respond to the conditions of its oceanfront location. The primary objective of this Report is to assess the vulnerability of the Site to flooding and erosion effects, and to recommend strategies to address those effects. Since the URA contains an 11,000 foot-long section of the Rockaway Peninsula, it is necessary to consider the overall historical changes, shore processes and shore protection projects for the Peninsula, past and present conditions along the shoreline and focus on the Arverne URA as a component of this barrier-island system.

The performance of past and present shore protection methods are evaluated in the Vulnerability Analysis and Alternative Measures sections of this Report (sections A and C, respectively). The existing shore and flood protection system in the Arverne URA consists of a series of groin fields, combined with a

Figure A-1: Arverne Development Site


Arverne
Site Boundary
Western Portion (Phase I & Phase II)
Eastern Portion (Phase III & Phase IV)
Public Beach
Boardwalk
50-Foot Park Strip
60-Foot Height Limit
Mapped Park
Existing Uses Excluded from Site
Developer's Option to Retain
Required Connections to Offsite East/West Roadways
Continuous North/South Mapped Streets
Continuous Access under Elevated Train
Subway Station
NYC/DOT Recommended Roadway Alignment
0'
800'
1600'
VERNAM BASIN
BARBADOES BASIN
SOMMERVILLE
CONCH BASIN
BAYSWATER PARK
EDGEMERE HOUSES
ARVERNE HOUSES
NORDECK APTS
OCEAN VILLAGE
BEACH CHANNEL DR
ROCKAWAY BEACH BLVD
EAST/WEST BOULEVARD
60 FOOT HEIGHT LIMIT LINE
COASTAL EROSION HAZARD AREA LINE
SHORE FRONT PARKWAY
BOARDWALK
FAA MARKER
TOWERS
EAST
PS 183
PS 42
BEACH 32
BEACH 35
BEACH 38
BEACH 56
BEACH 57
BEACH 58
BEACH 67
BEACH 69
BEACH 56 PL
THURSBY AVE
ELIZABETH AVE
BURCHELL RD
ALMEDA AVE
GOUVERNEUR AVE

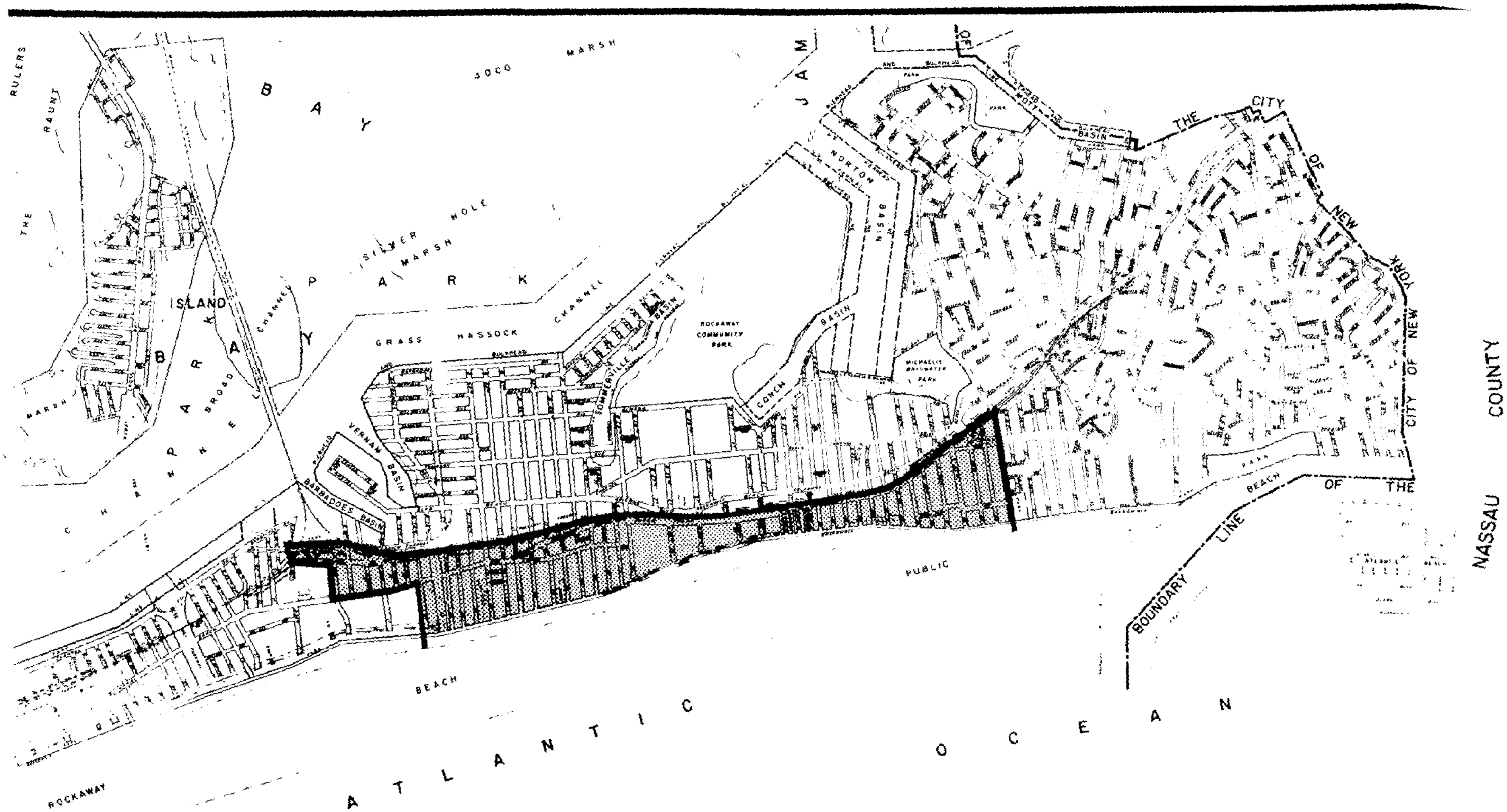


Figure A–1a

ARVERNE URBAN RENEWAL AREA
Queens, New York

Arverne Urban Renewal Area

0 800 1800 2800 ft

Department of City Planning

Dresdner, Robin & Associates, Inc.
Gruzen Samton Steinglass Architects, Planners
Edwards and Kelcey Engineers, Inc.
Abeles Phillips Preiss & Shapiro, Inc.

periodic beach fill program. Some upland areas have been filled to a higher elevation to protect past development from flooding. In this Report the analysis of Alternative Measures discusses the main components of the existing shore protection measures and reviews possible modifications and improvements that could be implemented.

This Report also addresses the federal, state and local programs for coastal zone and floodplain management which may affect development in the Arverne URA as well as other areas in the peninsula. These programs are detailed in Chapter B of this Report. Of primary importance with respect to development of the area are the requirements of the New York State Coastal Erosion Hazard Areas Act (Article 34 of the Environmental Conservation Law) and associated regulations (NYCRRSOS) and all existing laws and regulations relevant to shoreline erosion. Equally important are the Federal Emergency Management Agency's (FEMA) A-Zone standards for development in a flood hazard area as reflected in the requirements of New York City Local Law 33 of 1988 (previously known as Local Law 58, enacted in 1983).

This Report was funded by the Department of City Planning's Waterfront Revitalization Program (WRP) as a component of a larger Development Feasibility Report undertaken by the agency's Environmental Assessment Program. The goal of the WRP, in promoting the Report, is to encourage new development at Arverne which is sensitive to its barrier island location and minimizes the risk of damage from shoreline erosion and flooding.

MAJOR FINDINGS AND RECOMMENDATIONS

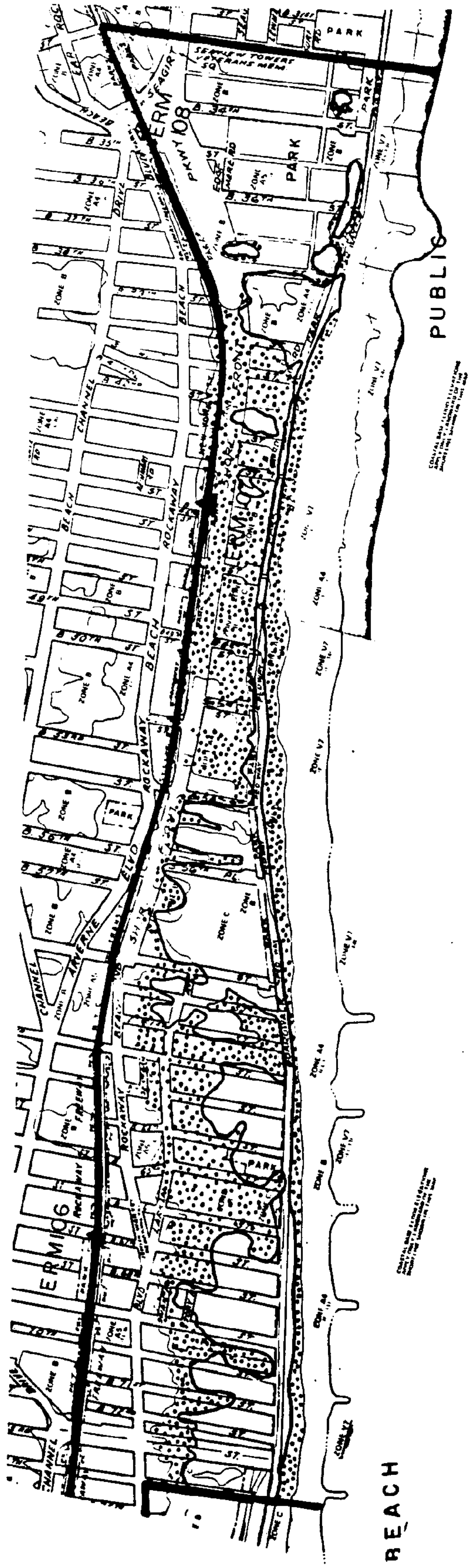
The Arverne URA consists of relatively flat topography with elevations that are generally less than 10.0 feet National Geodetic Vertical Datum of 1929 (NGVD). Beach sands in the Arverne URA range from medium sand on the foreshore to fine sand in the berm area. There is minimal dune development along the Arverne area, consisting of low incipient dunes having little or no stabilizing vegetation. The limits of the present beach are defined by a boardwalk about 16 feet above NGVD at the landward end of the beach berm.

The Arverne URA is subject to significant flooding from both tropical cyclones and extratropical storms (northeasters) which produce storm surge. Of the 816 Atlantic storms of the past 100 years, 93 have directly impacted the Arverne area (USACOE 1974). The numerical storm surge model indicates that the stillwater elevation of the 100-year flood in the Arverne area is 9.7 feet above NGVD. The predicted ten-year stillwater flood elevation is 7.4 feet above NGVD. In the V-Zone, superimposing predicted wave crests on the stillwater elevations indicates that maximum 100-year flood elevations in the Arverne area will reach 12 to 14 feet above NGVD. Thus, the Arverne project area would be subject to significant flooding from the ten-year flood and total flooding from the 100-year flood. Based on past storm events the probability of at least one tropical storm impacting the Arverne URA in a ten-year period is 0.85, whereas the probability of a hurricane occuring is 0.50. This potential for flooding should be considered in planning shorefront development. The elevations of certain areas in the Arverne URA that were classified by FEMA as B-Zones and C-Zones (see Figure A-2) are below the 9.7 foot 100-year flood elevation level, and therefore these areas should be required to meet FEMA A-Zone criteria with base-flood elevations of 10.0 feet above NGVD in order to be safe. Ten feet is considered to be appropriate based on an assumed commitment to shore protection and compliance with the coastal erosion hazard line.

The Arverne URA is also subject to the effects of beach erosion and flooding from episodic storm surge. The wave regime offshore of the Rockaway Peninsula is dominated by deepwater waves that approach from easterly quadrants. Waves less than four feet in height occur 70 percent of the time, and waves exceeding eight feet in height occur less than ten percent of the time. Recent observational records indicate that every month two or more wave energy events occur during which wave heights exceed 15 feet for periods of two to five days. The result is that the Arverne URA experiences periods of beach erosion followed by periods of accretion. A computer model of wave refraction patterns (Dobson, R.S., 1967) in the Arverne URA indicates strong refraction of waves around the shoals at the entrance of East Rockaway Inlet. Due to this refraction pattern, a reversal of net longshore drift in the Arverne area from west to east is predicted. On a yearly basis, maximum longshore drift in the Arverne URA is predicted to be about 90,000 cubic yards to the east towards East Rockaway Inlet. Beach fill placed in the Arverne URA between Beach 32nd and Beach 40th Streets is, therefore, subject to net easterly longshore transport which limits or eliminates its role as a feeder beach for areas to the west.

Existing shore protection structures in the Arverne URA consist of 11 stone groins having an average

Figure A-2



Recommended Flood Zones. Stippled pattern indicates portions of the Arverne URA now classified as FEMA B and C Zones that should be subject to FEMA A Zone standards based on the findings of the vulnerability analysis.

spacing of 700 feet and an average length of about 450 feet. Extensive beach nourishment has taken place along the Rockaway Peninsula including more than 12,000,000 cubic yards of sand placed on the beach between 1926 and 1962. The most recent shore protection project for the Rockaway Peninsula was designed by the U.S. Army Corps of Engineers (USACOE). In the Arverne area this project includes a protective beach between Beach 25th and Beach 39th Streets. This beach is designed to mitigate chronic beach erosion problems and reduce flooding hazards. The beach has a berm elevation of 10.0 feet above NGVD and is designed to protect the landward area from the ten-year flood (7.4 feet).

Erosion of beach fill placed at the eastern end of the Arverne URA is probably accelerated by the combined action of the easterly wave-driven longshore transport and tidal currents near East Rockaway Inlet.

Since completion of the original beach fill project in 1974-1976, six additional nourishment projects have been completed at two-year intervals. The last of these projects was completed in 1988. Although the legislation allows for extension of beach nourishment projects, continued nourishment by the USCOE is pending further study of the area and appropriation of funds. Authorization for the beach nourishment project is provided through the Water Resources Development Act of 1976 (42 U.S.C. 1962d-sf). The beach nourishment provision of this Act, as amended in 1986, reads:

"The Secretary of the Army, acting through the Chief of Engineers, is authorized to provide periodic beach nourishment in the case of each water resources development project where such nourishment has been authorized for a limited period for such additional period as determined necessary but in no event shall such additional period extend beyond the fiftieth year which begins after the date of initiation of construction of such project."

In summary, the findings of the Report conclude that to do nothing to prevent or mitigate shoreline erosion is not feasible in this area. The high natural beach recession rates, if left unabated, would preclude permanent development in the Arverne URA.

In the Alternative Measures Chapter of this Report (Chapter C) several structural and non-structural shore protection measures are considered for stabilization of the Arverne beachfront. Also included for consideration is the do-nothing approach.

Experience has shown that the existing conventional shore-perpendicular protection structures at Arverne have not been very effective in stabilizing the shoreline in this area. A more effective long-term approach may be to use shore-parallel breakwater elements, such as T-head groins or offshore breakwaters.

Offshore breakwaters would be very effective in stabilizing the beach but involve extremely high construction costs. In addition, they would interrupt the supply of littoral drift and could result in accelerated erosion of the downdrift beaches.

T-head groins would have a lesser stabilizing effect than offshore breakwaters but are more cost effective because of their much lower capital costs. T-head groins would also be less effective than offshore breakwaters in trapping the main littoral drift because the offshore breakwaters have a greater potential to retain more sand.

Artificial beach nourishment, presently used at Arverne, is the preferred "non-structural" shore protection measure over artificial sand dune development. Potential sources for beach fill material include: (1) offshore sources (currently being used); (2) nearshore sources; or (3) Atlantic Beach, east of the jetty at East Rockaway Inlet (using a sand bypassing system).

These alternatives and related others are discussed in detail in Chapter C, including comparative life cycle costs.

If no action were taken to protect the Arverne shoreline, such as continued beach nourishment, <u>there would be severe impacts to adjoining properties as a result of coastal flooding and erosion</u>. Results of the vulnerability analysis show that beach erosion continues to be a serious problem along the Rockaway Peninsula and particularly in the Arverne URA. In addition to frequent storms, beach erosion problems in the Arverne URA have been compounded by the proximity of the East Rockaway Inlet. Beach nourishment has succeeded in maintaining the shoreline position against high rates of erosion and reducing the flooding hazard to landward areas. However, nourishment is required every two years. If the "do nothing" alternative were considered, a dramatic increase in erosion and flooding hazards to the Arverne development project would result. Under the baseline sea-level rise scenario (0.01 feet of sea-level rise per year), the expected retreat of the shore line over the next 30 years, if no action is taken, would be at least 400 feet. This would move the shoreline well inside the Coastal Erosion Hazard Line proposed by the New York State Department of Environmental Conservation (NYSDEC). If the scenario with the highest sea-level rise proposed by the USEPA as a result of the Greenhouse Effect were assumed, the shoreline could be expected to retreat at least 2000 feet. This would result in the loss of the entire Arverne URA and require significant landward migration of the entire Rockaway Peninsula. In addition, for any of the scenarios between baseline and highest rate of sea-level rise, flooding hazards in the Arverne URA would be expected to increase if no action were taken. It is clear from this analysis that the Arverne URA must depend on a substantial shore protection project in order to exist at all.

For project planning, it is recommended that development not be allowed seaward of the NYSDEC Coastal Erosion Hazard Line. This recommendation is based on the assumption that, at a minimum, the Corps beach nourishment project will continue.

A. VULNERABILITY ANALYSIS

This chapter is a study of the area's physical environment and those factors most directly affecting flooding and erosion. Coastal dynamics and flooding susceptibility are presented first, followed by an analysis of erosion and shoreline conditions and an inventory of natural resources of the area.

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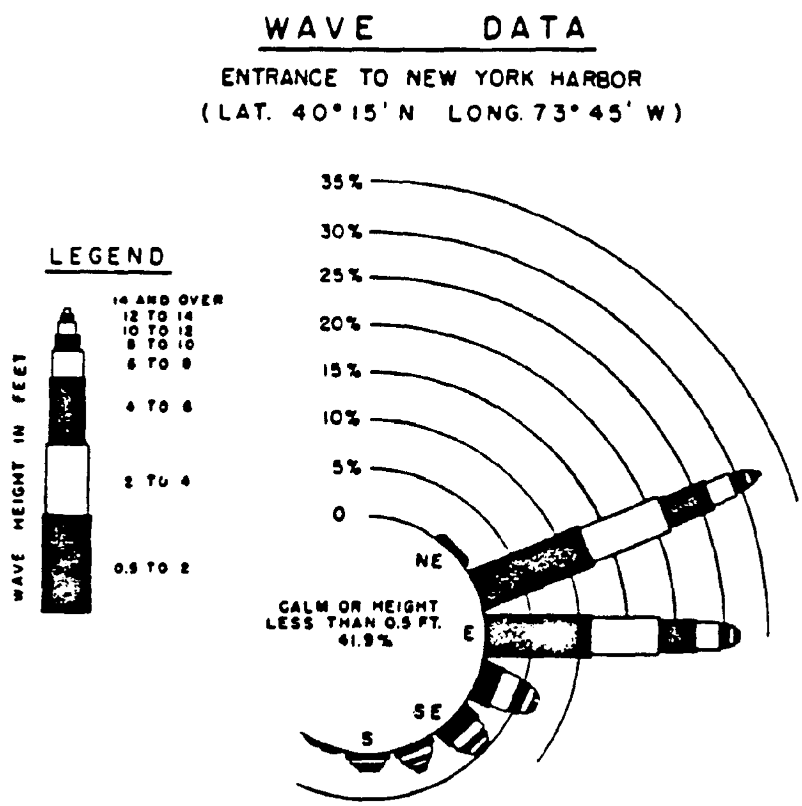
1. FLOODING AND COASTAL DYNAMICS

1.1 Waves

Storm waves 20 feet in height have been reported (USACOE, 1974) off the south shore of Long Island; wave gages operated off Gilgo Beach and Jones Beach to the east of Rockaway have recorded a maximum wave height of 13.4 feet. A statistical study based on hindcasting methods and synoptic weather charts indicates that waves offshore of New York Harbor predominantly approach from a northeasterly to a southwesterly direction (See Figure A-3). The largest predicted deep-water waves are between 25 and 30 feet in height.

Figure A-3



Distribution of wave heights according to direction at the entrance to New York Harbor based on hindcasting methods using synoptic weather charts (from the U.S. Army Corps of Engineers, 1974).

This hindcasted data indicates that 50 percent of the wave energy comes from the east-northeast direction, 25 percent from the east, and the remainder from the quadrant between east and south. Waves less than four feet in height prevail, occurring 70 percent of the time or more; and waves greater than four feet but less than eight feet in height occur less than 30 percent of the time. Waves exceeding eight feet in height occur less than ten percent of the time.

In addition to hindcasted wave-climate models, some observational data are available from the Coastal Waves Program (CWP) of the National Oceanographic and Atmospheric Administration. The long-term goal of this program is to provide accurate statistics on wave climate for all coastal regions of the United States. The first large-scale CWP measurement effort took place in the Mid-Atlantic Bight between 1982 and 1984 when five wave riders were deployed. The nearest wave gage to the Rockaway Peninsula was deployed about seven miles south of Shinnecock Inlet, which is about 70 miles east of the Arverne area. This gage was active for nearly two years between 1982 and 1984. Although data from this gage did not include directional data and cannot be related directly to the Arverne area, it does provide some information on deep-water wave climate.

Mean significant wave heights (average of the highest third of the waves) ranged from one foot to nearly seven feet on a monthly basis. Corresponding periods between waves ranged from six seconds to about nine seconds. The most important conclusion from analysis of offshore wave records is that several wave energy events occur every month. During each event, wave heights exceed 15 feet for periods of two to five days. Between these events, wave heights decrease to less than three to four feet.

Observations of breaking waves just a few hundred feet off the shoreline were limited to visual observation taken over the six-year period between 1968 and 1974 during a program conducted by the USACOE Coastal Engineering Research Center. The nearest observation station to the Arverne area was located 12 miles to the east on Jones Beach. Over the duration of this study, the mean breaker height was 2.6 feet and the mean breaker period was 6.3 seconds. The mean direction of approach of waves just prior to breaking was south-southeast. On a seasonal basis, monthly averaged wave periods varied from 5.0 to 7.6 seconds. Average monthly breaker heights varied from 2.3 to 3.3 feet. Wave approach patterns had an easterly component (coming from the east) over most of the year. The nearshore wave climate in the Arverne area is similar, but subject to variations in refraction patterns due to local bathymetry.

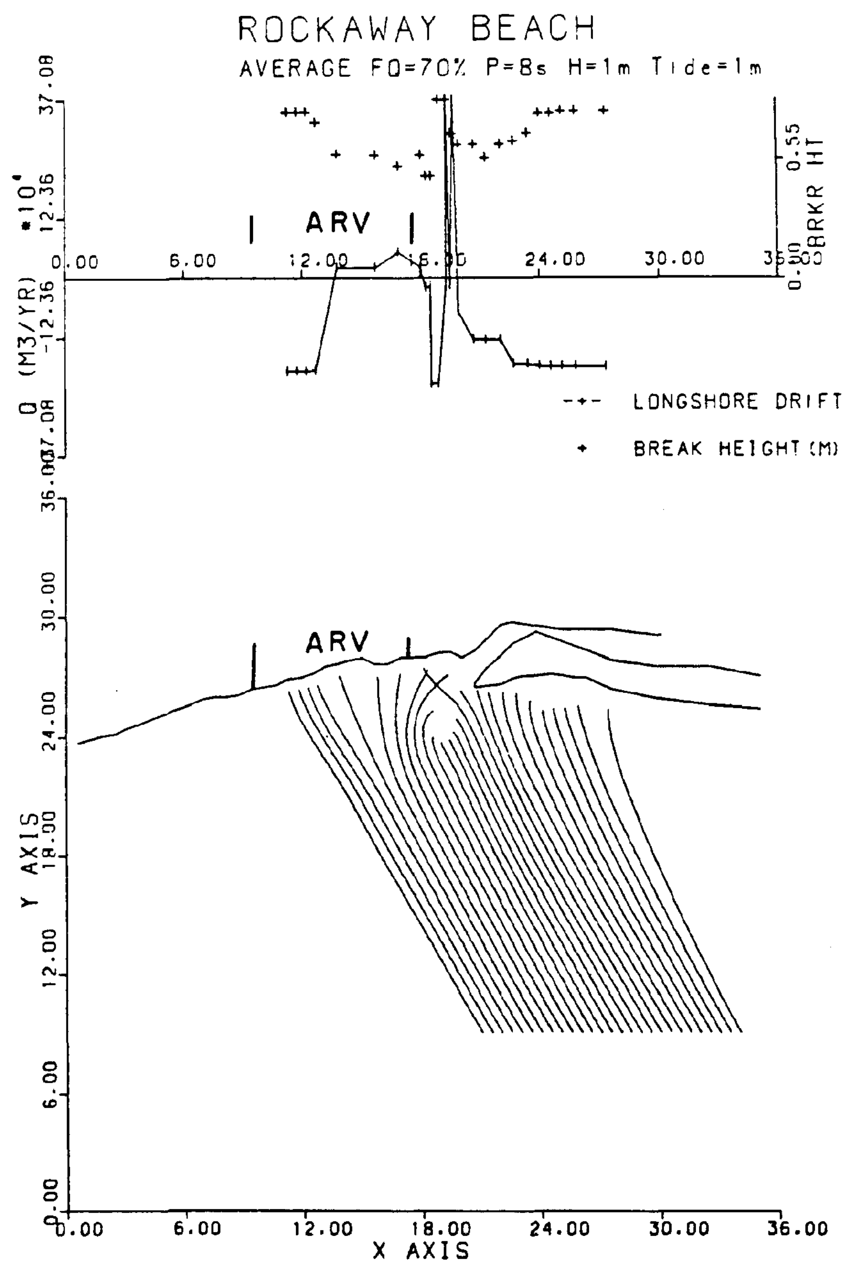
1.2 Wave Refraction Patterns in the Arverne Area

A wave refraction computer model was used to assess the effects of wave refraction in shallow waters on the sediment budget. The model, which computes refraction of monochromatic waves (well-defined wave height and period), begins with a deep-water wave and monitors its transit along a refracted path through shoaling depths to the surf zone, where the wave finally breaks. In addition to tracking the path of the wave ray (the line perpendicular to the wave crest), other parameters are continuously computed, including wavelength, phase velocity, water depth, wave height, rate of energy loss due to bottom friction, and bottom orbital velocity. In addition to wave parameters, the computer model permits calculation of net longshore sediment transport in the surf zone. This calculation is based on the power supplied to the surf zone by breaking waves and the direction of longshore currents generated by waves breaking at an angle to the shoreline. Input to the model includes (1) a bathymetric matrix for the region of interest; (2) tidal stage; (3) deep-water wave height, period and approach direction; and (4) frequency with which a particular set of deep-water wave conditions exist.

For modeling the Arverne area, bathymetry was taken from nautical charts 1:80,000 and 1:40,000 in scale. Deep-water wave conditions were taken from hindcasted wave data since it is the only source of directional information. The complete model run for the Arverne area consisted of an average of 18 distinct sets of initial conditions representing the wave climate. These included three tidal stages for each of six different wave-approach directions. Figure A-4 summarizes the model results for eight-second one-meter (3.28 feet) high waves approaching from six different directions ranging from east to southwest. The tidal stage for this model run is approximately 3.0 feet above NGVD. Results of the model indicate strong refraction of waves around the shoals at the entrance to East Rockaway Inlet.

Due to this refraction pattern, the model predicts a reversal of net longshore drift in the Arverne area from west to east. On a yearly basis, maximum longshore drift in the Arverne URA is predicted to move 91,000 cubic yards of sand to the east towards East Rockaway Inlet. East of Rockaway Inlet and just west of the Arverne area, net longshore drift is

Figure A-4



Predicted average wave refraction patterns at the eastern end of the Rockaway Peninsula for waves 1 m high and 8 second in period. Net yearly longshore drift and breaker height are also predicted. A net eastward drift is predicted for the eastern half of the Arverne area (positive values of longshor drift on the upper diagram).

predicted to move sand west at rates of up to 325,000 cubic yards per year.

The results of this model can only be considered qualitative because of uncertainties in the hindcasted wave data and the lack of field measurements of longshore sediment transport for calibration. The model does not simulate the details of surf zone dynamics, which include on-offshore sediment transport in addition to longshore transport. Despite these limitations, model results clearly indicate the influence of East Rockaway Inlet on the Arverne area.

1.3 Tides and Currents

Tides along the ocean-facing shoreline of Rockaway Beach are semidiurnal (two high tides and two low tides per day) and have a mean range of 4.5 feet and a spring range of 5.5 feet. At East Rockaway Inlet, in the immediate vicinity of the Arverne URA, the mean tidal range is 4.1 feet and the spring range 5.0 feet according to National Ocean Survey 1985 tide tables. Table A-1 lists mean and spring tidal ranges for various locations in the Rockaway area according to the tide tables.

The National Ocean Survey Tidal Current Tables indicate significant currents to the west and immediately south of both Rockaway Inlet and the East Rockaway Inlet. Maximum currents at Rockaway Inlet entrance are about 3.0 feet/second (fps) during flood tide and about 4.5 fps during ebb tide. At the entrance to East Rockaway Inlet, currents reach a maximum of approximately 3.5 fps during flood tide and 4.0 fps during ebb tide.

The effect of tidal currents in the Arverne URA due to the proximity of East Rockaway Inlet is uncertain. There are no field or modeling studies of tidal processes in this area due to the fact that stabilization of East Rockaway Inlet took place in the early 1930s and no design studies are available. However, in addition to tide-generated currents, the immediate beach area, inside the surf zone, is subject to wave-induced currents which, in combination with sand suspension by oscillatory wave motion, can transport significant quantities of sand both alongshore and offshore. Rip currents, which are narrow flows reaching speeds of up to 6.0 fps, can carry sand offshore for distances of up to 2000 feet depending on the wave energy contained in the surf zone where these currents are generated.

Table A-1

MEAN AND SPRING TIDAL RANGES*

Location	Mean Range (feet)	Spring Range (feet)
Rockaway Beach	4.6	5.6
East Rockaway Inlet	4.1	5.0
Rockaway Inlet	5.0	6.0
Beach Channel	5.1	6.2
Motts Basin	5.4	6.5
Norton Point	4.7	6.5
Canarsie	5.2	6.3
Mill Basin	5.2	6.3
Coney Island	4.7	5.7
Battery	4.5	5.4

* From the National Oceanic and Atmospheric Adminstration, 1985. Tide Tables: East Coast of North and South America, U.S. Department of Commerce, p. 286.

Shore-parallel or longshore currents generated by waves breaking obliquely to the shoreline can reach speeds of up to 7.0 fps. Maximum longshore current speeds occur just inside the breaker line and decrease linearly towards the beach. The effects of wave-generated longshore currents in the Arverne URA are reviewed in the previous section on Wave Refraction Patterns.

1.4 Winds

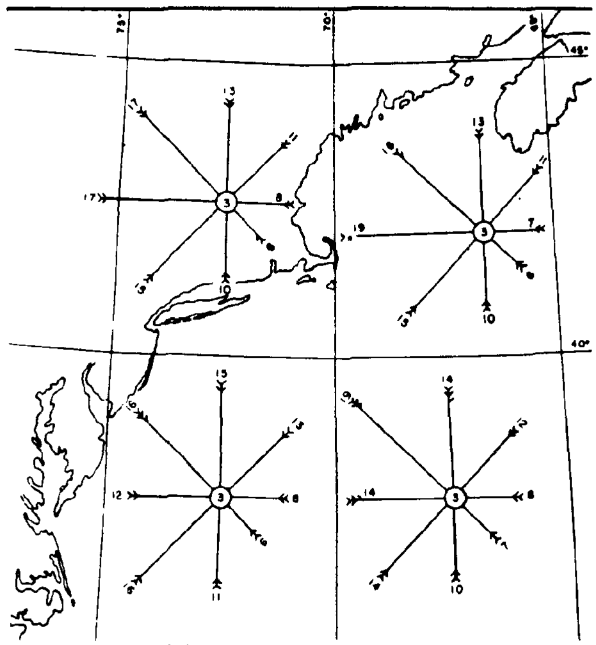
"Wind forcing" is one of the principal factors controlling coastal flooding and wave activity. High velocity onshore winds such as those occurring during many storms tend to pile up water against the shoreline and create steep, short-period waves. The combination of increased water levels and increased wave activity due to onshore wind patterns is a major factor in causing severe beach erosion. Storm-generated winds in the Rockaway area have been recorded in excess of 100 mph, although sustained winds during storms rarely exceed 75 mph.

According to observations at the Battery, New York City, during non-storm conditions, prevailing winds are from the northwest more than 20 percent of the time and from the south about 15 percent of the time (see Figure A-5). Wind patterns show a seasonal variation of northwesterly winds prevailing from October to May and southerly winds prevailing from June to September.

1.5 Storms

Tropical cyclones and extratropical storms (northeasters) have been important agents of flooding and erosion in the Rockaway area. Based on the occurrence of storms in the New York area over the past 300 years, the frequency of unusually severe storms is 3.1 per 100 years. The frequency of severe storms is 21.7 per 100 years. Tropical cyclones typically develop over open ocean areas when surface water temperatures are above 80° F. This usually occurs during the months of August through October, although the official tropical cyclone season is from June 1 to November 30. The counterclockwise vortex of tropical storms is due to winds blowing toward a low pressure central updraft. Tropical cyclones dissipate quickly when they pass over land masses, where they are deprived of the warm moist air which is their energy source. The path of an individual storm is unpredictable and erratic, but determined by its point of origin, and by the relative position and strength of low and high pressure centers located in the westerly wind belt and over the Atlantic Ocean.

Figure A-5

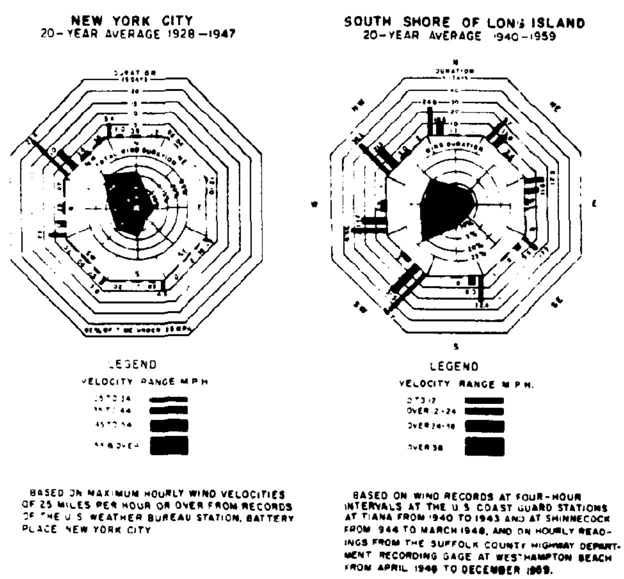


PREVAILING WINDS

WIND ROSES SHOW AVERAGE WINDS FOR 5° SQUARE OVER ENTIRE PERIOD OF RECORD. ARROWS FLY WITH THE WIND. FIGURES AT END OF ARROWS INDICATE PERCENT OF OBSERVATIONS WIND HAS BLOWN FROM THAT DIRECTION. NUMBER OF FEATHERS REPRESENTS AVERAGE FORCE, BEAUFORT SCALE. FIGURE IN CIRCLE REPRESENTS PERCENTAGE OF CALMS, LIGHT AIRS AND VARIABLES.

BASED ON OBSERVATIONS BY THE U.S. NAVY HYDROGRAPHIC OFFICE FOR 10 YEAR PERIOD, 932-1942.

WIND DIAGRAMS

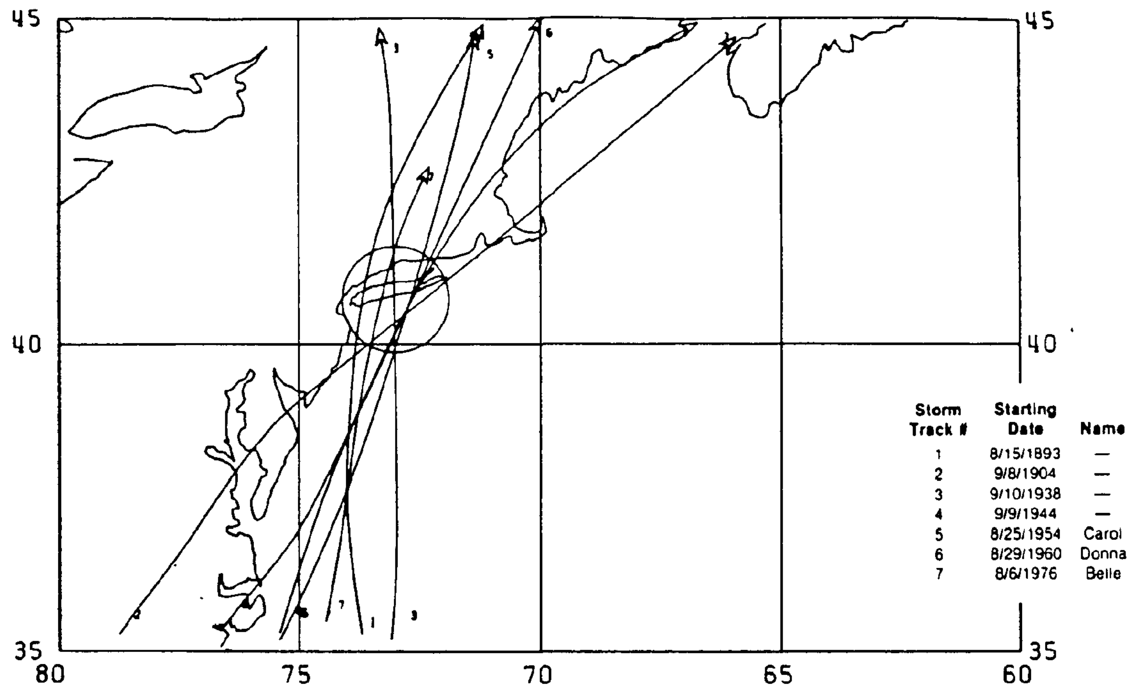


Wind rose diagrams depicting dominant and prevailing wind patterns in the project area (from the U.S. Army Corps of Engineers, 1974).

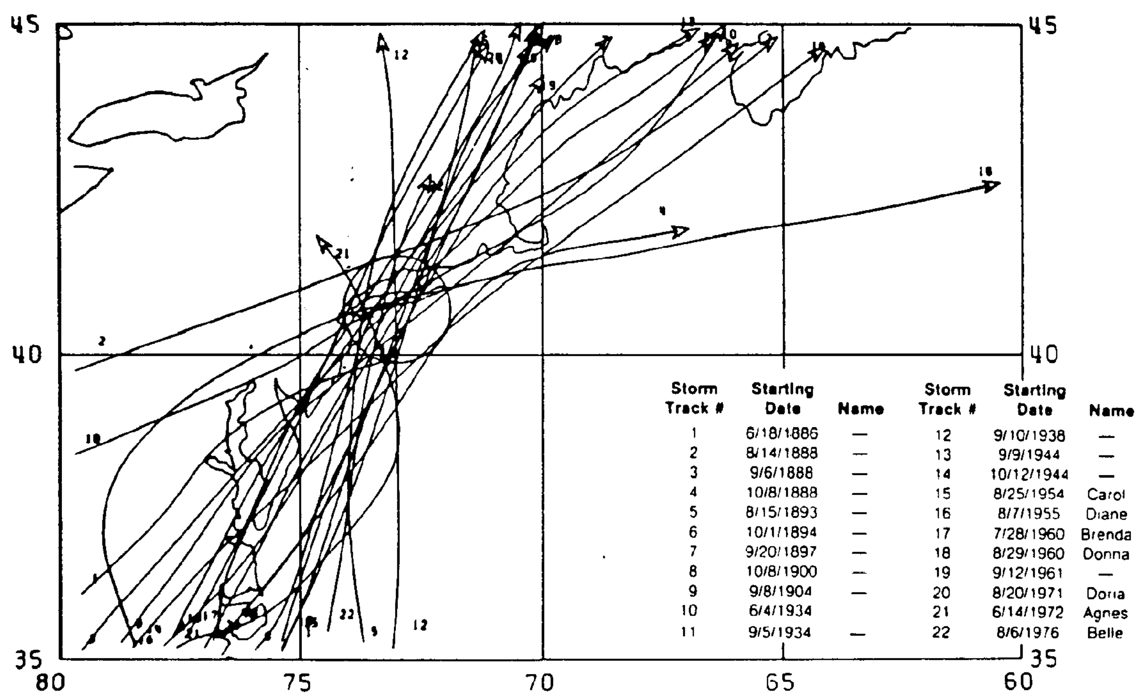
Tropical cyclones range in diameter from 50 to 500 miles. They include tropical storms, characterized by sustained winds exceeding 39 mph; hurricanes, characterized by sustained winds equal to or greater than 74 mph; and great hurricanes, characterized by sustained winds exceeding 124 mph. The area of high winds and greatest damage potential associated with such storms is typically an 85-mile diameter circle, but winds of 50 mph can occur as far as 150 miles from the center. Since in the northern hemisphere winds approach the center in a counterclockwise spiral, the highest wind velocities may occur from both easterly or westerly directions from the storm center. For storms passing through the study area, the greatest damage can be expected for cases where the storm center passes to the west. Under these conditions strong onshore winds will pile up water onshore and the storm surge will be maximized.

Northeasters develop in mid-latitudes in the fall, winter and early spring months in response to the interaction of warm and cool air masses along a weather front. They cover a much larger geographic area compared with tropical cyclones (including hurricanes), and occur with much greater frequency. They may be more than 1000 miles in diameter (two to three times larger than tropical storms). Northeasters also form a counterclockwise spiral directed toward a center of low barometric pressure, but winds are generally of lower velocity than tropical cyclone winds. During extratropical storms, winds are most often from the northeast quadrant, relative to the Rockaway area, hence the term "northeaster." Like tropical cyclones, northeasters produce high tides, large waves and heavy rainfall along the coast. Northeasters sometimes develop into complex storms when the relative position of high pressure centers and low pressure centers greatly intensifies wind speed. Northeasters can develop very rapidly and may give little or no advance warning and can persist up to ten days, although the usual duration of these storms is two or three days.

Analysis of National Weather Service data indicates that 816 tropical cyclones have occurred in the Atlantic tropical cyclone basin during the period 1886 to 1986. Among these storms a total of 278 or about 35 percent have crossed or passed immediately adjacent to the U.S. mainland. Hurricanes accounted for 158 of these storms, seven of which can be considered severe and two unusually severe (hurricane of September, 1938, and Hurricane Donna, September, 1960). Landfall of these episodic storms is a common event in the New York area, although the frequency here is low compared with the Gulf coast. Figure A-6



Hurricanes passing through the project area between 1886 and 1982 (from Neuman, 1984).



Tropical storms and hurricanes passing near the project area between 1886 and 1982. (from Neuman, 1984) shows the tracks of the seven hurricanes passing through the New York area during the period 1886 to 1982. During the same period, 15 tropical storms hit this area. Figure A-7 shows the paths of both tropical storms and hurricanes for this period. The most recent tropical cyclone to affect this area, Hurricane Gloria, September 27, 1985, is not shown in these figures, but its track was very similar to that of Hurricane Belle in 1976, the last hurricane prior to Gloria to hit this area.

Utilizing statistical data on the motion of tropical storms in the Atlantic region, Newman and Pryslack (1981) calculated the expected number of tropical storms and hurricanes per 100-year period impacting various locations along the Atlantic coast. Figure A-8 shows the two grids that include the New York area. Grid 517 in this figure pertains to the western Long Island and New York City area. Based on actual tropical storm occurrence and movement data, the expected number of tropical storms entering Grid 517 per 100 years is 19. Seven of these storms would be hurricanes. Using this same data set, the probability of at least one tropical storm occurring in the study area over a ten-year period is 0.85, whereas the probability of a hurricane occurring is 0.50. If a time period longer than ten years is used for these predictions, the probability of storm occurrence is even higher.

1.6 Storm Surge

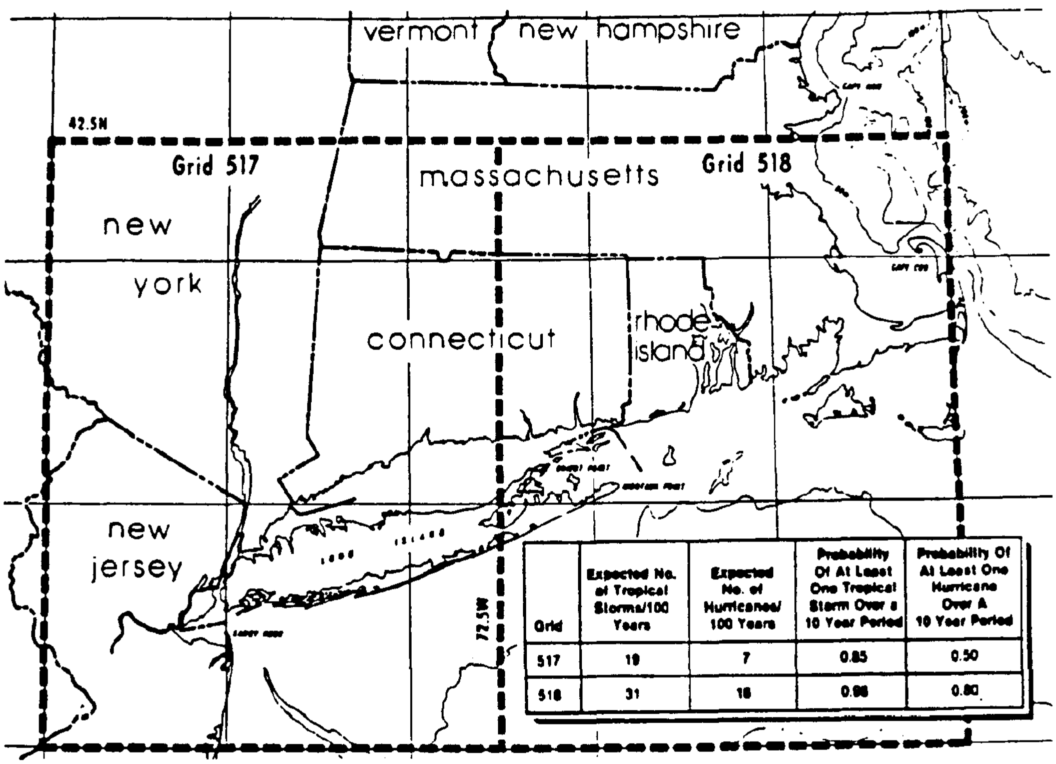
Background

Both tropical cyclones and extratropical storms produce storm surges, defined as the difference between observed water level and that which would have been expected in the absence of the storm. The height of the surge associated with a particular storm depends largely on four processes:

(1) The Inverted Barometer Effect: The sea surface rises in response to low pressure associated with storms. On the open ocean, a pressure drop of one inch of mercury will theoretically lead to a 13-inch rise in sea surface elevation.

(2) Wind Set-up: Wind stress on the water surface will cause water levels to increase along the fetch in a downwind direction. Wind stress and wind set-up are proportional to the square of the wind velocity and, therefore, set-up increases exponentially with increasing wind speed.

Figure A-8



Grid	Expected No. of Tropical Storms/100 Years	Expected No. of Hurricanes/100 Years	Probability Of At Least One Tropical Storm Over a 10 Year Period	Probability Of At Least One Hurricane Over A 10 Year Period
517	19	7	0.85	0.50
518	31	16	0.96	0.80

Expected number of tropical storms and hurricanes per 100 years impacting the New York and Long Island areas (from Neuman and Pryslak, 1981).

(3) Wave Set-Up: Breaking waves transport water into the near-shore zone, leading to increased water elevations. Wave set-up may account for as much as six feet of storm surge height.

(4) Rainfall Effect: Intense rainfall during storms can lead to an increase in water levels. This is especially true for enclosed shallow lagoons and bays. The effects of storm surge on a particular shoreline depend in part on the orientation and configuration of the shoreline. In general, shoreline configurations that favor amplification of the astronomical tide will also favor an increase in storm surge height. Such configurations include low inner-shelf and shoreface slopes and shallow embayments in back-barrier areas, such as is the case of the Rockaway Peninsula.

Shoreline flooding and erosion are often related to the magnitude of the storm surge with respect to the stage of the astronomical tide, the intensity of the storm, the speed of the storm and angle of storm attack at the shoreline. Tropical cyclones and northeasters produce different effects with respect to the last three factors. As previously noted, the strongest winds in tropical cyclones are located in a narrow band surrounding the center, or eye, of the storm. Storm-surge peaks and maximum wind speeds are not found at the eye of the storm but are displaced to the right of the storm track. Winds in the right quadrants of the counterclockwise spiral are reinforced by the forward movement of the storm. This can have a significant effect since hurricanes have been known to travel at speeds of over 50 mph. Wind and wave set-up of water levels are maximized in the right half of tropical cyclones. South-facing shorelines such as the Arverne URA aligned perpendicular to storm tracks (see Figure A-7) can receive the full impact of the reinforced winds and wave set-up. If a storm passes to the right of a coast, wind and waves will be directed offshore, thus minimizing shoreline damage. In addition, winds to the left of the storm track are weaker because these winds blow opposite to the direction of forward storm translation.

In general, fast moving tropical cyclones have peak storm surges that are higher than slower moving storms. However, if there is no overtopping of a barrier island by a storm surge, a slow moving storm will cause higher surge in the bay areas than a faster moving storm. In this case there is more time for water to move into the bays through tidal inlets. However, if barrier overtopping occurs, a faster moving storm will result in higher surges in the bay.

Wind direction during a northeaster depends on the relative position of the storm track. When an extratropical storm center passes to the west of the Rockaway Peninsula, winds blow initially from the east or southeast. As the storm moves, winds shift to the south and then to the west.

On the other hand, if the storm passes to the east of Rockaway, initial winds blow from the northeast and later blow from the west and northwest. The first set of conditions would be more destructive since initial onshore winds would tend to increase the storm surge due to wind and wave set-up at the shoreline of the Arverne URA.

The strong winds and extreme tides of tropical cyclones usually last less than six hours in a particular area. The wind and wave effects of extratropical storms, although less severe, can last up to four or five tidal cycles. Such a prolonged attack during successive high tides can lead to extensive shore erosion. This situation occurred during the March 6-8 storm in 1962, when storm surge caused abnormally high water levels on five successive high tides. The long duration of northeasters can result in higher flood levels in bay areas than those associated with hurricanes producing the same surge levels in open ocean waters. In addition, urbanization and dredging and wetland destruction have been shown to significantly increase the areal extent of storm surge flooding along bay shorelines.

Rockaway Peninsula

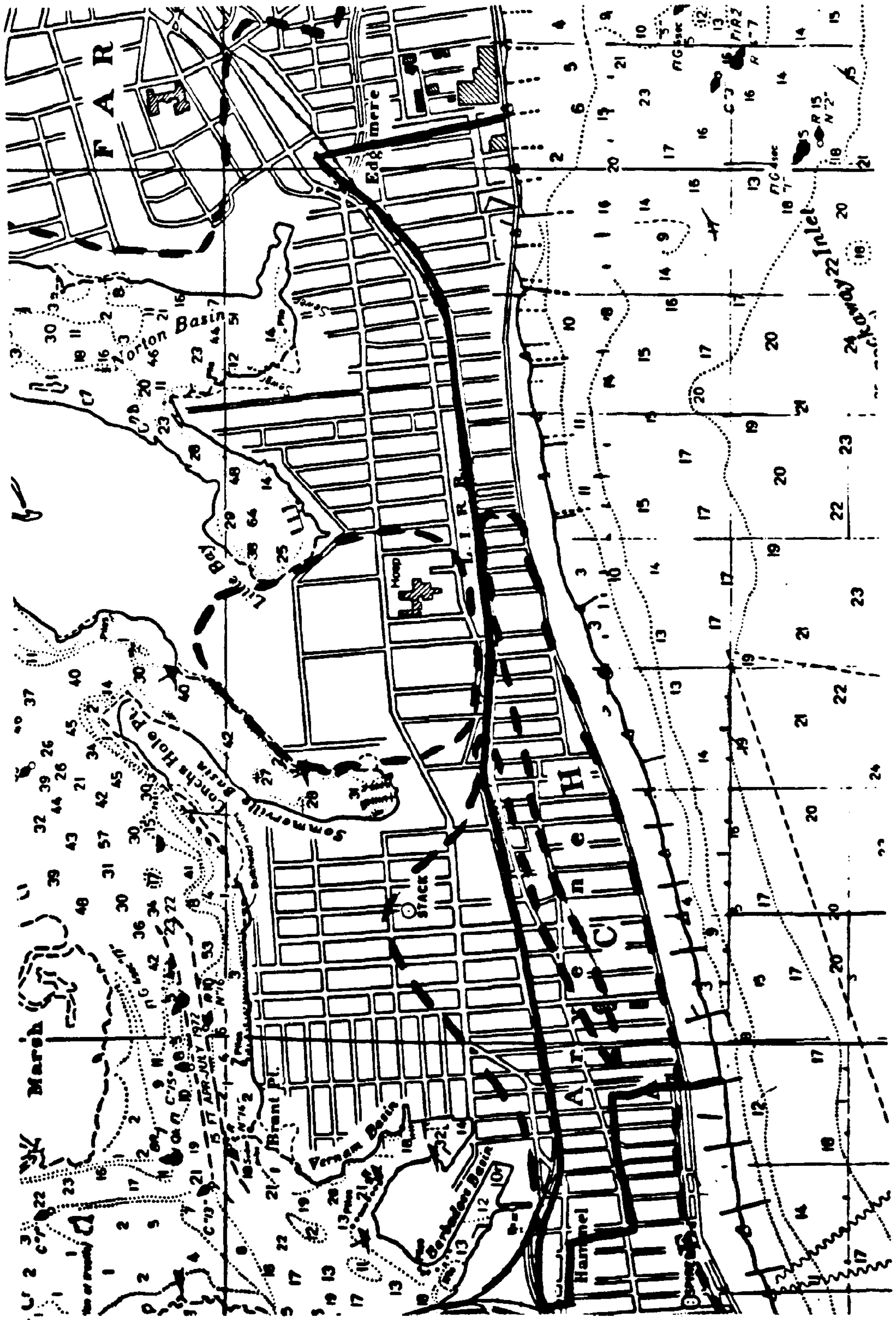
The storm surge of record for the Rockaway Peninsula occurred during the extratropical storm of November 25, 1950. The maximum surge during this storm was 8.2 feet but corresponded to a water level of about 5.8 above NGVD because of coincidence with low tide. Maximum water level recorded at Fort Hamilton during this storm was 7.5 feet above NGVD, occurring about six hours before maximum surge during high tide. Winds of up to 50 mph that continued for 17 hours during this storm caused a sustained storm surge. Damage in the Rockaway area due to flooding and wave attack were valued at $500,000 (in 1950 dollars). In addition to extensive beach erosion and damage to shorefront structures along the peninsula, flooding was particularly severe in the Edgemere section at the eastern end of the Arverne URA. The peninsula was completely overwashed in this section as a consequence of flooding from both the bay side and ocean side.

More than 200 homes were damaged by flooding. The stillwater elevation of 7.5 feet recorded during this storm approximates the ten-year flood. Therefore, any new development in the Arverne URA would be subject to the level of flooding that occurred during the 1950 storm once every ten years.

The hurricane of September 12, 1960 (Donna), which produced damage over $15,000,000 in the New York City area (in 1960 dollars), was also unusually severe. This hurricane skirted the North Carolina coast and was reported 100 miles east of Atlantic City at 11 A.M. on September 12. The eye of the storm passed over the project area at high tide. The track of this hurricane is shown in Figure A-6. Sustained winds were reported in the 60- to 80-mph range and gusts up to 97 mph were reported. Maximum stillwater levels reported at Fort Hamilton reached 8.6 feet above mean sea level, which corresponded to a surge of about 6.3 feet above the predicted high tide. Flooding from the bay side was even greater than from the oceanside; flood levels at the Rockaway sewage treatment plant were 10.5 feet above NGVD. Extensive flooding and shore erosion on the Rockaway Peninsula occurred. Figure A-9 shows the approximate maximum extent of flooding due to this storm. In the Arverne area, the Peninsula was completely washed over and damage to homes exceeded $2,500,000. It is noteworthy that the flooded area of Rockaway Peninsula during this storm corresponds closely to the 100-year flood zone indicated on recently issued FEMA flood insurance maps for this area. However, the central pressure index (CPI) of Hurricane Donna was 28.65 inches of mercury, which corresponds approximately to a ten-year storm according to the statistical occurrence of all hurricanes.

The most significant single storm with respect to beach erosion in the project area was the March, 1962, storm. This storm began on March 4, 1962, as weak circulation along a cold front in the Atlantic Ocean of Florida. Concurrently, a large but weak storm was moving eastward through the Mississippi Valley. By March 5 these two storms began to merge. The offshore storm center intensified, moved northward and completely incorporated the weaker storm. By March 6 the storm area included the eastern third of the United States and a large part of the western North Atlantic. The storm stopped its northward movement and became stationary off the eastern U.S. coast, breaking into a complex pattern of centers. Sustained winds reached 35 to 45 mph and gusts reached 70 mph. A continuous storm surge of 3 to 5 feet coupled with spring-tide conditions caused water levels to reach 7.1 feet above NGVD at the Battery.

Figure A-9



— — Approximate maximum flood line in the Arverne Area that resulted from Hurricane Donna, September, 1960.

The worst storm damage to New York City from this storm occurred along the Rockaway Peninsula, where beaches were severely eroded and shore front structures including groins and boardwalks were damaged. After this storm, the U.S. Army Corps of Engineers conducted emergency beach restoration work along the Rockaway Peninsula. This consisted of 175,000 cubic yards of sand along a 2000-foot stretch of beach in the Arverne URA.

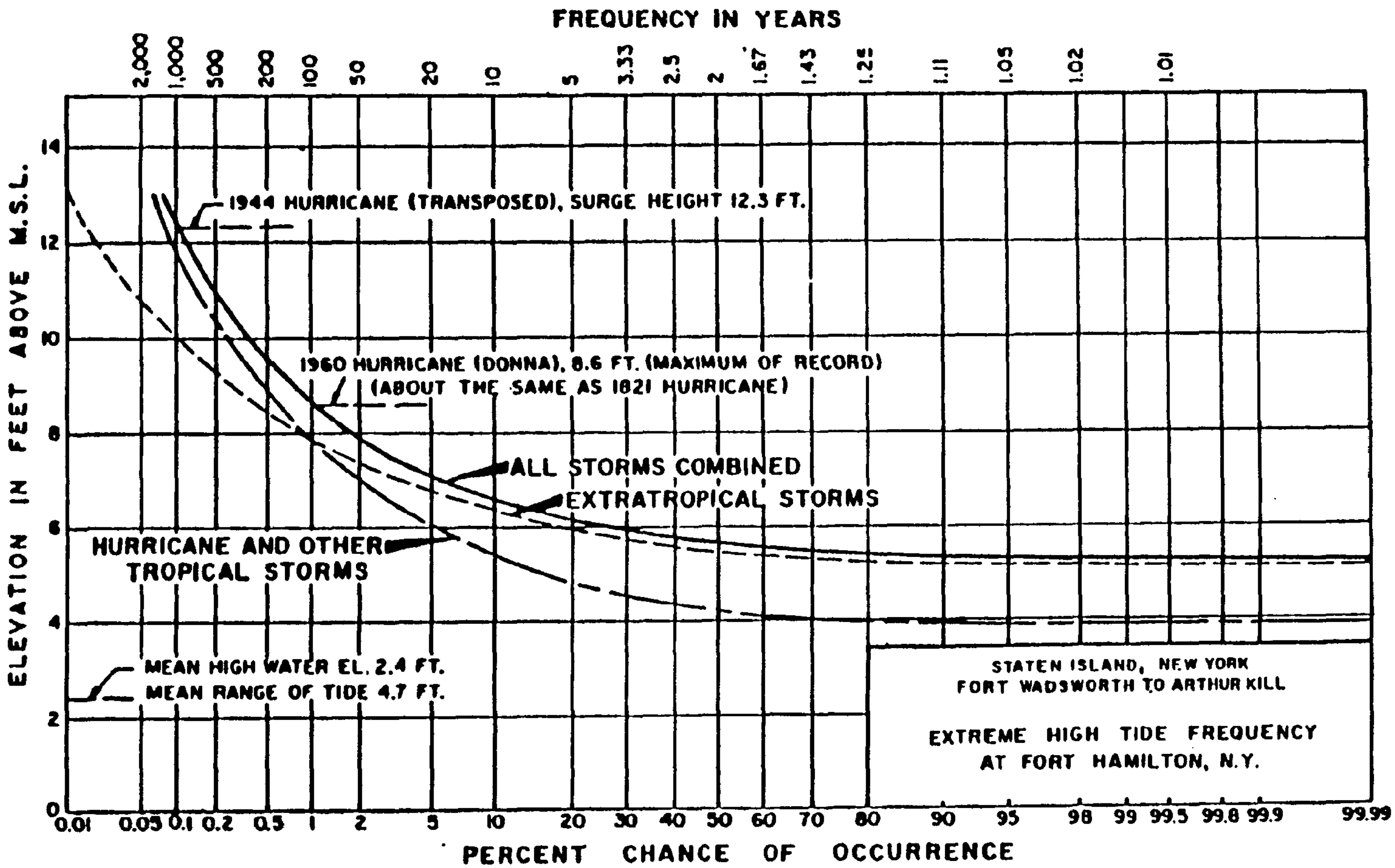
Total damage in the New York City area due to this storm was estimated at $17 million (in 1962 dollars).

Records from long-term tide gages have been used to compile stage-frequency curves that describe the recurrence of flood levels in the Rockaway area (Moore et al., 1983). The stage-frequency curve describing the recurrence of flood levels in Fort Hamilton is shown in Figure A-10. The frequency of high tides is drawn separately for tropical and extratropical storms (U.S. Army Corps of Engineers, 1964). The upper part of the Fort Hamilton curve is based on analysis of historical extreme tides from noncontinuous records over the last 300 years, whereas the lower section of the curve is based on continuous tidal records between 1892 and 1962. From this diagram it can be seen that statistically the ten-year surge elevation, or the ten percent chance of occurrence in any year, is about 6.7 feet, and the 100-year surge elevation or one percent chance of occurrence in any year is 8.6 feet above NGVD. The stage-frequency curve for tide gage records at the Battery is shown in Figure A-11. The upper portions of this curve have not been adjusted using historic storm data, but the statistical ten- and 100-year flood elevations are higher than those from the Fort Hamilton, Brooklyn, location. The ten-year flood at the Battery is predicted to be 6.8 feet, and the 100-year flood is predicted to reach 9.0 feet above NGVD.

1.7 Review and Analysis of NYC Flood Insurance Study

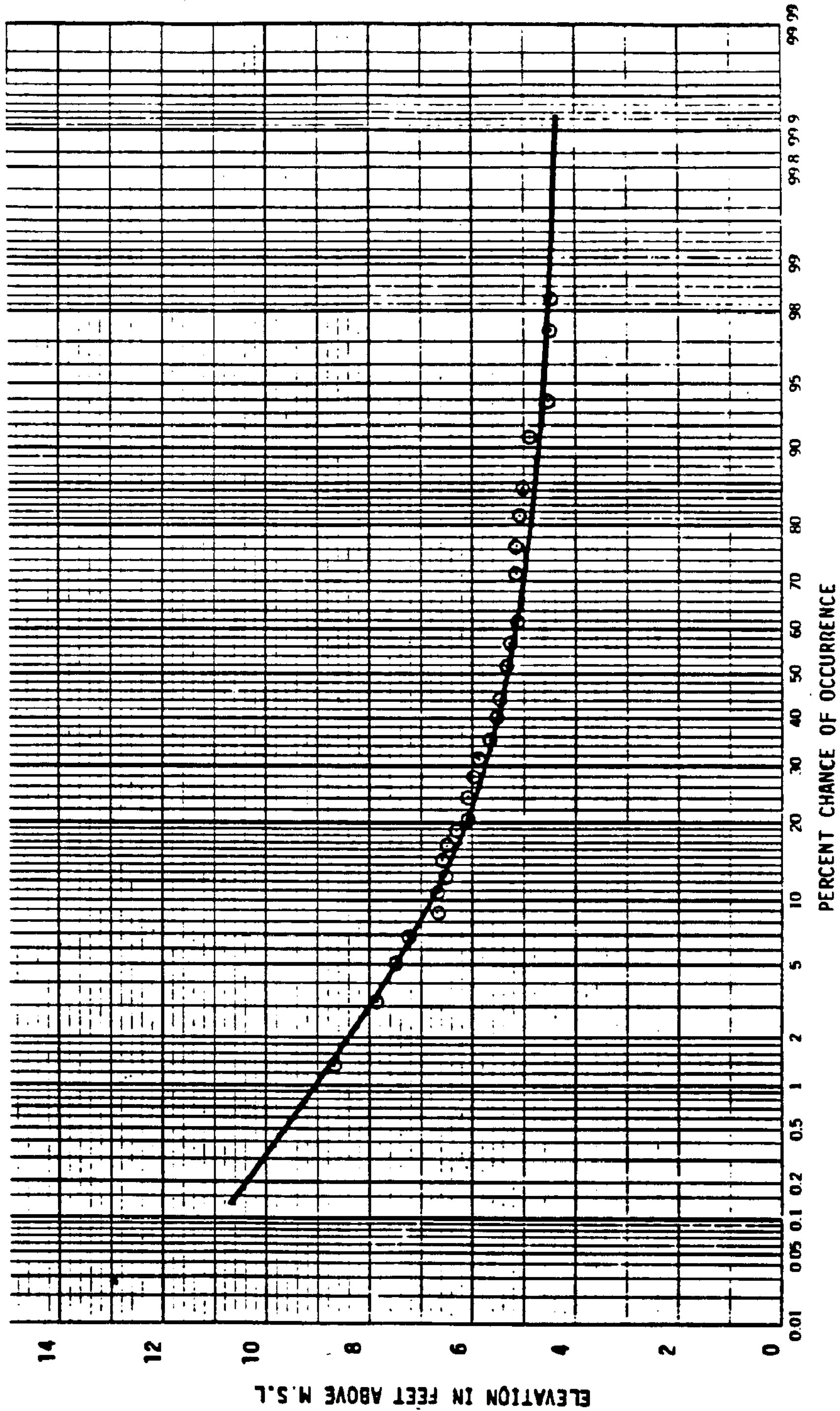
Although the stage-frequency analysis for tide-gage records in the New York vicinity is useful in determining expected flood levels at certain intervals, it cannot be quantitatively applied to intermediate areas where flood levels can vary significantly due to topographic effects. In order to compile meaningful predictions of surge levels in the New York City area, the New York State Department of Environmental Conservation (NYSDEC) commissioned a

Figure A-10



Stage - frequency curves compiled from long-term tide gage records at Fort Hamilton, N.Y. (from the U.S. Army Corps of Engineers, 1964).

Figure A-11



Stage - frequency curve compiled from long-term tide gage records at the Battery (from Camp Dresser and McKee, 1983).

study of predicted storm surge elevations using numerical modeling techniques (Camp, Dresser & McKee, Inc., 1983). This study is referred to hereafter as the NYC Flood Insurance Study. The results of this analysis were used by the Federal Emergency Management Administration (FEMA) to generate Flood Insurance Rate Maps (FIRM), the effective date of which is November 16, 1983, for New York City's participation in the National Flood Insurance Program.

The basic approach used in the NYC Flood Insurance Study was to define the relation between storm frequency and water elevation at all points in the New York City area. The resultant graphs are referred to as frequency elevation or stage-frequency curves. In order to accomplish this, tropical storms (including hurricanes) and extratropical storms (northeasters) were separately simulated and the parameters of each were used as input to hydrodynamic storm-surge models. The synthetic hurricanes were produced using the Joint Probability Method (JPM), which consists of a series of Monte Carlo numerical experiments relating causes and their known statistical probabilities of effects and their derived statistical properties (Camp, Dresser and McKee, Inc., 1983). In this method the surge-producing potential of a tropical storm or hurricane is described by five basic parameters: (1) probabilities of the central pressure index (CPI), (2) probabilities of the radius of maximum winds, (3) probability of forward velocity of the storm, (4) probability of the storm track and (5) probability of coincidence with an astronomical tide. The probability distribution (with time) of each of these parameters is developed from historical meteorological records and combined to form the joint probability distribution of the storm-producing potential.

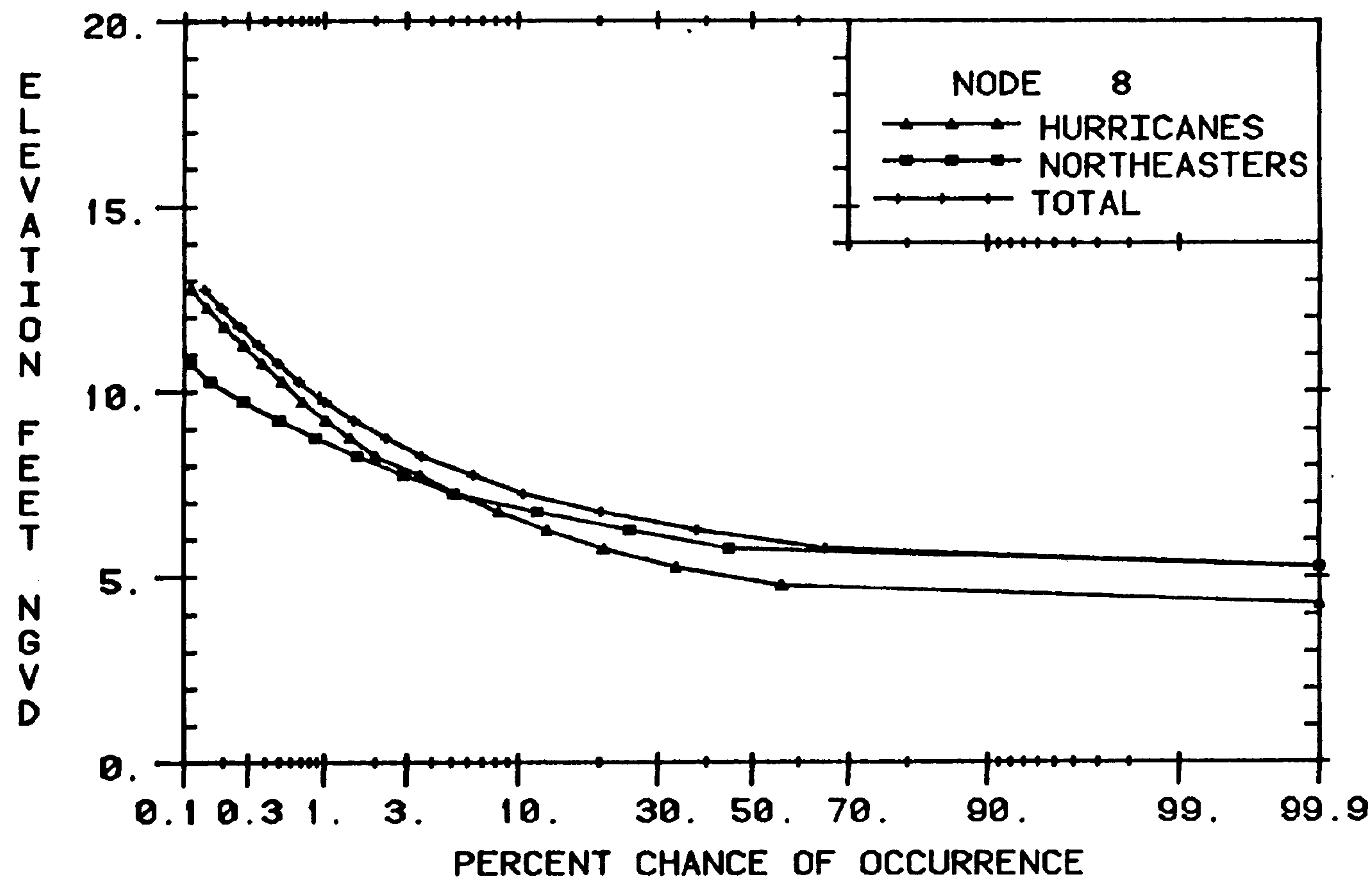
With this information, a large number of storm events are synthesized from the numerical models, and maximum water-surface elevations are determined for each nodal point. From a statistical evaluation of these data, a stage-frequency curve is developed for each nodal point. From the stage-frequency curve, the predicted elevation of a flood having a given probability of recurrence (10, 50, 100, 500 years, etc.) can be determined. As explained in Section B (NFIP Requirements), the base flood elevation (also called the 100-year flood elevation) is the elevation for which there is a one-percent chance in any given year that flood levels will equal or exceed that elevation.

The development of synthetic extratropical storms or northeasters was similar to that of hurricanes in the NYC Flood Insurance Study. Models were developed to similate wind stress and atmospheric pressure gradients from the observed surface pressure field of a particular storm. An adaptation of the Joint Probability Method was then used to produce synthetic northeasters from historical weather records. Again, the parameters of the synthetic storm were used as input to the numerical models of storm surge.

Two numerical models were applied in the NYC Flood Insurance Study (Camp, Dresser and McKee, 1983). One model (the Offshore Model) simulates hydrodynamic conditions on the outer continental shelf according to a relatively coarse computational grid used to conserve computing costs where less detail is needed. The coastline of New York is hydrodynamically complex because of the dynamic interaction of the various waterways and embayments with the ocean. Therefore, a second model (Link Node Model) was used to simulate storm surge along the coast. The Link Node Model is capable of simulating flooding and drying of shoreline areas. The stage-frequency graphs produced by these numerical models show the synthetic storm surges associated with extratropical and tropical storms having specified parameters of recurrence (10, 50, 100, 500 years, etc.). From the results, stage-frequency curves were predicted for each of the nodes of the nearshore Link Node Model. Predicted stage-frequency curves agree well with curves computed with existing tide gage data. For instance, the predicted and measured total elevation frequency curves for the Battery (hurricanes and northeasters) correspond very closely over the entire range considered (.02-1 events per year). The predicted ten-year stillwater flood elevation is 7.4 feet and the predicted 100-year flood is 9.7 feet above NGVD. Figure A-12 shows this in the predicted stage-frequency curve for node 8, which includes the Arverne URA of the Rockaway Peninsula.

To combine the effects of breaking wave heights with stage-frequency curves, which depict only stillwater elevations, a wave crest analysis was also performed in the NYC Flood Insurance Study. This was done using a computer program that simulates shoaling wave characteristics along a series of shore-normal transects in the study area. Wave heights predicted from the wave-crest analysis are added to stillwater elevations predicted from the numerical storm surge predictions in order to obtain total flood elevations. Table A-2 summarizes the results at the Arverne URA shoreline for the combined stage-frequency analysis and wave crest analysis for the 100-year flood. Interpolation of these data shows that the 100-year wave-crest elevations are 12 to 14 feet above NGVD within the V-Zones in the Arverne area. The wave

Figure A-12



Predicted stage-frequency curve for the Arverne Area of the Rockaway Peninsula (from Camp Dresser and McKee, 1983).

Table A-2

WAVE CREST ANALYSIS IN THE ARVERNE URA*

Transect	Location	Elevation (feet) Stillwater 100-Year	Maximum Wave Crest 100-Year
JB-30	From Beach 17th St. to Beach 36th St.	9.7	12
JB-40	From Beach 36th St. to Beach 61st St.	9.7	15
JB-50	From Beach 61st St. to 100 feet west of Beach 73rd St.	9.7	15
JB-60A	From Beach 73rd St. to 350 feet west of Beach 84th St.	9.7	15

*From Camp, Dresser and McKee, 1983.

forecasting technique used in the NYC Flood Insurance Study is based on empirical methods outlined in the Shore Protection Manual (U.S. Army Corps of Engineers, 1977) and is not capable of accounting for the complex refraction-diffraction effects that occur in shallow water. In addition, it is not capable of accounting for water-level set-up caused by breaking waves or processes that can add significantly to flood elevations during storms. In contrast to the storm-surge analysis, the wave-crest analysis in this study should only be used as a general guideline. In addition, no wave crest analysis is provided for lesser flood levels, such as the ten-year flood. Since the wave-crest analysis provides predictions only at discrete transects, interpolation was used to produce the FEMA Flood Insurance Rate Maps.

The 100-year elevations shown on the FEMA maps, the product of superposition of the empirical wave-crest analysis on numerically predicted storm surge, must be considered approximate because of the limitations of the wave analysis. In addition, some discrepancies exist between the published FEMA Flood Insurance Rate Maps and the results of the predictions from the nearshore numerical model of flood elevations. For instance, the areas landward of the boardwalk along the beach in the Arverne URA are not classified consistently with the predictions. The section of the Arverne URA between approximately Beach 39th Street and Beach 74th Street is designated as B-Zone landward of the boardwalk on the Federal Flood Insurance Maps for this area. This section is up to 1000 feet wide and is bordered on the landward side by an A-Zone (area of 100-year flood). The predicted 100-year stillwater flood elevation for this area is 9.7 feet above NGVD (see Table A-2). Comparison with the topographic data used as input to the Link Node Model for coastal storm surge indicates that the elevation of this area varies from 4.8 feet to 13.8 feet above NGVD. Many portions of these B and C-Zones are lower in elevation than the 9.7-foot stillwater level for the 100-year flood, and some areas are about 5 feet below this elevation. The average elevation of this area (Beach 39th to Beach 74th) is 8.2 feet NVGD, or about 1.5 feet below the 100-year flood elevation. The portions of this area that should be at FEMA A-Zone standards according to elevation are shown in Figure A-2. Overall, the results of the storm surge analysis as shown by the 100-year flood elevation on the FEMA maps show that the Arverne area is subject to significant flooding from both the ocean side and bay side. This is particularly true for the eastern end of the Arverne Urban Renewal Area between Beach 32nd and Beach 38th Streets.

An additional point to consider about the FEMA maps is the interpretation of the boardwalk as a C-Zone (area of minimal flooding) because of its elevation at approximately 16 feet NGVD. This is a highly permeable and fragile structure posing no barrier to coastal flooding.

Implications of The NYC Flood Insurance Study For The Arverne URA

As explained in Chapter B (State and Federal Programs), a FEMA A-Zone is an area whose elevation is below that of the 100-year flood for that area. Thus, much of the shore-parallel B-Zone with its land elevations below the level of the 100-year flood meets the FEMA criteria for an A-Zone. In addition, even higher elevations in this area are likely due to the breaking wave process not accounted for by the simplified wave-crest analysis in the New York City Flood Insurance Study. As a result, it is recommended that development for the areas of the shore-parallel B- and C-Zones indicated on Figure A-2 be required to meet FEMA A-Zone construction standards. Furthermore, it is recommended that the base-flood elevation be 10 feet above NGVD for these areas. Ten feet is considered to be appropriately based on an assumed commitment to shore protection and compliance with the coastal erosion hazard line.

1.8 Site Design Recommendations

Techniques available to attain the A-Zone first floor elevation requirements include 1) the use of earth fill to raise site grades, and, 2) the use of piles to provide foundation support and attain the required first floor elevations. The use of earth fill, in general, is the lower cost alternative.

The choice of an appropriate technique is related to a number of considerations. As discussed in Chapter C (Planning and Design - Subsection - Techniques For Shore and Flood Protection), proper grading of the site is very important to attain proper drainage. This is particularly important during flooding events, so that emergency access and egress can be provided. Thus, the use of earth fill within the site must be carefully coordinated with a comprehensive analysis of street grades and area-wide drainage.

In addition to this drainage consideration, the use of earth fill to attain the required A-Zone elevations may result in the reliance on the fill material as foundation support.

In coastal A-Zones, FEMA recommends that the use of earth fill for elevation should be limited to areas of minimal velocity water and wave action due to potential foundation undermining from scour and erosion (FEMA, 1986).

For the purposes of this evaluation two prototypical building types have been assumed:

Category 1: one to four stories
(one-four floors)

Category 2: four to twelve stories
(four-twelve floors)

It is also assumed for the purpose of this Report that Category 1 buildings would use either suitably chosen earth fill or piles as foundations.

For the Category 2 building, it is assumed for this Report that piles would be used as the foundation.

The area from the boardwalk to 250 feet landward is limited by the City to buildings of no more than 60 feet in height and is the area which (see Figure A-1) would be the most probable location for the Category 1 buildings. However, this area is within the A-Zone which is most likely to be subjected to velocity and wave effects from overwash action during major storms. The potential then is for the earth fill foundation to erode. Since the dunes in this area are not well developed, they offer very little protection. Additionally, the use of earth fill as foundation material to attain A-Zone elevations would result in the obstruction of velocity waters at the structures and the channeling of flow in areas adjacent to them, further enhancing the potential for erosion of the earth fill foundation.

Thus, consistent with the overall site grade and drainage requirements discussed above, the use of earth fill to attain the A-Zone elevations in the first 250 feet landward of the boardwalk is not recommended due to the potential for scour and loss of foundation support.

For other locations, the use of earth fill as foundation to attain the A-Zone first floor elevations may be suitable. However, an analysis of the site drainage and related water velocities should be conducted to evaluate the potential for scour.

2. GEOLOGY

The western portion of Long Island (Brooklyn and Queens) is characterized by an east-to-west trending topographic ridge in the northern areas, a seaward-sloping sedimentary plain extending from the ridge to the coastal area. The east-west ridge is a glacial end moraine of fill formed by the glacial advance to the area during the Pleistocene Era. The south-sloping surface is a glacial outwash plain of sand and gravel deposits which formed from the melt waters of the glacier.

The south shore of the island is characterized by a barrier island/bay complex, with beach sands and dunes characterizing the barrier island, and fine-grained sediments and marsh deposits characterizing the bays and bay margins behind the barrier.

The barrier beaches and bay sediments are younger than the glacial outwash and are derived from it by the action of rising sea level.

3. EROSION AND SHORELINE CONDITIONS

3.1 Topography, Shoreline Features And Bathymetric Changes

In general, the shoreline of the Rockaway Peninsula has undergone a significant amount of recession over the past 150 years and has been strongly influenced by the presence and stabilization of the two associated inlets. The history of Rockaway Inlet and East Rockaway Inlet have controlled the overall size of the Rockaway Peninsula and, to a large extent, the stability of the Rockaway shoreline by exerting a strong influence over the sediment budget. The various phases in the evolution of both Rockaway and East Rockaway Inlets correspond to periods of either relative stability or erosion along the adjacent shoreline.

Movement of beach sand by wave action takes place not only above but also below the water out to a depth of about 30 feet. At that depth, even the longest waves have little effect in moving the sand. In the landward portion of the beach there is a nearly horizontal terrace of sand, called a "berm," brought ashore by the turbulent action of the breaking waves (see Figure A-13). Sloping seaward from the berm is

Figure A-13

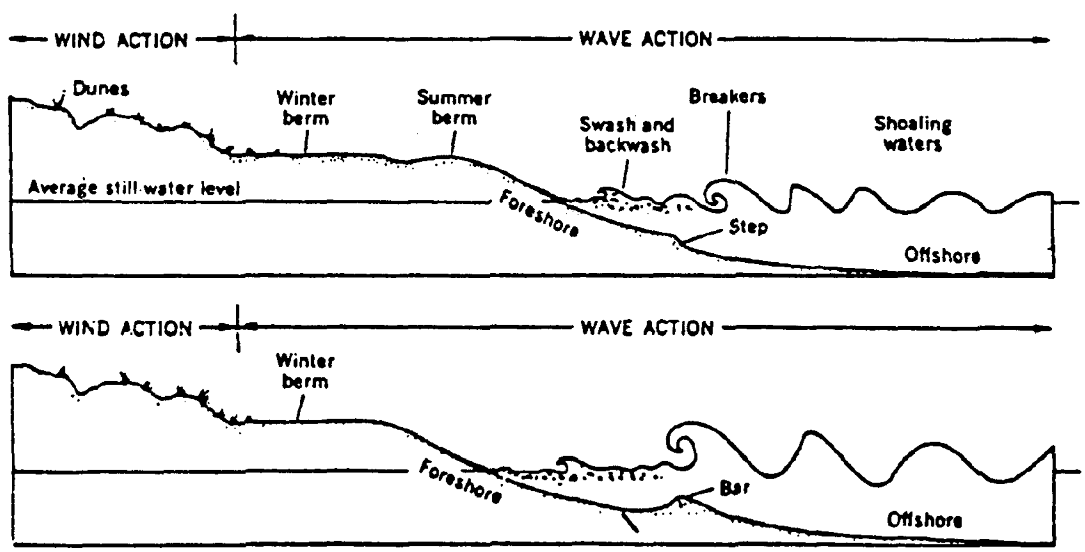


Diagram illustrating parts of a barrier beach and the changes that take place between summer (top cross section) and winter (bottom cross section).

the "beach face," or "foreshore," against which the waves constantly break. Seaward of the beach face lies the "offshore," a sloping sand surface extending out into deeper water that is covered, even at low tide, by the sea. Once formed, such barrier beaches as Fire Island Beach, Jones Beach, Long Beach, Rockaway Beach, and the many others located south of Long Island, are persistently remolded and significantly altered. A beach responds with great sensitivity to the forces that act upon it -- the waves, winds and longshore currents.

The migration inland of the barrier island is one of the most significant changes that will eventually occur to the Rockaway Peninsula. The barrier bar or island may grow seaward temporarily, but the main movement is landward as the barrier retreats under the attack of waves.

The history of East Rockway Inlet has been particularly important in determining the stability in the project area at the eastern end of the Peninsula. At the time of the first accurate U.S. Coast and Geodetic Survey in 1835, East Rockaway Inlet was located approximately three miles east of its present location, and the eastern end of the Rockaway Peninsula was attached to the headland. By 1855 the inlet assumed a form similar to its present form but located about one mile to the east of its present location. After 1860 this inlet closed and by 1879 there were two inlets to the east. The major inlet was located 3.5 miles to the east of the present inlet and a minor inlet was located about two miles from the present inlet entrance. Downdrift or westward migration followed by inlet closure and updrift or eastern re-breaching of inlets is a typical cycle for unstabilized tidal inlets. This cycle also influences shoreline stability. For instance, during the post-1860 period when East Rockaway Inlet was located much further to the east than at present, the shoreline in the study area was in a period of relative stability. By the time of the 1909 Coast and Geodetic Survey, the inlet once again assumed its present configuration and continued to migrate westward until construction of a large stone jetty in 1933-34. The shoreline along the Arverne URA underwent both accretional and erosional episodes during this period and has suffered an overall net erosion during this century.

Shoreline and Bathymetric Changes, 1835-1961

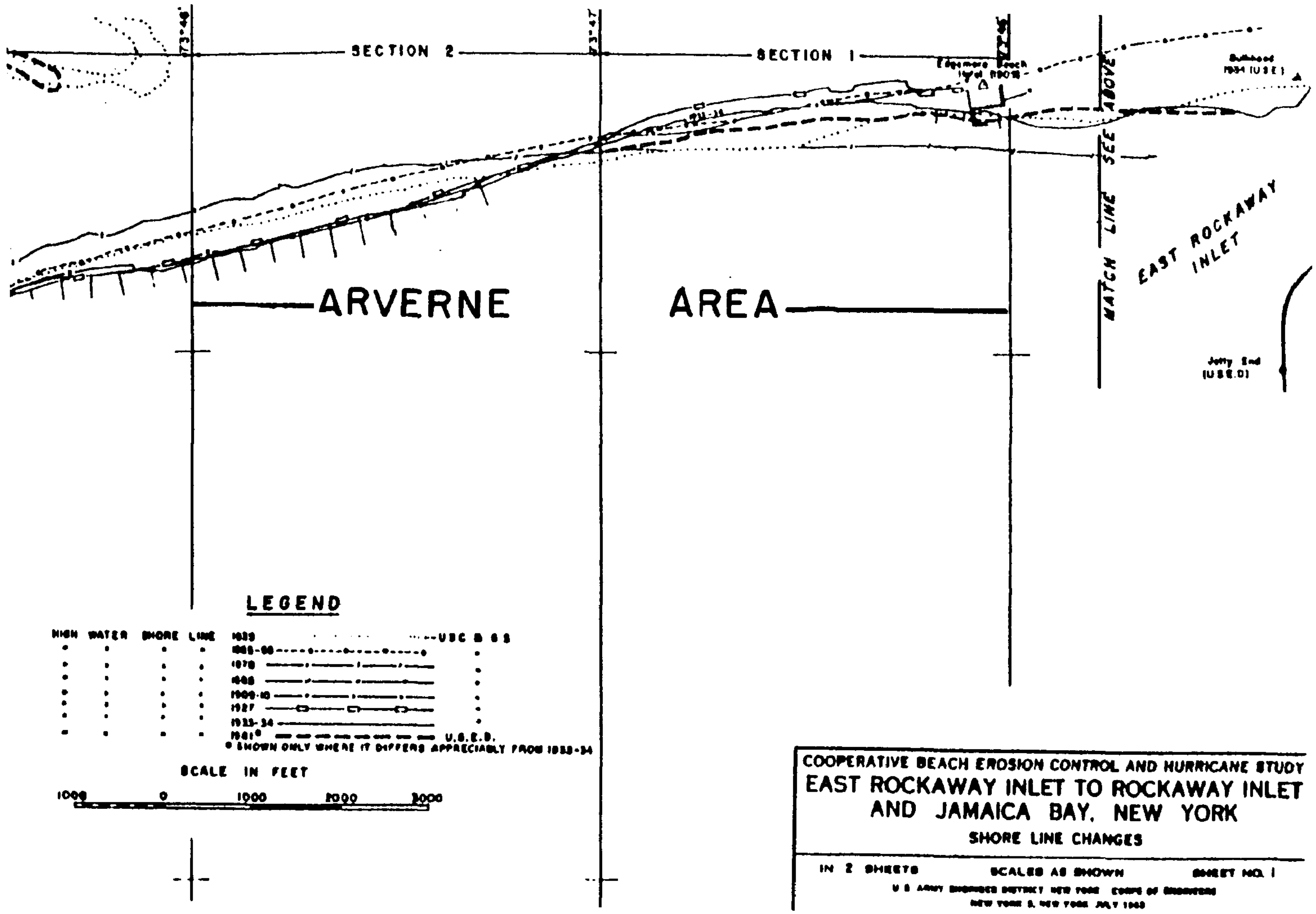
The high water shoreline of the Rockaway Peninsula has retreated from the beginning of accurate records in 1835, but has fluctuated between episodes of accretion and erosion over shorter periods of time. A Survey Report compiled by the USACOE (1964) documents shoreline and bathymetric changes along the Rockaway Peninsula in ten sections, each section being equal to one minute of longitude (Figure A-14).

Section 1 and Section 2, between Beach 34th and Beach 72nd Streets, termed the Edgemere to Arverne portion, include most of the Arverne URA. In these sections, the shoreline retreated an average of about 240 feet between 1835 and 1856 (an average of about 11 feet per year). It was during this period that East Rockaway Inlet made its first historically documented advance to the west. Between 1856 and 1878 East Rockaway Inlet closed, and much of the shoreline along the Arverne URA accreted seaward, by more than 400 feet in some areas (Table A-3). Between 1878 and 1933 East Rockaway Inlet again migrated rapidly to the west, and the Arverne shoreline between Beach 34th and Beach 50th Streets again retreated by approximately 560 feet (an average of about 11 feet per year), although the western half of this portion showed a net accretion of about 360 feet.

During the portion of this early period for which accurate bathymetric data are available (1885 to 1927), all contours in the Arverne URA retreated by an amount comparable to that of the shoreline, varying between 500 and 1000 feet. Similar to the shoreline, the bathymetric contours along the western half of this section shifted seaward by about 150 feet. In the period between 1927 and 1961, the high water line along this section advanced between 25 and 330 feet seaward. The offshore contours between six and 30 feet also advanced seaward between 200 and 500 feet (Tables A-3 and A-4). During this period, approximately 5,400,000 cubic yards of fill were placed on the beach in the Far Rockaway to Arverne area, accounting for about 75 percent of the volumetric accretion that contributed to seaward movement of the contours.

The history of the shoreline along the portion of the Rockaway Peninsula between Arverne and Rockaway Park (Sections 3 and 4) was somewhat different from the eastern portion Between 1835 and 1856. This stretch of shoreline retreated at a moderate rate, averaging between about 50 and 160 feet in that area, or about two to eight feet per year (see Sections 3 and 4 in Table A-3). This recession continued from 1856 to 1878, ranging from about 130 to 190 feet. Between 1878 and 1927, this portion of shoreline advanced. Seaward accretion ranged from about 200 to 370 feet over this period. The erosion of the beach and shoreface along the Edgemere portion to the east

Figure A-14



Shoreline changes along the Arverne Renewal Area of the Rockaway Peninsula between 1835 and 1961 (from the U.S. Army Corps of Engineers, 1964).

AVERAGE SHORELINE MOVEMENT IN FEET[1]

ATLANTIC OCEAN FROM EAST ROCKAWAY INLET TO ROCKAWAY INLET

1835 - 1961

+ Accretion   - Erosion

Section	Length (ft)	1835-1856	1856-1878	1878-1910	1910-1927	1902-1928	1927-1934	1928-1934	1934-1961
*1	4,700	-341	+482	-410	-157	-	+165	-	+166
*2	4,700	-144	- 82	+374	- 12	-	+ 21	-	+ 3
3	4,900	- 46	-188	+313	+ 55	-	0	-	+ 9
4	5,000	-160	-130	+ 53	+154	-	0	-	- 8
5	5,100	+ 99	-223	- 11	+ 74	-	+ 14	-	+ 21
6	5,100	-	-217	+108	+ 50	-	+ 25	-	+ 47
7	5,100	-	-	-	-	-261	-	+110	+ 27
8	4,900	-	-	-	-	-224	-	+118	- 43
9	2,350	-	-	-	-	-	-	+ 96	+ 69
10	9,300	-	-	-	-	-	-	-	+1790
Total Average Movement (ft)		-115	- 65	+ 72	+ 30	-243	+ 36	+108	+270
Total Annual Movement (ft/yr)		-5.47	-2.95	-2.25	+1.76	-9.34	+5.14	+ 18	+10.0

*Arverne Renewal Area

[1] From the U.S. Army Corps of Engineers, 1974.

Table A-4

AVERAGE OFFSHORE CONTOUR MOVEMENT IN FEET[1]
ATLANTIC OCEAN FROM EAST ROCKAWAY INLET TO ROCKAWAY INLET
1885 - 1961
+ Accretion   - Erosion

Contour Interval		Section *1	*2	3	4	5	6	7	8	9	10
	Length (ft)	4,700	4,700	4,900	5,000	5,100	5,100	5,100	4,900	2,350	9,300
1885-1927											
6		-	-	+351	+548	+274	+ 72	-	-	-	-
12		-1010	+168	+419	+326	+185	- 52	-1729	-	-	-
18		- 650	+136	+286	- 20	-592	-2170	-3280	-	-	-
24		- 510	+153	- 49	+ 6	-850	-1792	-1733	-	-	-
30		- 747	- 30	-245	-766	-1215	-1033	- 714	-	-	-
1927-1961											
6		+ 197	- 19	-193	- 3	+132	+235	+ 4	+105	-	-
12		+ 270	+ 24	-216	+ 17	+ 55	0	- 237	- 11	-	-
18		+ 457	+368	+437	+ 6	-135	- 249	- 513	-681	-	-
24		+ 410	+581	+1056	+210	-271	- 356	- 166	- 60	-	-
30		+ 517	+ 6	+1240	+908	+833	+ 594	+ 318	+417	-	-
1932-1961											
6		-	-	-	-	-	-	-	+112	+495	+1820
12		-	-	-	-	-	-	-	+ 7	+ 27	+ 861
18		-	-	-	-	-	-	-	-601	-470	- 940
24		-	-	-	-	-	-	-	+ 15	-171	+ 211
30		-	-	-	-	-	-	-	+690	+1300	+2000

*Arverne Renewal Area

[1]From U.S. Army Corps of Engineers, 1974.

during this period may have contributed to the buildup of the Arverne to Rockaway Park portion. Bathymetric records show that between 1885 and 1927 accretion also took place on the submerged portion of this area. Bathymetric contours for Sections 3 and 4 from six up to, but not including, 30 feet advanced. However, for all four sections the 30-foot contour retreated from about 30 to as much as 770 feet, with the amount of retreat increasing toward the west (Table A-4).

From 1927 to 1961 the Arverne to Rockaway Park portion of shoreline remained more or less in the same position due to a significant amount of beach fill (see Sections 3 and 4 in Table A-3). More than 12,000,000 cubic yards of sand, or an average of 200 cubic yards per foot of beach, had been placed on the beach between 1926 and 1962. Some erosion did take place along the submerged portions of this area, particularly along the six- and 12-foot contours (see Sections 3 and 4 in Table A-4).

The effects of the Rockaway Inlet have been significant in the Rockaway Park to Jacob Riis Park area. In 1835, Rockaway Point at the western end of the island was near the present eastern boundary of Riis Park. Between 1835 and 1856 this point advanced a mile or about 250 feet per year to the west. Between 1856 and 1878 the point advanced another mile to the west, and the shore of Rockaway Park and Belle Harbor simultaneously retreated about 200 feet. Between 1878 and 1927 the newly formed beach in front of what is now Jacob Riis Park and the beach just to the east at Rockaway Park and Belle Harbor fluctuated slightly but showed no strong erosional or accretional trends.

U.S. Coast and Geodetic Survey bathymetric maps published in 1885 indicate a large shoal south and west of the present-day Riis Park. This was probably related to the presence of Rockaway Inlet in this vicinity just prior to this period and, most likely, was the remnant of an ebb-tidal delta or a seaward inlet shoal. Erosion of this shoal between 1885 and 1927 probably provided some source material for the westward extension of Rockaway Point during this period. The rate of westward migration of the point was approximately 250 feet per year until 1900 and then decreased to about 150 feet per year until 1928, when Rockaway Point reached its present location. Between 1885 and 1933, when the Rockaway Inlet jetty was built, the peninsula extended westward by more than three miles. The volumetric accretion rate along this section at Rockaway Point averaged about 800,000 cubic yards per year between 1885 and 1900 and approximately 400,000 cubic yards per year since. Variations of the accumulation rate ranged from 350,000 to 535,000 cubic yards per year. During the period between 1885 and 1927 the beach and shoreface areas to the east of Rockaway Point lost an average of 550,000 cubic yards of sand per year, approximately balancing the volume of accretion at Rockaway Point.

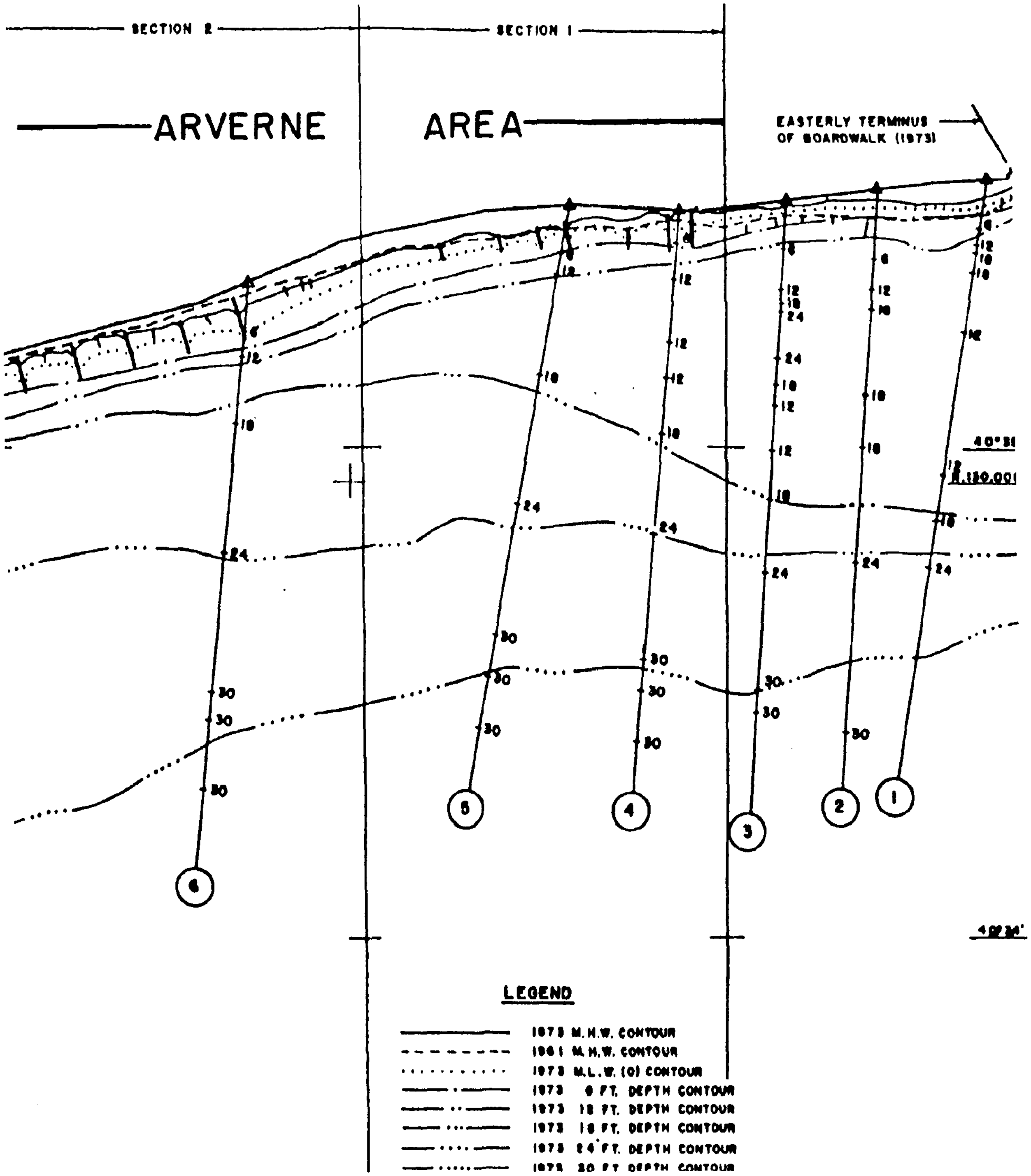
Thus, the sediment budget of the Rockaway Peninsula consisted of a strong net westward longshore drift of about 550,000 cubic yards per year past a given point, and a corresponding average accumulation (and extension) at Rockaway Point of about 500,000 cubic yards per year during this period. Excess sediment not accounted for by accretion at Rockaway Point (approximately 50,000 cubic yards per year) may have been bypassed to and around Rockaway Inlet or lost to the offshore region. This sediment budget agrees in order of magnitude to the yearly longshore drift (440,000 cubic yards per year) that can be estimated from surf zone experiments conducted by the USACOE (1964).

From 1927 to 1961 Rockaway Point continued to accrete sediment at an average of about 470,000 cubic yards per year, whereas the beach and shoreface area along the rest of the Rockaway Peninsula to the east gained an average of about 60,000 cubic yards per year. The source of sand for accretion at Rockaway Point is uncertain, but significant erosion along the center of the peninsula (about 63,000 cubic yards per year) and the addition of significant volumes of beach fill (averaging about 350,000 cubic yards per year) may account for the continued accretion at Rockaway Point. An additional component of the sediment budget during this period was apparently sand bypassing across East Rockaway Inlet. The average rate of accretion along the eastern half of the peninsula was approximately 125,000 cubic yards per year. This, combined with beach fill projects, kept this part of Rockaway Peninsula, including the present Arverne URA, relatively stable.

<u>Shoreline and Bathymetric Changes, 1961-Present</u>

Between 1961 and 1973 only two relatively small beach fill projects were completed: (1) following the March, 1962, storm the USACOE placed 175,000 cubic yards of sand on the beach between Beach 67th and Beach 78th Streets; and (2) the City of New York placed 300,000 cubic yards of beach fill between Beach 83rd and Beach 96th Streets in 1967. During this period a significant landward retreat of the high water line took place in most sections of the Rockaway shoreline (see Figure A-

Figure A-15



Shoreline changes along the Arverne Renewal Area of the Rockaway Peninsula between 1961 and 1973. Range lines 1 to 6 indicate the location of beach and shoreface profile comparisons between 1961 and 1973 (from the U.S. Army Corps of Engineers, 1974).

15). According to surveys conducted by the USACOE, the the greatest average shoreline retreat, amounting to 68 feet, took place along the eastern half of the Arverne URA shoreline between Beach 34th and Beach 50th Streets (Section 1, in both Figure A-15 and Table A-5). The western half of the Arverne URA between Beach 50th and Beach 74th Streets (Section 2 in Figure A-15) shifted seaward at the high water line but suffered significant erosion at depths greater than 12 feet (Table A-5).

The remainder of the Rockaway Peninsula surveyed by the USACOE in 1961 to 1973 displayed shoreline retreat for the most part and erosion of the submerged areas to depths of 30 feet (Figure A-15, Table A-5). Some accretion did take place on the submerged portions offshore of the Arverne URA (Section 1 in both Figure A-15 and Table A-5) at depths greater than 12 feet. The accretion, however, can be attributed to buildup of tidal shoals associated with the entrance of nearby East Rockaway Inlet. Figures A-16a and A-16b show the changes at ten profiles (or range lines) surveyed by the Corps of Engineers between 1961 and 1973. Locations of the profiles are shown in Figure A-15. In almost all cases these profiles show retreat of the mean sea level shoreline and appreciable loss of sediment to depths of 20 feet.

A 1974 examination of volumetric accretion and erosion from an analysis of changes in shoreline and depth contour position by the USACOE indicates a massive loss of sediment due to erosion between 1961 and 1973. Annual losses were found in shoreline Sections 2 through 6 (see Figure A-15) ranging from about 50,000 cubic yards per year in Section 6 to about 310,000 cubic yards in Section 4. Section 1, which is 4500 feet long and includes about half of the Arverne URA (see Figure A-15), was the only shoreline segment that showed volumetric accretion during this period (approximately 105,000 cubic yards per year), despite the fact that the mean high water line underwent significant retreat which resulted in significant beach erosion (Table A-5). All of this accretion occurred on the submerged shoreface due to growth of tidal shoals as previously described.

Erosion of the submerged portion of the shoreface either precedes or corresponds with landward retreat of the shoreline. Significant volumetric loss from the shoreface allows greater penetration of wave energy to the shoreline and depletes the nearshore supply of sand that can be exchanged with the beach. In addition, a depleted shoreface will increase the effects of flooding on the beach and areas landward of

AVERAGE SHORELINE AND OFFSHORE DEPTH CONTOUR MOVEMENT IN FEET[1]

1961 TO 1973 EAST ROCKAWAY INLET TO JACOB RIIS PARK

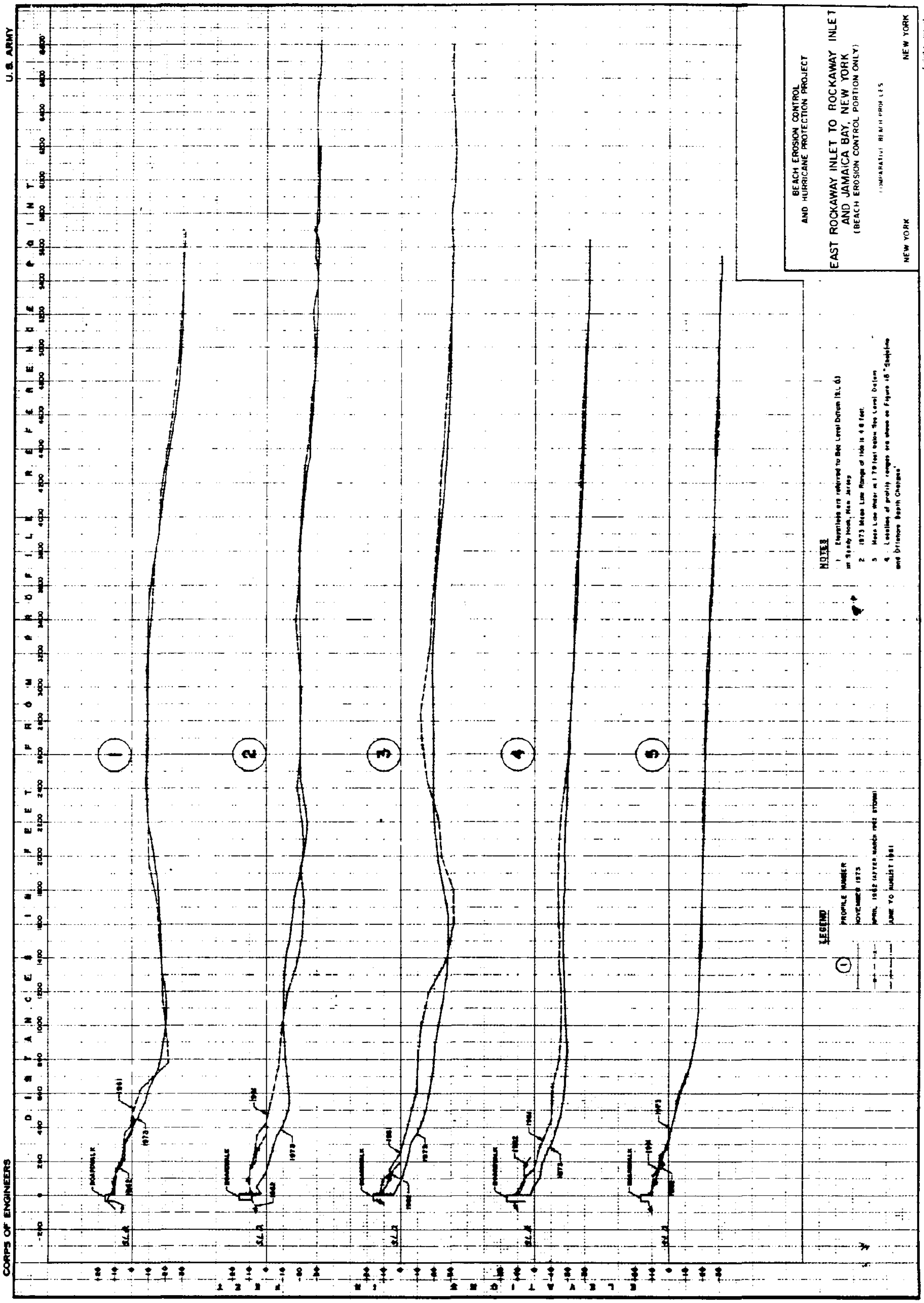
Shoreline or Depth Contour (m.l.w.)	Section Number and Length in Feet					
	*1	*2	3	4	5	6
	4,700	4,700	4,900	5,000	5,100	5,100
M.H.W.	- 66	+ 98	+ 15	- 33	- 16	+ 13
6	+ 4	+216	+188	- 96	-227	-153
12	- 36	+110	+187	-275	-254	-193
18	+161	-488	-789	-680	-319	-148
24	+214	-576	-1373	-1203	-395	+ 99
30	-695	-790	-2244	-932	-199	+326

(a) 12.33 years in period
(b) - indicates landward movement
(c) + indicates seaward movement

*Arverne Renewal Area

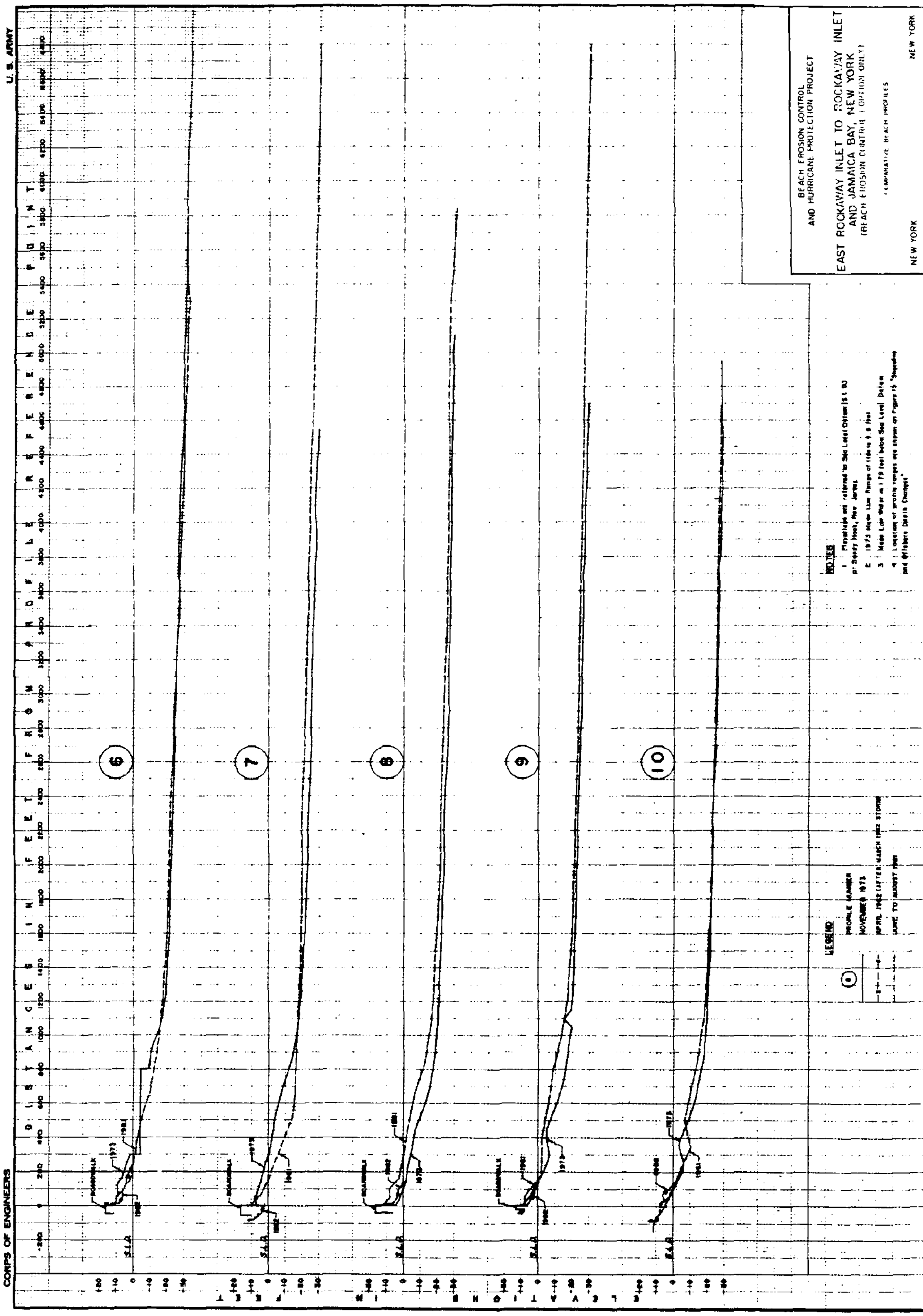
[1]From the U.S. Army Corps of Engineers, 1974.

Figure A-16a



Comparison of beach and shoreface profiles along the eastern half of the Rockaway Peninsula between 1961 and 1973. Profiles 4 and 5 are representative of the Arverne Renewal Area (from U.S. Army Corps of Engineers, 1974).

Figure A- 16b



Comparison of beach and shoreface profiles along the central portion of the Rockaway Peninsula between 1961 and 1973. Profile 6 is located at the western end of the Arverne Renewal Area (from the U.S. Army Corps of Engineers, 1974).

the beach during storms. Overall, permanent loss of sediment volume from the shoreface indicates a period of erosion that will result in shoreline retreat and increased flooding hazards.

Over the thirteen years since 1973, shoreline retreat and volumetric losses of sand from the beach and shoreface have been greatly reduced by a series of beach fill projects that resulted in a total of more than five million cubic yards of fill being placed on the beach. Much of this fill was from the USACOE beach erosion control program initiated in response to the Water Resources Development Act of 1974. The program was installed along the Rockaway Peninsula between 1975 and 1977 and has continued with periodic nourishment of the beach in two areas since that time (a western area between Beach 86th and Beach 110th Streets, and an eastern area between Beach 25th and Beach 39th Streets). The last scheduled nourishment operation, however, occurred in 1988. At this time the federal role in any continued shore protection work in the Arverne URA (and general area) is under consideration.

Beach profiles obtained from the U.S. Army Corps of Engineers depict before and after conditions with respect to the 1984 to 1986 beach nourishment project. In addition, for this project, 11 beach profile stations were established along the Arverne shore to monitor performance of the beach nourishment program. Four monthly surveys have been completed. Based on this information, the topography and shoreline characteristics within the primary study area can be summarized as follows.

The terrain of the Rockaway Peninsula is low lying, nearly flat and generally less than ten feet above mean sea level. The topography of the Arverne URA and its surrounding area is shown in Figure A-17. Prior to beach replenishment, the subaerial beach in the Arverne area was less than 50 feet wide and extended to the waterline at a slope between one in 30 and one in 15 (2^{o} - 4^{o}). The submerged upper shoreface extends seaward at a slope of above one in 30 (2^{o}) to depths of 30 feet. Beyond this depth the seaward slope is less than one degree. After completion of recent beach replenishment projects, part of which includes the Arverne area, the subaerial beach berm is 100 to 200 feet wide and nearly flat, whereas the beach foreshore and submerged shoreface extend seaward at about two degrees to a depth of about 20 feet. Figure A-18 illustrates the natural and proposed post-fill beach and shoreface profiles.

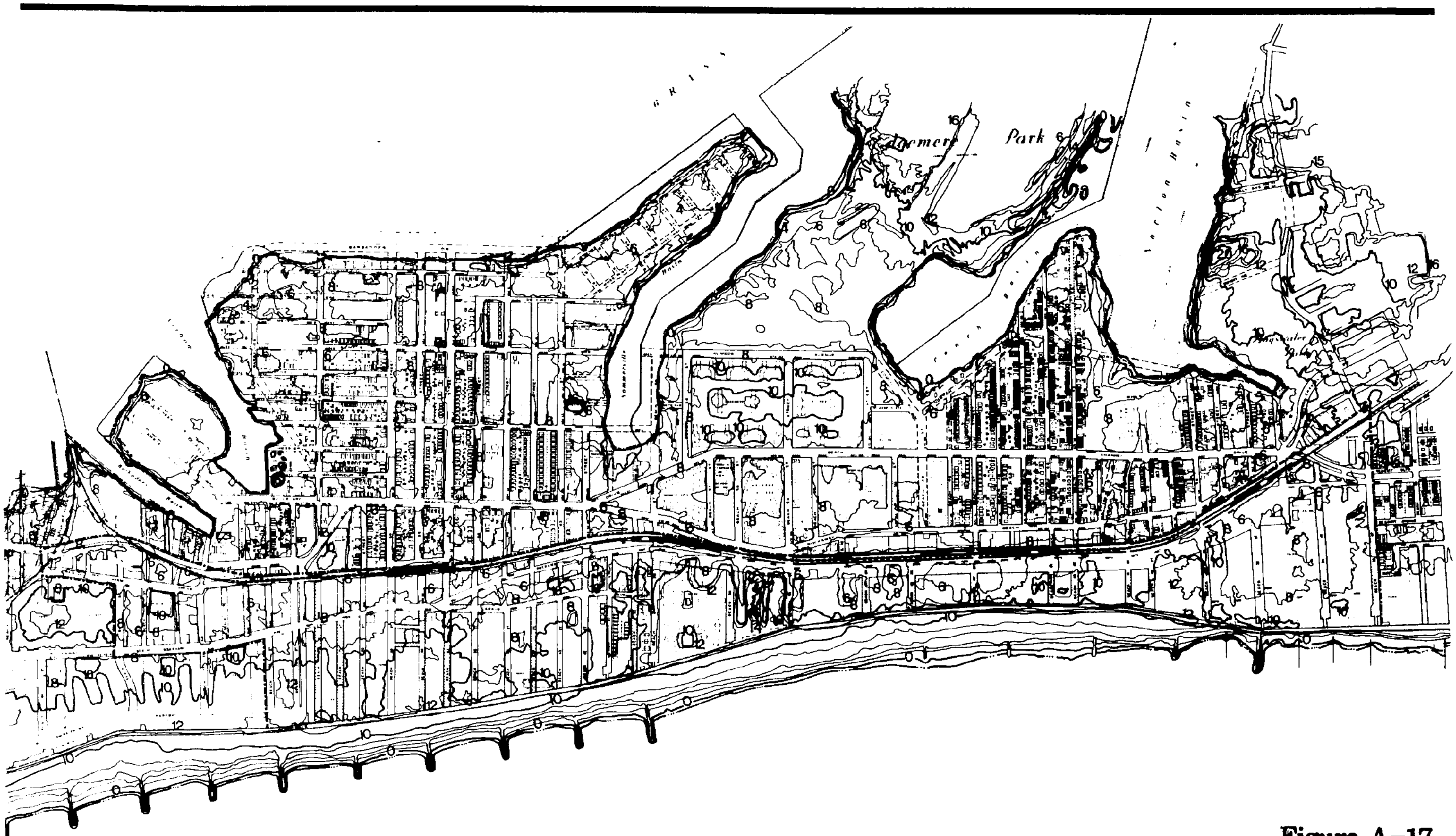
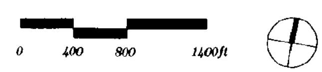


Figure A-17



ARVERNE URBAN RENEWAL AREA
Queens, New York

Department of City Planning

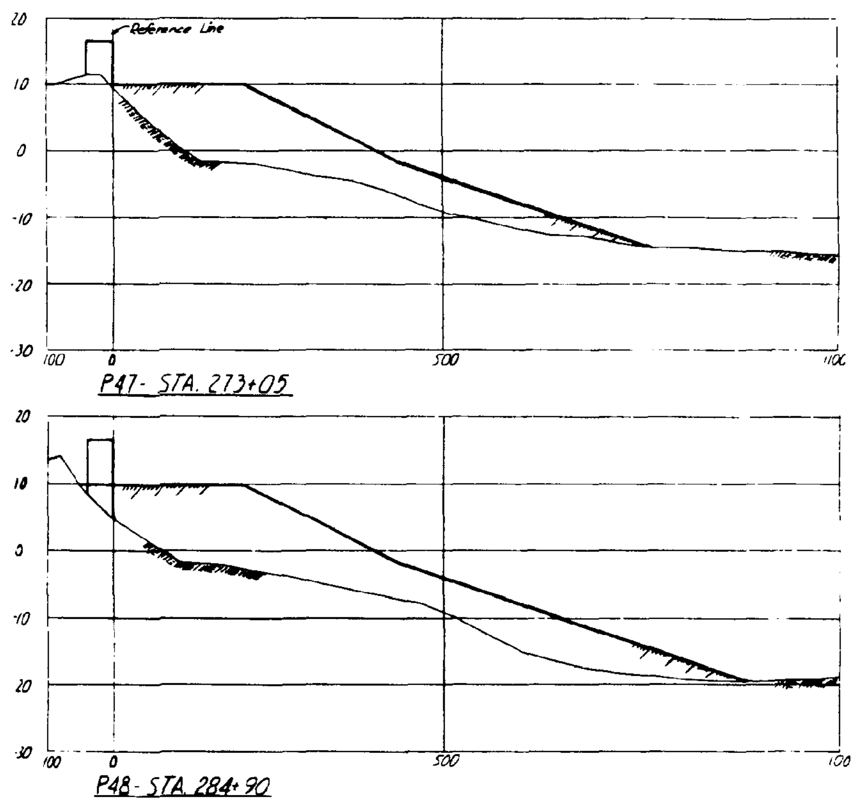
Dresdner, Robin & Associates, Inc.
Gruzen Samton Steinglass Architects, Planners
Edwards and Kelcey Engineers, Inc.
Abeles Phillips Preiss & Shapiro, Inc.

Topography

Contours on 2 Ft. Interval
Contours on 10 Ft. Interval

Source: Based on topographic survey prepared for the Dec. 1981 flood study. Original from NYSDEC Topographic Maps, Albany, N.Y. (1979).

Figure A-18



Beach and upper shoreface profiles in the Arverne area at B40th Street (P47) and B36th Street (P48) showing the existing profile in 1974 and the proposed profile after beach replenishment (from the U.S. Army Corps of Engineers, 1974).

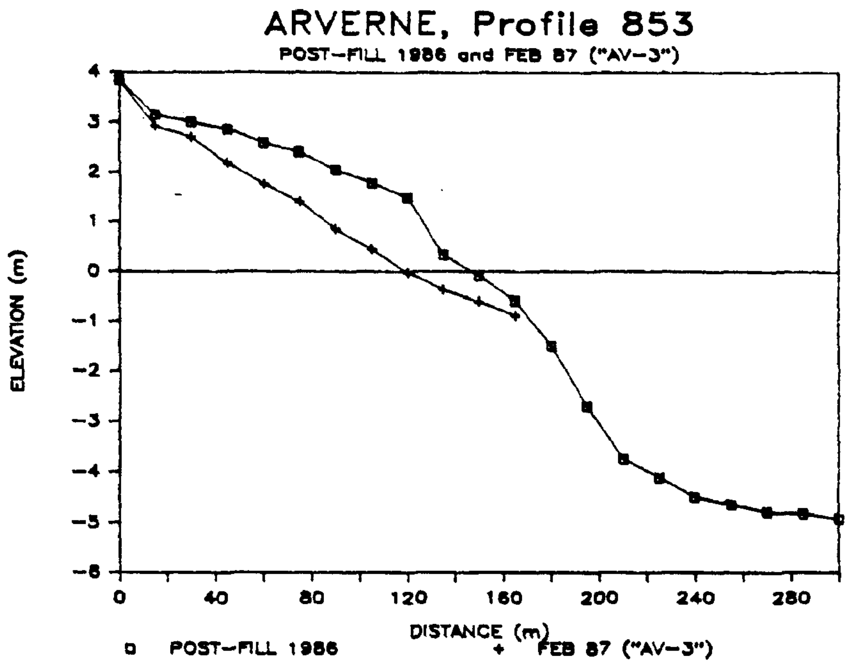
Surficial deposits of the natural beach are medium to fine sand ranging in average diameter from 0.20 mm in the Arverne URA to about 0.45 mm in the Fort Tilden area. These are average values for combined samples of the beach. In the cross-shore direction from the berm (or backshore) to the base of the upper shoreface there is considerable variation in sediment size. Sand forming the berm areas tends to be fine-grained, having a median diameter of about 0.26 mm. The median diameter of sand from the foreshore of the beach at mid-tide level is about 0.35 mm. Seaward of this point, sediments tend to become finer to a minimum of 0.18 to 0.10 mm in water depths of 18 to 30 feet.

Further seaward at depths greater than 40 feet, sediment diameter again becomes coarse as the nearshore sediments of the inner shelf are approached. The onshore increase in sediment size across the upper shoreface toward the beach is consistent with shoaling wave action, which tends to preferentially transport coarser sand onshore and finer sand offshore. The finer-grained sediment found in berm areas, and in the incipient dune building areas in the vicinity of the boardwalk, are due to winnowing of the fine sand fraction of the lower beach by wind action. In addition to natural conditions, sand fill placed on the beach and submerged shoreface will be subject to the same wave and wind sorting processes.

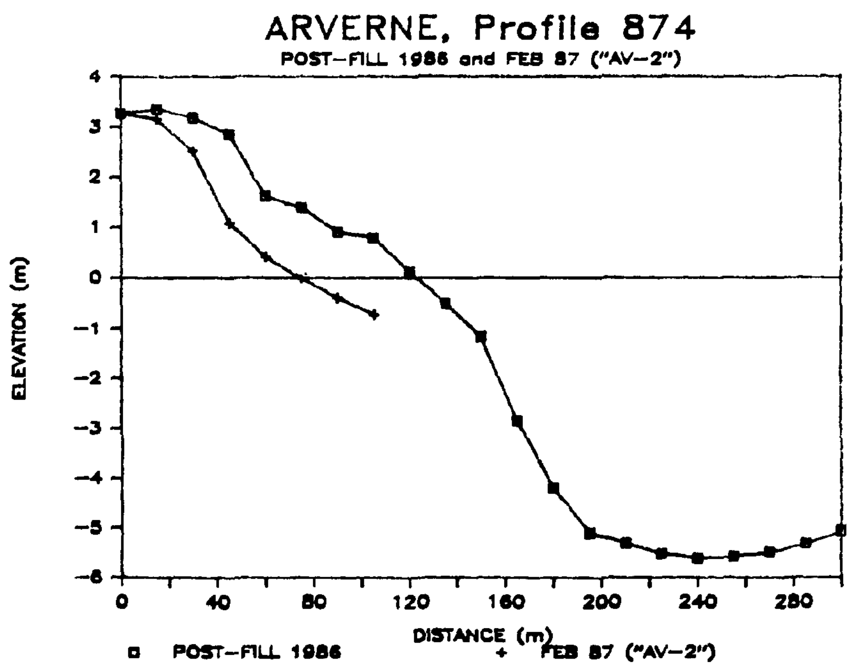
Textural properties of the borrow material to be used for beach nourishment projects are an important consideration in the design of a successful project. Fine materials tend to be readily suspended and transported offshore providing little or no use for the nourished beach. Thus, sources of fine, well-sorted (poorly graded) borrow materials are usually excluded from consideration as potential beach fill material. Borrow material with the same grain size distribution as the native beach material is most suitable for fill since the distribution of grain sizes naturally present on a beach represents a state of dynamic equilibrium between the supply and the loss of each size and the dynamics of the site. Borrow material slightly coarser than the native beach is usually suitable. In cases where these comparable grain size conditions do not occur, an additional volume of fill may be required to attain the desired stable beach characteristics as a result of the winnowing action of five sizes to which the borrow material is subjected.

The performance of the 1986 beach nourishment project in the Arverne URA is summarized in Figures A-19, A-20 and A-21. The post-fill beach at Beach 38th Street

Figure A-19 & 20

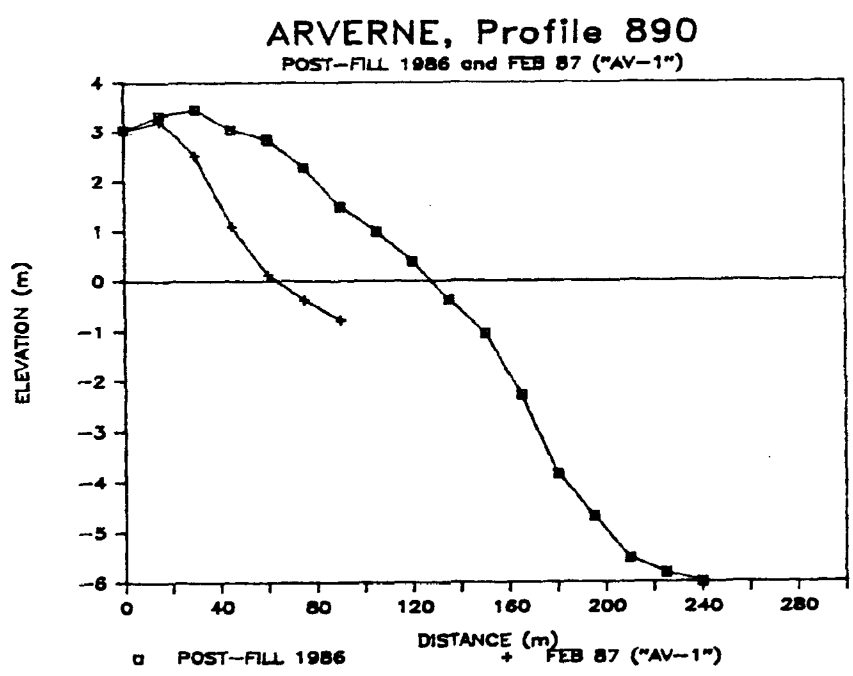


Beach profile change at B38th Street between August, 1986 and February, 1987 showing loss of hydraulic beach fill.



Beach profile change at B34th Street between August, 1986 and February, 1987 showing loss of hydraulic beach fill.

Figure A-21



Beach profile change at B33rd Street between August, 1986 and February, 1987 showing large volumetric loss from hydraulic beach fill.

(Profile 853), Beach 34th Street (Profile 874), and at Beach 33rd Street (Profile 890) is compared with the subaerial and intertidal beach (from the boardwalk to approximately mean low water). Volumetric losses of the beach during this period ranged from 125 cubic meters (160 cubic yards) to 210 cubic meters (275 cubic yards) of sand per meter of beach. In the section of the Arverne URA that overlaps with the nourishment area (Beach 32nd to Beach 40th Streets), beach profile measurements indicate a total loss of about 16,000 cubic yards of sand above mean low water since placement of the beach fill in August 1986. The largest losses occurred at the eastern end of the Arverne area where losses averaged about 200 cubic yards per meter of beach. In terms of shoreline retreat, these volumetric losses resulted in retreat of the mean sea level shoreline by 100 to 225 feet in six months. Although nourishment operations in the Arverne URA have maintained the beach and provided protection against the ten-year flood, the fill project in the Arverne URA is considered the least successful in the District by the New York District Corps of Engineers office, because of the high rate at which the fill has eroded. High erosion rates are thought to be caused by the proximity of East Rockaway Inlet. The wave refraction analysis performed for the Arverne URA indicates strong refraction patterns around the inlet shoals and a reversal of net longshore drift to an easterly direction towards the inlet. Wave refraction patterns combined with scouring by tidal currents are probably the factors causing the relatively high erosion rates of the hydraulic fill.

In summary, over the past 150 years, the shoreline of the Rockaway Peninsula has suffered a total retreat of more than 500 feet in some areas. Rates of retreat have varied from as much as 25 feet per year in the short term to as little as two feet per year in the long term. Short-term rates are generally related to the influence of tidal inlets on adjacent shorelines, loss of beach fill used to nourish the beach, and specific storms. Long-term rates of shoreline retreat are related to the rate of sea-level rise and sediment supply.

3.2 Past and Present Shore Protection Projects

More than 240 groins have been built on the Rockaway oceanfront over the past 65 years. More than 80 percent of these were relatively short, closely spaced timber groins, some of which have been partially or totally destroyed. At present, there are 23 groins constructed from stone. In the Arverne

URA, a total of 11 stone groins are formed with an average spacing of about 700 feet and length of about 450 feet. Early groin-building work was completed between 1920 and 1930, but most of the large stone groins were built after 1940. The jetties at both Rockaway Inlet and East Rockaway Inlet were built in the early 1930s. Both these structures have acted as significant barriers to longshore transport.

Extensive beach filling has taken place along the Rockaway Peninsula. Between 1926 and 1962 more than 12,000,000 cubic yards of sand, or an average of 200 cubic yards per foot of beach, have been placed on the beach.

The area between Beach 3rd and Beach 54th Streets, which includes the eastern half of the Arverne URA, was the first area of the peninsula to be developed. Records indicate that 18 timber groins were constructed in this area prior to 1915 but were later destroyed and replaced by newer structures. In 1928, the Borough of Queens built 21 timber groins and a bulkhead between Beach 25th and Beach 54th Streets and placed 1,450,000 cubic yards of sand in the same area. In 1956, the New York State Department of Public Works (DPW) built five stone groins between Beach 36th and Beach 49th Streets; and in 1958 DPW placed an additional 1,250,000 cubic yards of sand between Beach 9th and Beach 52nd Streets.

In the area between Beach 54th and Beach 109th Streets, which includes the western half of the Arverne URA, the only early work consists of two groins built near Beach 55th Street and three groins built between Beach 62nd and Beach 64th Streets in 1920. All of these early structures were subsequently destroyed and replaced by later structures. In 1926 the Borough of Queens built 39 timber groins between Beach 54th and Beach 109th Streets and simultaneously placed 7,500,000 cubic yards of sand in the same area. In 1961 the New York State Department of Public Works built four stone groins, each 500 feet in length, between Beach 62nd and Beach 70th Streets and in 1962 added three similar groins between Beach 70th and Beach 80th Streets. Following the March, 1962, storm the USACOE placed 175,000 cubic yards of sand on the beach between Beach 67th and Beach 78th Streets. In 1965, construction of three stone groins, each 600 to 700 feet in length, at Beach 86th, Beach 83rd and Beach 60th Streets completed the final phase of groin building on the Rockaway Peninsula in the vicinity of the Arverne URA. A similar history of groin building and beach filling took place along the shoreline west of the Arverne URA, where, between 1920 and 1961, a total of

111 groins were built and approximately 5,500,000 cubic yards of sand were placed on the beach.

The present shore protection project for the Rockaway Peninsula was designed by the USACOE. It was authorized as a multi-purpose hurricane protection and erosion control project by the Flood Control Act of 1965 (Public Law 89-298), in accordance with the recommendations of the Chief of Engineers in House Document No. 215, 89th Congress. This authority was later modified by the Water Resources Development Act of 1974 (Public Law 93-251) to provide for the separate construction of the beach erosion control portion of the project, independently of the hurricane protection portion.

The major provisions of the 1965 federally authorized shore protection project include the following:

a. A hurricane barrier 4,500 feet long across the entrance to Jamaica Bay, having a 600-foot navigation opening and two 150-foot gates that would partially close the opening to 300 feet;

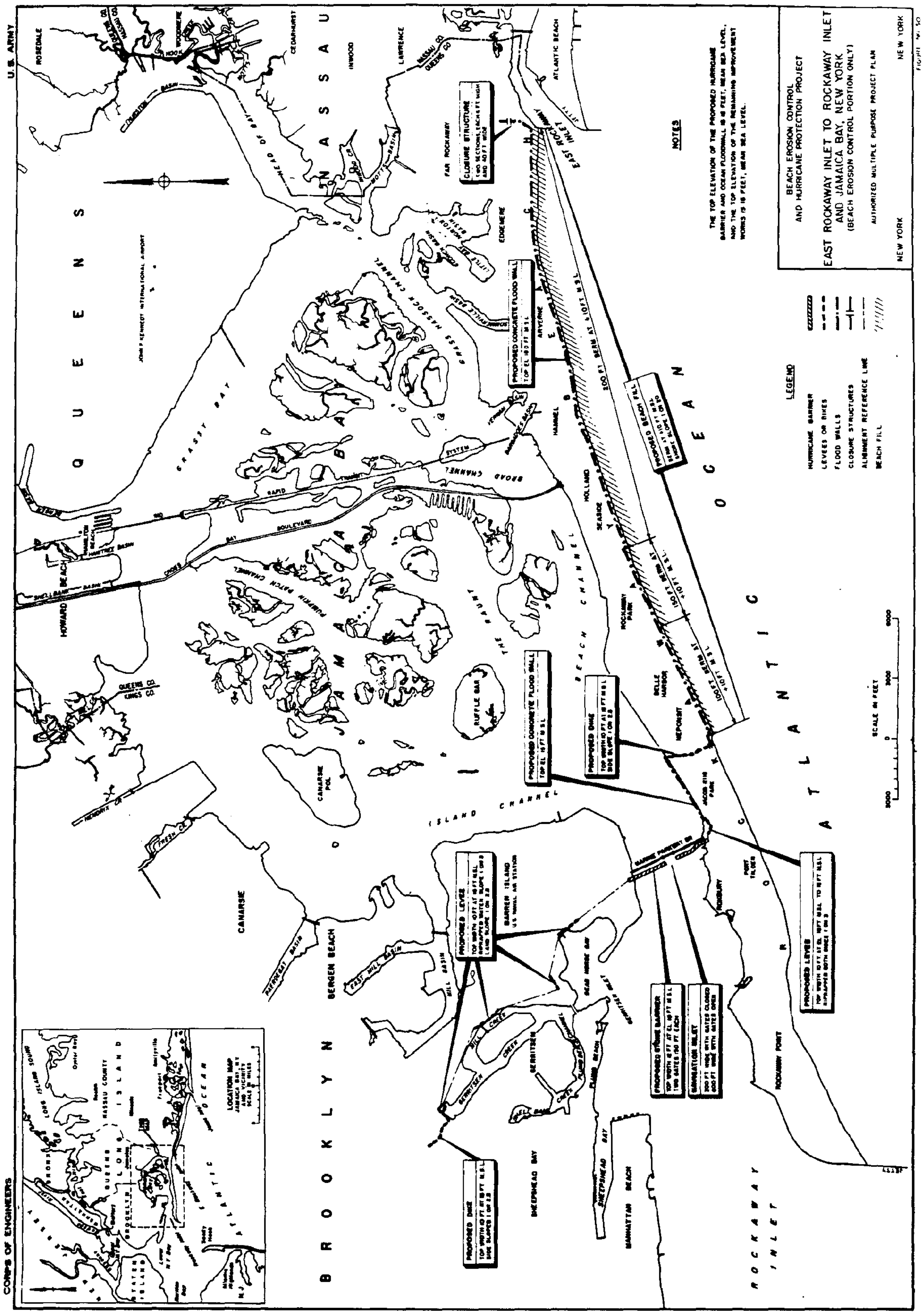
b. Dikes and levees 1.2 miles long to high ground north from the barrier and dikes, levees and seawalls 7.7 miles long at the eastern end of the Rockaway Peninsula;

c. Fill placement along the six-mile oceanfront having a berm 100 to 200 feet wide at 10.0 feet above NGVD; and

d. Federal participation at a 50-percent share in the cost of periodic beach nourishment of the erosion control portion of the project for ten years after completion of the initial beach fill.

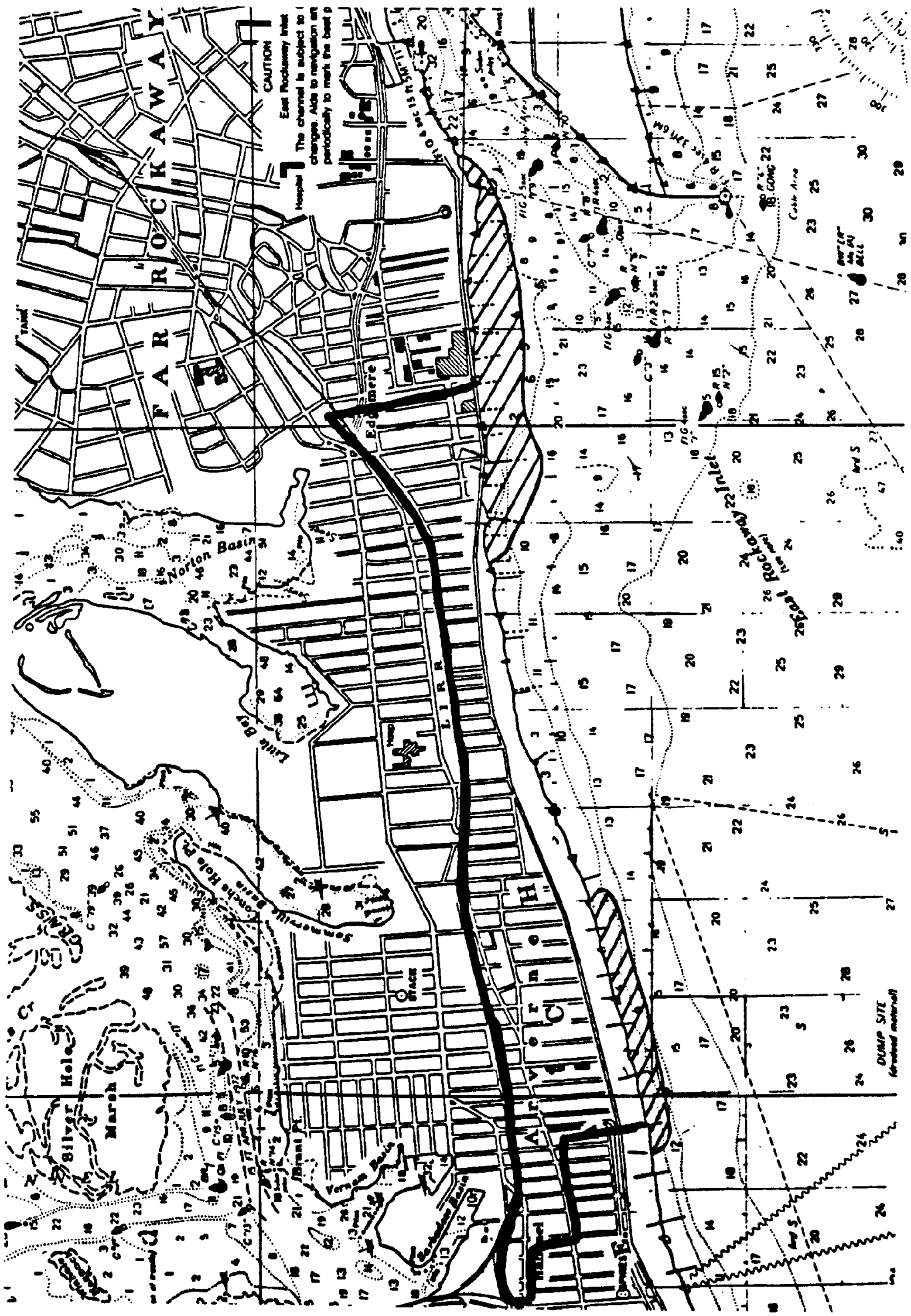
Figure A-22 indicates the major aspects of the proposed beach erosion and hurricane protection project in the Arverne URA. Figure A-23 shows in more detail the beach erosion control (beach fill) portion of the project. The latest approved project plan, dated July, 1973, and including both the hurricane protection and beach erosion portions, was estimated to cost between $115,200,000 and $116,599,000, depending on the location of the borrow area for beach fill material. At the time of its design, the complete shore protection project was found to be economically justified by the USACOE. However, environmental impacts in Jamaica Bay from construction of the barrier across Rockaway Inlet were considered to be unacceptable. A physical model of Jamaica Bay was constructed by the USACOE Waterways

Figure A-22



Major components of the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Beach Erosion and Hurricane Protection Project (from the U.S. Army Corps of Engineers, 1974).

Figure A-23



Location of hydraulic fill projects in the Arverne Area of the Rockaway Peninsula.
The design profile of the fill is shown in Fig. A-18 (from the U.S. Army Corps of Engineers, 1974).

Experiment Station and a numerical model was constructed by the Rand Corporation (unpublished report) to investigate the impact of the hurricane flood protection project on Jamaica Bay. These studies were completed and indicated no significant environmental impact in the Bay, but because of the lack of support, the hurricane protection plan was dropped.

Modified provisions of the Water Resources Development Act of 1974 called for separation of the hurricane protection plan from the beach erosion plan and for immediate completion of the erosion control project only, due to the critical nature of the severely eroded shorefront along 6.2 miles of public beach.

The beach erosion control project was first installed along Rockaway Peninsula between 1975 and 1977 and has continued with periodic nourishment of the beach in two areas since that time (a western area between Beach 86th and Beach 110th Streets and an eastern area between Beach 25th and Beach 39th Streets). Initial cost of the project was estimated at $19,802,000; however, actual cost of the initial fill was $15,940,000. The first fill project utilized three borrow areas. The westerly borrow area (No. 1) is situated approximately 8,000 feet southwest of Rockaway Point. Borrow area No. 2, which is much closer to the fill area, is situated about 6,000 feet south of Rockaway Park. Borrow area No. 3, which is about 4,000 feet offshore of Far Rockaway, is at the eastern end of the USACOE project area. In the selected borrow areas, the material is, on the average, slightly finer and more poorly sorted than the natural beach sand, but is reasonably well situated for beach fill.

The specific design of the protective beach was based on the need to protect the existing shorefront against wave attack and wave runup occurring during coastal storms of moderate energy. The beach berm elevation of 10.0 feet above NGVD (Figure A-18) was designed to provide protection against storms having a ten-year frequency of occurrence or a surge of 6.5 feet above mean sea level. A berm width of 100 to 200 feet at elevation 10.0 feet was considered to provide adequate protection against wave attack during severe storms. The seaward slope of the fill was designed at one on 30 (1.9°), to be adjusted by littoral forces after fill placement.

In order to stabilize the restored beach, the USACOE selected periodic beach nourishment. They determined that the large volumetric losses that occurred along the Rockaway Peninsula between 1961 and 1973 represented accelerated rates due to increased frequency of storms and would not be typical for determining long-term nourishment needs for the project. Accordingly, a nourishment rate of 345,000 cubic yards per year was used in the project design. As previously stated, the Federal Government would assume 50 percent of nourishment costs for a ten-year period at an estimated cost of $544,000 annually (1974 dollars). The New York District Corps of Engineers also considered constructing additional groins to stabilize the restored beach but concluded that the benefits of adding the groins would not outweigh the additional costs.

Since completion of the original beach fill project in 1974-76, five additional nourishment projects have been completed at approximately two-year intervals. Two areas have been filled under this nourishment project along the Rockaway Peninsula. A western area between Beach 86th and Beach 110th Streets and an eastern area between Beach 25th and Beach 39th Streets each received between 500,000 and 680,000 cubic yards of material during each nourishment project. As noted in Section 1.2, the eastern area between Beach 25th and Beach 39th Streets is subject to set easterly longshore transport of sand towards East Rockaway Inlet, which eliminates its role as a feeder beach for reach areas to the west, as originally planned by the Corps (1964, 1974).

In August 1986 both the western and eastern nourishment areas were filled using sand from borrow area No. 2 offshore of Rockaway Beach. The amount of fill placed during the 1986 fill project was 1.2 million cubic yards at a total cost of $7,800,000 ($6.50 per cubic yard). In the western area 680,000 cubic yards of sand were placed on the beach. In the eastern fill area, which is in the Arverne URA, approximately 520,000 cubic yards of sand were placed.

The last scheduled beach nourishment action took place in 1988. This completed the ten-year commitment that was appropriated for the project. Although the USACOE has authorization to provide 50 years of beach nourishment to the area (see below), continued nourishment is pending further study of the area and appropriation of funds. Authorization for the beach nourishment project is provided through the Water Resources Development Act of 1976 (42 U.S.C. 1962d-5f). The beach nourishment provision of this Act, as ammended in 1976, reads:

"The Secretary of the Army, acting through the Chief of Engineers, is authorized to provide periodic beach nourishment in the case of each water resources development project where such nourishment has been authorized for a limited period for such additional period as determined necessary but in no event shall such additional period extend beyond the fiftieth year which begins after the date of initiation of construction of such project."

3.3 Projected Shoreline Changes

This section provides an analysis of shoreline changes over a 30-year period under a no-action alternative where no beach nourishment or protection is provided. If an estimate of the rate of shoreline recession can be established, then the benefits of reducing or eliminating erosion control projects in the Arverne URA can be compared with the cost of maintaining the shore.

Prediction of shoreline changes in the future can be based on historical trends of shoreline retreat and the assumption that factors such as the rate of sea-level rise and sediment supply will remain more or less unchanged for 50 years or more into the future. In the case of the Rockaway Peninsula, records show that the rate of shoreline erosion can be relatively high for a few years after artificial maintenance of the shoreline is stopped. Thus a higher erosion rate has been assumed in the first ten years of the evaluation period. It is also assumed that fill shall have been completed up to the start of the no-action evaluation period. Subsequently, the rate of shoreline recession may slow to a more natural rate related to sediment supply, rate of sea-level rise and storm frequency.

If shoreline retreat is predicted at intervals of 5, 10, 20 and 30 years, it can be assumed that the rate of retreat will be relatively high over the first ten years while the beach and shoreface return to natural equilibrium by undergoing erosion. When averaged over the longer term (20 to 30 years), the shoreline can be considered to be in a state of natural retreat rather than erosion. Under this condition, the beach maintains an average volume while shifting landward. Records compiled by the U.S. Army Corps of Engineers (1964, 1974) indicate that in the short term, retreat of the high water line may be as much as 20 feet per year on the average. If this rate were assumed to hold over a ten-year period, then a total retreat of 200 feet could be expected.

Once the shoreline comes into equilibrium with natural conditions, rates of shoreline recession can be expected to be largely in response to sea-level rise and in the range of five to ten feet per year, according to historical records compiled by the USACOE (1964). If the upper limit of this range were selected (ten feet per year), then the shoreline retreat between ten and 30 years would be on the order of 200 feet for a total of 400 feet over a 30-year period. Using the above assumptions, the predicted 5, 10, 20 and 30-year high-water shorelines are plotted for the Arverne URA in Figure A-24. However, these predictions should only be used as a general guideline. On a year to year basis the rates of shoreline retreat (or accretion) can vary greatly depending on the frequency of storms. In addition, factors such as sediment source and the rate of sea-level rise are subject to man-made influence and natural changes that are generally unpredictable. The rate of sand bypassing at East Rockaway Inlet and increased rates of sea-level rise from the so-called Greenhouse Effect predicted by the USEPA (1983) may further contribute to shoreline retreat even over relatively short periods of time.

3.4 Sea-Level Rise

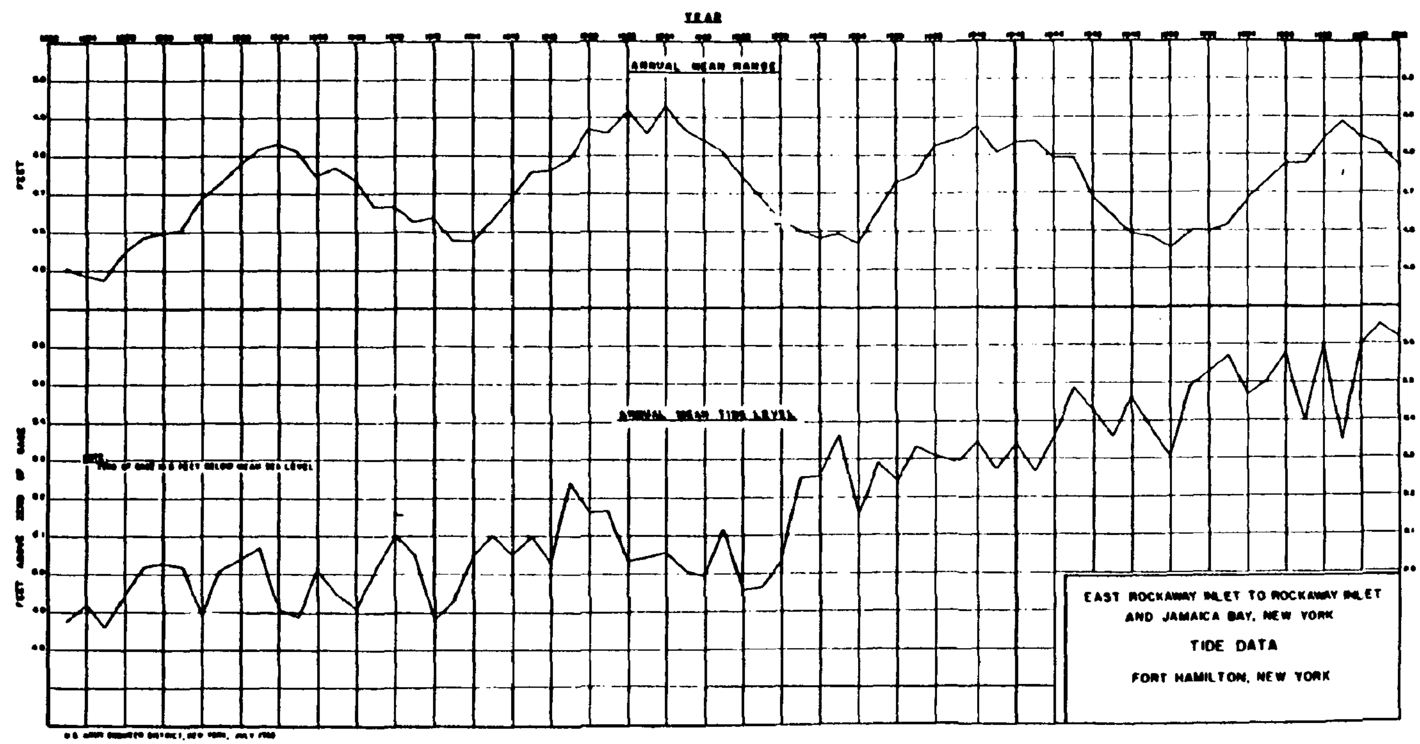
In the short term, rates of shore erosion vary due to factors such as storm intensity and frequency and man-made changes. In the longer term, over periods of 50 years or more, shoreline recession is driven by the relative rate of sea-level rise. On this time scale, the beach can be viewed as retreating in a series of episodic "erosional" jumps due to storms, but the resulting long-term recession rate of the shoreline, which is lower than short-term erosional rates, is controlled by sea level. Based on long-term tide gage records at Fort Hamilton, Brooklyn, the relative rate of sea-level rise in the New York area is on the order of .01 feet per year (Figure A-25). This trend agrees well with trends shown in other nearby tide records from Sandy Hook, New Jersey, and Willets Point, on the north shore of Long Island (Hicks, 1974).

From analysis of sea-level trends over the past 100 years using tidal data such as that collected at Fort Hamilton, it has been suggested that relative sea levels at many locations may now be rising as fast as at any time during the last several thousand years (Gornitz, et al., 1981). However, there is additional concern that the rate of sea-level rise may increase due to the increasing level of carbon dioxide in the earth's atmosphere. This results in a phenomenon known as the Greenhouse Effect. If recent trends in fossil fuel burning continue, it is believed that atmospheric carbon dioxide may double by the middle of the next century. This, along with an increase in

Figure A-24

Predicted high water shorelines for the Arverne Renewal Area for 5,10,20 and 30 years into the future. Scale of the Photograph is approximately 1:13,500.

Figure A-25



Annual mean tide level and annual mean tidal range computed from tide-gage records at Fort Hamilton, Brooklyn, N.Y. Annual tide levels indicate a sea level rise of 0.7 feet between 1893 and 1962. Note the 18.6 year cycle in tidal range that results from interaction of the earth's orbit with the moon's orbit (from the U.S. Army Corps of Engineers, 1964).

other "greenhouse gases" such as nitrous oxide, methane and chlorofluorocarbons, could result in an increase in the earth's average surface temperature of 1.5 to 4.5°C (2.7 to 8.1°F) (National Academy of Sciences, 1982).

Climatic change of this sort can influence sea level by two mechanisms: the thermal expansion of oceanic waters and the melting of glaciers. At our present level of knowledge, the specific magnitude of climatic change over the next century and the effects on sea level are difficult to predict accurately.

The range of global warming can be affected by positive feedback mechanisms such as the increase in atmospheric water vapor. This would add to the global warming trend. On the other hand, negative feedback mechanisms such as increased cloud cover would limit the Greenhouse Effect by reflecting solar radiation. Even if climatic changes could be accurately predicted, the responding thermal expansion of the ocean cannot be predicted with certainty since existing models of heat dispersion through the ocean are incomplete. Studies of global climatic change and world ocean circulation sponsored by the U.S. National Science Foundation will eventually provide better methods of predicting sea-level rise, but quantitative predictions of sea-level rise from these experiments are still years away. Despite these drawbacks, the USEPA has suggested a range of scenarios for sea-level rise over the next 20 to 100 years. Under their baseline scenario, sea level will rise by 0.15 feet, or at about the present rate, between 1980 and 2000. The low USEPA scenario suggests a sea-level rise of 0.3 feet (about twice the present rate) between 1980 and 2000. The high USEPA scenario suggests a 0.75-foot rise in sea level (about five times the present rate) between 1980 and 2000. These scenarios should be treated only as possibilities, the probabilities of which are unknown at this point. However, consideration of the USEPA scenarios provides maximum and minimum estimates for erosion hazards in the Arverne area.

Assuming equilibrium conditions under which there is an adequate supply of sand to the beach and shoreface, the long-term rate of shoreline retreat would be between one and three feet per year. This assumes that the overall shoreface slope (1:100 to 1:300) remains constant as sea level rises and is translated landward and upward along a constant trajectory. Long-term shoreline recession under these conditions has been occurring in some areas along the eastern end of Long Island (Leatherman, 1985; Smith and Zarillo, 1987). Short-term erosion rates, and in some cases accretion rates, are at least an order of magnitude higher along the Rockaway Peninsula than the predicted long-term recession rate. In addition, there is substantial evidence that the actual long-term recession rate for the Arverne URA is higher than the rate predicted according to sea-level rise. Therefore, other factors in addition to sea-level rise and storm activities are involved in determining the stability of shorelines. Chief among these is the occurrence of tidal inlets. The influence of East Rockaway Inlet on wave refraction patterns and sediment budget in the Arverne URA has already been reviewed. Additional effects of tidal inlets on shoreline stability are reviewed under Shoreline and Bathymetric Changes (Section 3.1).

Thus, if the sea-level rise scenarios suggested by the USEPA were applied to the New York area, the rate of sea-level rise and the position of sea level would be quite different than if the 0.01 foot per year rate were assumed to continue. Under the USEPA's low, medium (average of low and high) and high scenarios, sea level in the New York area will increase between 0.9 and 2.1 feet in the 45 years between 1980 and 2025. For the low scenario this represents an increase in the average rate of sea-level rise to 0.02 feet per year or about double the rate over the past century. For the high scenario, the rate of sea-level rise is predicted to increase to about 0.05 feet per year or about five times the baseline rate. Further increase in the rate of sea-level rise may occur over the next century so that sea level may rise as much as 7.6 feet by the year 2075.

The proposed USEPA accelerated rates of sea-level rise are only speculative. Therefore, the consequences of accelerated rates of sea-level rise for the Arverne URA and the Rockaway Peninsula cannot be quantitatively predicted with certainty. However, if a linear relationship were assumed between increases in the rate of sea-level rise and the rate of shoreline recession, the shoreline of the Arverne URA would retreat by 2000 feet over the next 30 years if USEPA's high scenario is assumed. This is similar to recession rates now being experienced by barrier islands along some areas of the Louisiana coast that have rates of relative sea-level rise of up to 0.1 feet per year due to submergence (Pendland and Boyd, 1981). Louisiana shorelines are retreating between 17 and 65 feet per year, which yield 500 to 2000 feet of retreat over a 30-year period. Maximum relative rates of sea-level rise in Louisiana (0.1 feet per year) are similar to the maximum rates that would be experienced in the New York area under USEPA's high scenario.

setback distance of 400 feet. Neither the NYSDEC Erosion Hazard Line nor the No-Action 30-year shoreline recession analysis take into account the likely potential for additional recession due to sea-level rise caused by the Greenhouse Effect. When this factor is considered, as a high scenario case, retreat could be as much as 2000 feet over the next 30 years. Thus, the use of the NYSDEC Erosion Hazard Line as a setback is suggested only if it is accompanied by a beach nourishment program comparable to the recent Corps program in this area. Without this level of shore protection, erosion would be severe and substantial portions of the proposed Arverne URA development could be damaged.

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4. NATURAL RESOURCES

4.1 Subsurface Investigations

A subsurface investigation program was developed to determine the general soil profiles of the Arverne URA and to determine soil permeabilities. A total of seven 2-1/2 inch diameter borings were made during November, 1986. Falling head permeability tests were performed at five-foot increments at three of the borings (see Figure A-26: Boring Location).

According to the soil borings (see the Test Boring Logs in Appendix A), the uppermost soil stratum is a brown to tan, loose to medium dense, medium fine to fine sand, with a trace of silt. Underlaying the top layer, down to at least 42 feet, is a grey, medium dense to dense, medium to fine sand, with a trace of silt and fine gravel. A lens (isolated pocket) of black organic silty clay at a 25-foot depth (thickness of three to four feet) was found at one boring (B-2), and a few thin layers of clayey silt (1/8 to 1/2 inches thick) were found at two other borings.

The permeability of the soil was in the 10^{-2} to 10^{-4} cm/sec range (good permeability), as would be expected for barrier island sand. Negligible permeability was found for the silty clay encountered in boring B-2. Based on the subsurface investigation, the water table generally lies three to five feet below the ground surface.

Generally, from the limited boring data available, the bearing capacity is estimated to range from 1.5 to 2.5 tons per square foot. This range can be characterized as moderate capacity, which would be considered fair

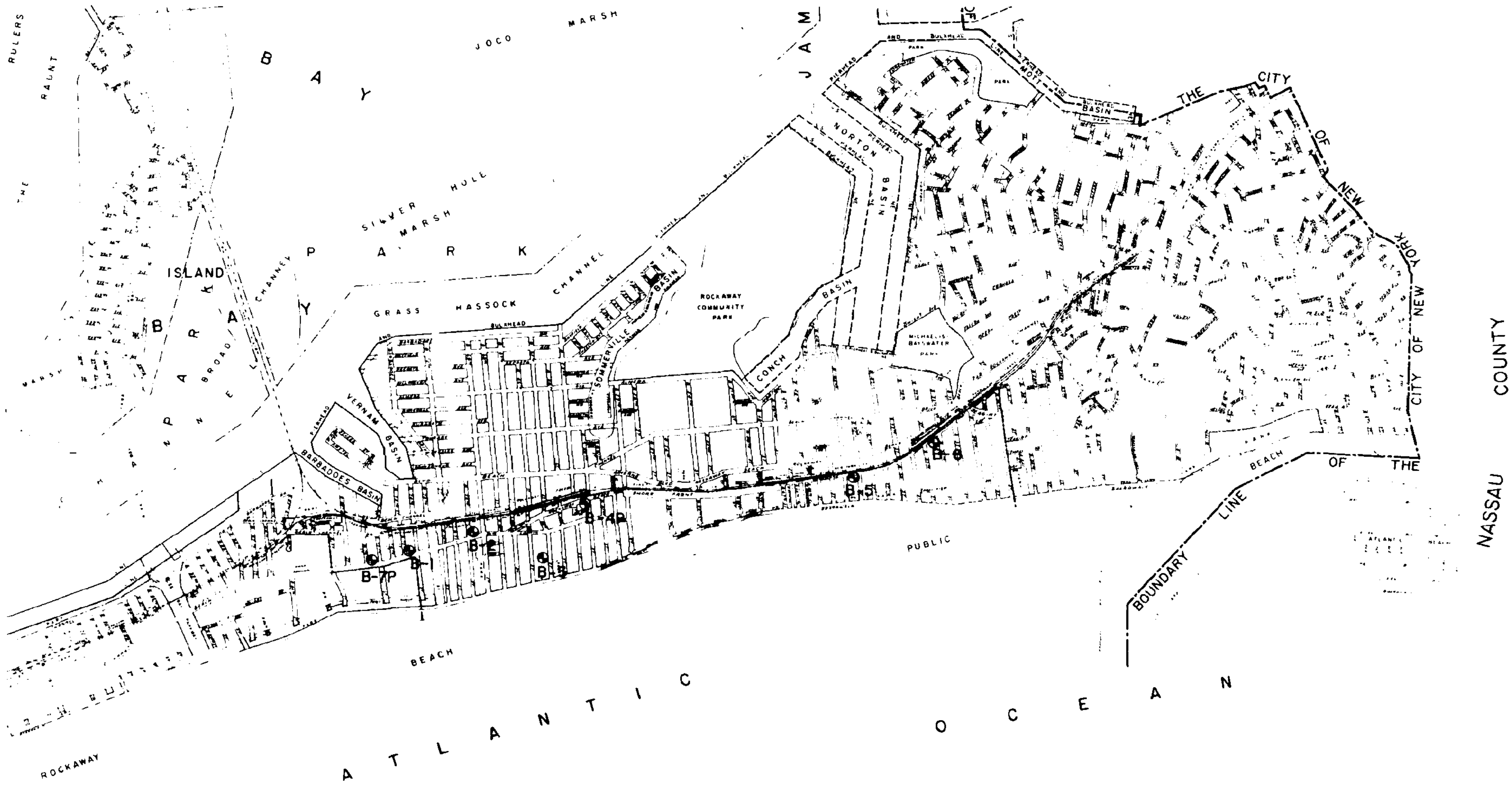

Figure A–26

ARVERNE URBAN RENEWAL AREA
Queens, New York

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Boring Location

Boring
Boring with Falling Head Permeability Tests

0 800 1600 2800 ft

to good. For example, residential buildings up to four stories could possibly be supported by shallow foundations. Residential buildings greater than four stories or heavier structures, such as a parking garage, could possibly require deeper foundations.

Any decision regarding foundations should consider the flooding vulnerability and building recommendations outlined in Section 1 and would require additional subsurface investigation.

4.2 Ecology

Vegetative communities are the dominant component of the ecology in the Arverne URA and reflect the influence of topography, drainage, soil type and, to some extent, episodic storms which impact the area. In addition, vegetative cover reflects man-made factors such as construction, pedestrian and vehicular traffic and shore protection projects that have been completed in the Arverne URA. Vegetative communities near the shoreline also provide habitats and nesting areas for certain species of birds and animals.

In order to determine vegetative communities, ten transects were sampled between Beach 32nd and Beach 74th Streets. Each transect was spaced approximately 300 meters apart except for those areas where buildings or pavement have precluded all vegetative cover. Samples were taken over a two-square meter section every 30 to 60 meters along each transect. Percent coverage of dominant species was determined. Results of the survey show that flora living in the Arverne URA reflect the recent urban development rather than the longer-term natural history of less developed shoreline areas. Vegetation is composed of a mixture of dune communities and terrestial herbaceous communities composed of natural and introduced species.

The dune community begins approximately 30 feet north of the boardwalk along most of the Arverne URA. The seaward boundary of this community depends on the mobility of the sediment in the berm area of the beach and the incipient dune area. The dune building area begins just a few feet seaward of the boardwalk and extends landward to the margin of vegetation. This zone is somewhat wider at present due to the source of sand provided by the beach fill project (August, 1986). Dune-building activity tends to encroach on existing vegetative cover until dunes become stable and acquire vegetation.

At present, the dune community is approximately 90 to 120 feet wide and covers areas that are nearly flat, as well as low dune-like forms that are apparently the remains of earlier episodes of minor dune building. The width of this zone probably varies with time depending on beach fill projects that provide a source of fine sand for periods of dune building. The dominant species of the dune community is Ammophila breviliquata (Beach grass) and Solidago sempervirons (Seaside Goldenrod). These species represent short-grass continental dune species that are typical of the northern part of the Atlantic barrier island coast. Dune communities must be able to withstand high intensities of salt spray deposition and respond to periodic burial by sand. Occasional annuals such as Cakile endentula (Sea rocket) and Xanthium echinatum (Beach clotbur) grow among the Ammophila and Solidago. These plants complete their entire life cycle between major storms and avoid salt spray deposition by either maintaining low-growth forms or by growing under the protective canopy of more salt-spray tolerant species. Other than these few species, the incipient dune area is largely unvegetated. This area, parallel to the boardwalk and dominated by beach grass and the occasional annual plants, is not undergoing competition with shrubs or trees that would be found in coastal dune communities outside urban areas. The more common shrubs such as Prunus Maritima (Beach plum) and trees such as Pinus rigida (Pitch pine) associated with well-developed dune systems are not present in the Arverne URA. Since no real succession occurs in dune communities, no significant change in the dominant dune community species can be expected with time.

North of the incipient dune area and dune communities lie the open blocks of herbaceous vegetation where structures once stood until the late 1960s. The blocks of vegetation are interrupted by the paved streets that served the previous development. Within the blocks, remnants of old foundations and indiscriminate dumps occur, which influence the present vegetative cover. Land not covered by old foundations is veneered with a thin cover of organic matter, presumably the result of vegetative decay. Underlying the thin layer of organic matter is a mixture of coarse to fine sand, part of which may be fill placed to support the foundations of previous development. Drainage patterns vary depending upon whether foundations or relatively well-drained sand occur in a particular area. Patterns of specific vegetative cover vary according to drainage pattern. The present terrestial herbaceous community is a mixture of cool seasonal grasses, a few shrubs or trees and annual plants. The most frequently encountered grass is Andropogon gerardi (Beard grass), fescues and Phragmites communis (Reed grass). Annuals and shrubs are a mixture of introduced ornamental shrubs such as Ligustrum sp. (Privet) and Elaeagnus (Russian olive) and naturally occurring species such as Myrica pennsylvanica (Bayberry). A list of dominant plant species for both the dune and terrestrial communities is given in Table A-6.

A small faunal community is supported by the terrestrial herbaceous plant community. Fauna living or utilizing this area feed predominantly on seeds, molluscs, crustaceans, small fish, insects or garbage. The most exotic species observed in the area is the Ring-necked pheasant (Phasianus colchicus), which is an introduced ground-feeding game bird sustained largely by grass seeds. The Arverne URA is large enough to support only two to four of these birds at most. Another species commonly observed in the area is the Morning dove (Zenaidura macroura), which is a native bird feeding on seed. The Herring Gull (Larus argentatus) was the most common bird observed in the area. This species feeds on molluscs, small fish, crustaceans and garbage. Two species of sparrows were also commonly observed, including the Chipping Sparrow (Spizella passerina) and Field Sparrow (Spizella pusilla). These species feed on weed seeds, insects and grain seeds.

No threatened or endangered species were observed, and, based on a review of literature sources for Jamaica Bay, no such species that might be found in the general area would be expected to be found in the Arverne URA because of the urban nature of the Site.

The New York State Tidal Wetlands Maps were reviewed, and the only area classified as wetlands in the Arverne URA is the littoral zone seaward from the mean high water line. A physical reconnaissance of the Arverne URA supports the finding that no tidal wetlands occurred on the Site landward of the mean high water line.

Table A-6

DOMINANT PLANT SPECIES IN THE ARVERNE URA

Ambrosia artemisiifolia
Ammophila breviliqulata
Anaphalis margaritacea
Andropogon gerardi
Apocynum cannabinum

Baccharis halimifolia

Cakile edentula
Cenchrus tribuloides
Clematis virginiana
Cuscata gronovii

Daucus carota

Elaeagnus
Eleusine indica
Eragostis spectailis

Festuca elatior
Festuca ovina

Ligustrum sp.
Lonicera sempervirens

Malus sp.
Mulberry
Myrica pennsylvanica

Oenothera biennis

Prunas sertina
Prunus maritima
Phragmities communis

Setaria glauca
Solanum
Solidago odora
Solidago sempervirens
Spartina patens

Trifolium repens

Verbascum thapsus

Xanthium echinatum

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B. STATE AND FEDERAL PROGRAMS

1. INTRODUCTION

This section examines the state and federal programs for coastal zone and floodplain management which may affect development in the Arverne URA. The three major regulatory programs with respect to development in the Arverne URA are: the New York Coastal Erosion Hazard Areas Act, the State Coastal Management Program and the Federal Emergency Management Agency's (FEMA) floodplain management regulations.

Coastal management and floodplain management is also effectuated through City programs. Specifically, all coastal activities in the City of New York are under the scope of the New York City Planning Commission acting as the City Coastal Commission, which is responsible for the implementation of the New York City Waterfront Revitalization Program (WRP). FEMA regulations in New York City have been incorporated into and are enforced through Local Law 33 of 1988 (formerly Local Law 58 of 1983), administered by the New York City Building Department. Both the City's coastal management program and floodplain management program are discussed in this section along with their respective state and federal programs.

Most of the state controls which affect the coastal area are codified in the New York State Environmental Conservation, Transportation, Navigation, Public Service, and Energy Laws and both the Waterfront Revitalization and Coastal Resources and the Coastal Erosion Hazard Areas Acts.

The Waterfront Revitalization and Coastal Resources Act is the enabling legislation through which New York implements its Coastal Management Plan prepared pursuant to the Federal Coastal Zone Management Act of 1982. Any development within the coastal zone boundary must be consistent with these state policies as well as with the City's coastal policies. The policies relevant to the Arverne URA are discussed further on in this chapter. Of particular importance with regard to this project are those policies which address flood and erosion control and protection structures, development, public access and recreation.

The New York Coastal Erosion Hazards Area Act (ECL Article 34) was established to protect sections of the New York coastline which are prone to erosion from the action of the adjacent water bodies. It has a number of associated regulations which contain standards to control certain activities and development that could hasten coastal erosion or displacement of land along the coast. Proposed development plans must be compatible with the regulations and associated Coastal Erosion Hazard Area maps. Regulations were drafted in 1983 and amended March 1988 and are subject to public review. In the primary impact area the boundary of the Coastal Erosion Hazard Area (CEHA), as delineated in the final CEHA maps issued in December 1988, parallels the Arverne boardwalk and includes some area north of the boardwalk. It is our recommendation that all development should be located landward (north) of this final Coastal Erosion Hazard Area boundary as shown in Figure B-1. This recommendation is a product of the Vulnerability Analysis, specifically the analysis provided in Projected Shoreline Changes, presented in Chapter A.

The requirements of the National Flood Insurance Program (NFIP), as iterated in New York City Local Law 33, also pose specific requirements and constraints to development in the coastal area. Under floodplain management policies, construction in higher risk areas, while not precluded, is restricted. The analysis indicates that development in the Arverne URA proceed in a manner consistent with the minimum construction standards required by NFIP and Local Law 33. The FEMA A-Zone minimum standards require that: all new and substantial improvements to residential buildings have the lowest floor (including the basement) elevated to or above the base flood elevation (BFE); and all new or substantial improvements to non-residential buildings must have the lowest floor (including the basement) elevated or floodproofed to or above the BFE.

Another major consideration in the development of Arverne is the USACOE's past and present involvement in the area, particularly their beach stabilization programs. Over the past 65 years, 240 groins have been built along the Rockaway Peninsula. The USACOE was responsible for building two stabilizing jetties, at the Rockaway Inlet and East Rockaway Inlet, as significant barriers to longshore transport. Between 1926 and 1962 the USACOE's beach fill program placed

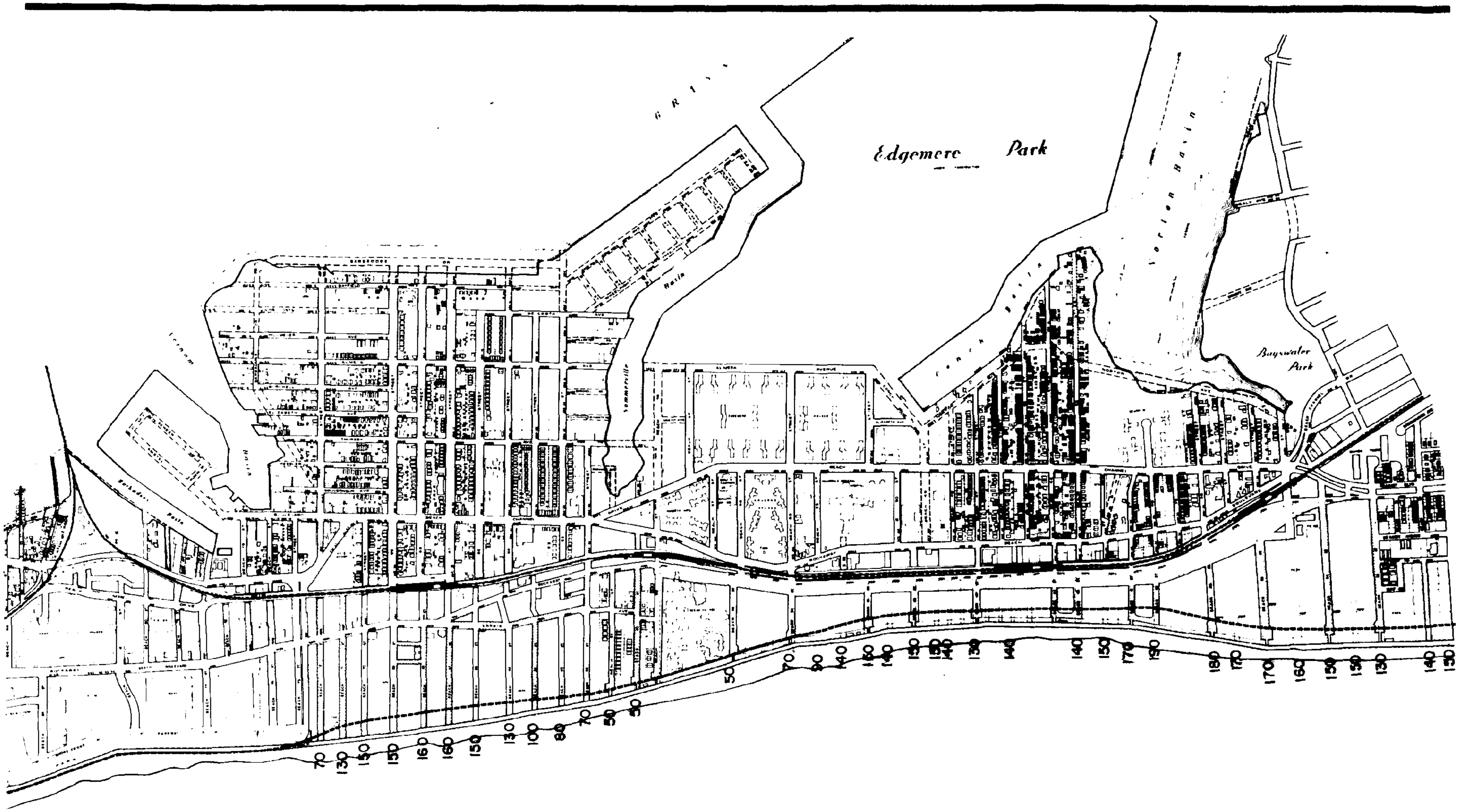


Figure B-1

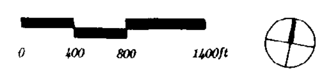
ARVERNE URBAN RENEWAL AREA
Queens, New York

Department of City Planning

Dresdner, Robin & Associates, Inc.
Gruzen Samton Steinglass Architects, Planners
Edwards and Kelcey Engineers, Inc.
Abeles Phillips Preiss & Shapiro, Inc.

Coastal Erosion Hazard Area

Note: Dimensions are given in feet north of the Boardwalk, on the centerline of the street. They are estimated from the preliminary map (aerial photo) provided by the NYSDEC Coastal Erosion Management Program, Albany, N.Y.



over 12,000,000 cubic yards of sand along the Rockaway Peninsula beaches. The USACOE's most recent project also entailed beach fill. The design of the project was based on the need to protect the existing shorefront against wave attack and wave runup during coastal storms of moderate energy. Two areas have been filled under this nourishment project along the Rockaway Peninsula. A western area between Beach 86th and Beach 110th Streets and an eastern area between Beach 25th and Beach 39th Streets have each received between 500,000 and 680,000 cubic yards of material during the biannual nourishment project. Both the USACOE past and present programs are discussed more thoroughly in Chapter A, Vulnerability Analysis.

The last scheduled beach nourishment action took place in 1988. Although the USACOE may continue a beach nourishment program for a period of up to 50 years through the Water Resources Development Act of 1976 (42 U.S.C. 1962d-5f), continued nourishment is pending further study of the area and appropriation of funds.

In addition to the USACOE beach stabilization projects, the City and State were also responsible for the erection of protective structures (mostly groins) along the Rockaway Peninsula's Atlantic coastline. The City's projects occurred in the earlier part of the century, during the 1920s and 1930s, while the State's projects are more contemporary, having been completed in the 1950s and 1960s.

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2. FEDERAL, STATE AND CITY COASTAL ZONE POLICIES

2.1 Coastal Zone Management Act

In 1972, Congress passed the Coastal Zone Management Act (16 U.S.C. 145 et seq.) to conserve, develop and protect the nation's coastal resources. The term "coastal resource" as used in this Act refers to any coastal wetland, beach, dune, barrier island, reef, estuary, or fish and wildlife habitat, if any such area is determined by a coastal state to be of substantial biological or natural storm protective value. The Act states that the "key to more effective protection and use of the land and water resources of the coastal zone is to encourage the states to exercise their full authority over the lands and waters in the coastal zone by assisting the states . . . in developing land and water use programs . . . including unified policies, criteria, standards, methods, and processes for dealing with land and water use decisions . . . . " The Act provides for coastal states to receive grant monies for the purposes of establishing and implementing a State Coastal Management Program.

In response, New York State formulated a Coastal Management Program to manage coastal resources and coordinate state agencies involved in making decisions concerning coastal resources. The focal point of the State's Coastal Management Program are 44 state coastal policies which relate to the revitalization, preservation and enhancement of the State's diverse shoreline.

The policies are based on coastal issues identified by the public, local governments and the New York State Department of State as crucial to meeting the goals of the program. The issues include promoting waterfront revitalization; promoting water-dependent uses; protecting fish and wildlife habitats; protecting and enhancing scenic areas; protecting and enhancing historic areas; protecting farmlands; protecting and enhancing small harbors; enhancing and protecting public access; providing solid and useful data and information on coastal resources and activities to decision makers; and coping with erosion and flooding hazards. These were examined in relation to the coast's assets, problems and needs.

Compliance with these coastal policies is not only a state issue but also a local issue. The New York State program encourages local municipalities to participate by developing local coastal programs. New York City's Waterfront Revitalization Program (WRP), passed by the Board of Estimate in 1982, supports the state program. The WRP identifies the critical problems of the New York City waterfront and proposes solutions to balance the use, conservation and preservation of the waterfront area. The City's program includes the State's 44 coastal policies, plus 12 additional city policies which focus the state program on city issues. The WRP advises that those policies that refer to erosion and flood control are particularly important for the Rockaway Peninsula. The WRP designates the Rockaway Peninsula as an Erosion/Flood Hazard Special Management Area. Enforcement of these policies is by the Department of City Planning, Waterfront Division.

Potential plans to develop Arverne must address the 44 coastal-related policies in the State Coastal Management Plan as well as the 12 additional city policies. However, not all of the 56 policies are applicable to the Arverne development, so that those policies which were deemed to be specifically applicable are examined in the following discussion. The specific policy issues as they affect and are affected by the potential development of the Arverne primary study area are discussed below. The policy is set forth in the first paragraph of each item.

Use of the discussion points following each policy will provide a framework for development in the Arverene URA that is consistent with state and city requirements while recognizing existing conditions and constraints.

2.2 State Coastal Zone Management Plan Policies

Policy 1: Restore, revitalize, and redevelop deteriorated and underutilized waterfront areas for commercial, industrial, cultural, recreational and other compatible uses.

A century ago Rockaway was a fashionable resort, its shoreline dotted with mansions and hotels. The area prospered through the 1930s, the fine beach remaining its chief attraction. After World War II, several factors brought about a decline in the resort area. The emergence of air travel and the proliferation of automobiles permitted access to more distant resorts. The summer bungalow in the Rockaways lost some of its prestige. This led to the renting of many bungalows to impoverished families. The bungalows, which were built as summer residences and lacked insulation, deteriorated rapidly, and many of them lacked heating and plumbing as well.

In 1965 Arverne was designated an Urban Renewal Area. The designation was followed by the adoption of an Urban Renewal Plan (1968) which required most properties in the project area to be acquired and cleared by the City. The area currently encompasses approximately 300 acres of mostly vacant land under the jurisdiction of the New York City Department of Housing Preservation and Development (HPD). Through a Development Feasibility Study completed in June 1987, it was determined that the area can be redeveloped in a manner that is compatible with adjacent areas and with public use of the beachfront, and recognizes the existence of storm and flood hazards.

Policy 2: Facilitate the siting of water dependent uses and facilities on or adjacent to coastal waters.

Pursuant to the coastal zone and floodplain management regulations, there will be no development in areas adjacent to coastal waters. All the area seaward of the boardwalk will remain in its natural state as a beach area available to the public-at-large for water-related recreational uses.

Policy 5: Encourage the location of development in areas where public services and facilities essential to such development are adequate.

Arverne has the advantage of being located in an urban community with access to mass transit, highways, and health, educational and social services. The scale of the development project will, however, necessitate upgrading both public services and infrastructure to accommodate the projected population of the Site.

Policy 6: Expedite existing permit procedures in order to facilitate the siting of development activities at suitable locations.

As specified in the WRP, New York City "for appropriate types of development activities in areas suitable for such development will coordinate to the maximum extent practicable and synchronize existing permit procedures and regulatory programs, as long as the integrity of the regulations are not jeopardized." This will be implemented through the City's Coastal Commission which, according to the WRP, will act by "reducing overlapping permitting requirements and coordinating all review by agencies involved in waterfront project review." The City will be responsible for coordinating project reviews.

Policy 8: Protect fish and wildlife resources in the coastal area from the introduction of hazardous wastes and other pollutants which bioaccumulate in the food chain or which cause significant sublethal or lethal effect on these resources.

Arverne will essentially be a residential development with no industrial or limited commercial activities. All sanitary sewage will be collected, treated and disposed of in accordance with state and federal regulations. As the focus of development is residential with supporting commercial uses, no significant amounts of hazardous wastes are expected to be generated.

Policy 11: Buildings and other structures will be sited in the coastal area so as to minimize damage to property and the endangering of human lives caused by flooding and erosion.

Development in Arverne will be located so as to be landward of the coastal erosion hazard area. By not developing within the state-designated coastal erosion hazard area, the developer will minimize the risk of erosion and flooding hazards. The Vulnerability Analysis indicates that the development should comply with FEMA A flood hazard regulations and New York City Local Law 33 of 1988 (see Figure A-22). As per this Analysis, the first floor of habitable space would be required to be at least ten feet NGVD. Flood control measures should be coordinated with area-wide drainage plans.

Policy 12: Activities or development in the coastal area will be undertaken so as to minimize their adverse effect upon natural resources and property from flooding and erosion.

The proposed Coastal Erosion Hazard Area as delineated by the NYSDEC for Arverne encompasses natural protective features identified as nearshore areas, beaches and primary dunes. The Coastal Erosion Management Regulations, detailed further on in this Chapter, protect these areas from any activities that could lead to or contribute to their degradation.

In addition, the selected developer for Arverne will be required to provide appropriate plantings and fencing within 50 feet of the boardwalk to re-establish the primary dune ecosystem.

Policy 13: The construction or reconstruction of erosion protection structures shall be undertaken only if they have a reasonable probability of controlling erosion for at least thirty years as demonstrated in design and construction standards and/or assured maintenance or replacement programs.

Chapter C of this report examines several methods of shore protection that have been and can be implemented to control erosion in the study area. Structural measures include modification of the existing groin system, offshore breakwaters and revetments and bulkheads. All proposed alternative techniques are assessed in terms of their comparative effectiveness, long-term effectiveness and expected or anticipated performance over time for this particular area of the coast; the 50-year life cycle costs for alternatives are also given.

NYSDEC's Coastal Erosion Hazard Regulations require a permit for the construction or reconstruction of erosion protection structures. The regulations also require that any coastal erosion protective measures have a reasonable probability of controlling erosion for at least thirty years. A commitment to Arverne will be needed by city, state and federal agencies to provide long-term support for the coastal protection program.

Policy 14: Activities and development, including the construction or reconstruction of erosion protection structures, shall be undertaken so that there will be no measurable increase in erosion or flooding at the site of such activities or development, or at other locations.

Chapter A, Vulnerability Analysis, has a detailed discussion on present and past conditions of the shoreline in the renewal area, including an analysis of the range of flood and erosion control measures that are most appropriate for the area. Any structural measures constructed to protect the Arverne shoreline will be designed to minimize adverse effects of the adjacent shoreline (see Chapter C). See also Policy 13.

Policy 15: Mining, excavation or dredging in coastal waters shall not significantly interfere with the natural coastal processes which supply beach materials to land adjacent to such waters and shall be undertaken in a manner which will not cause an increase in erosion of such land.

The only relevant actions that relate to this policy are those that involve shore protection. These would require federal, state and city review and approval.

Policy 16: Public funds shall be expended for activities and development, including the construction or reconstruction of erosion control structures, only where the public benefits clearly outweigh the long-term monetary and other costs such as the potential for increased erosion and adverse effects on natural protective features.

The capital expenditures and 50-year life cycle costs for the construction and maintenance of several alternative erosion control structures is given in Chapter C of this study. Although the financing scheme for implementing erosion control in the Arverne URA has yet to be determined, it will in all likelihood necessitate the expenditure of public funds.

The public benefits of protecting the Arverne URA and the Rockaway Peninsula are certainly much more difficult to quantitatively assess but they can be qualitatively discussed.

First, and perhaps most importantly, although the Arverne URA is now mostly vacant, the rest of the

Peninsula is heavily populated and contains many high-rise structures along the waterfront. Reduction of erosion hazards and adverse effects on natural protective features is a necessary expense to provide for the safety of the existing community. As indicated in Chapter A, Vulnerability Analysis, failure to provide shore protection could threaten existing development proximate to the waterfront.

In addition to being a place to live, this coastal barrier island is an important local and regional resource. The Arverne beaches along with the other Rockaway beaches are visited by 3.8 million people each season. Protection of this recreational resource is very important to New York City.

The Rockaway Peninsula also functions as a breakwater providing protection for the Jamaica Bay Wildlife Refuge and the southern shores of Brooklyn and Queens.

If nothing were done to protect the shore, it is clear from the vulnerability analysis provided in Chapter A that not only would development of the Arverne URA be an impossibility, but that also the future of the entire Peninsula would be jeopardized.

Policy 16 must be interpreted in a manner consistent with Policy 1, which encourages redevelopment of underutilized waterfront areas. Redevelopment of the Arverne URA provides enhanced support for measures to maintain the beach and justifies public investment in recreation and for residences in the area.

Policy 17: Non-structural measures to minimize damage to natural resources and property from flooding and erosion shall be used whenever possible.

Chapter C discusses structural and non-structural techniques to control erosion. Since 1976, the USACOE has maintained two periodic beach fill programs in the study area: Beach 25th Street to Beach 40th Street ("East Site"), which includes a small portion of the Arverne URA, and Beach 86th Street to Beach 110th Street ("West Site"), which abuts the Arverne URA. To date this program has been only mildly successful, and less so in the East Site than the West Site. However, the proposed action favors non-structural methods to control erosion to the extent practicable. As discussed in Chapter C, non-structural measures, such as adherence to the Coastal Erosion Hazard Area (CEHA) line and application of the minimum FEMA design standards are proposed to guide development in Arverne.

The last scheduled beach nourishment action took place in 1988. Although the USACOE may continue the beach nourishment program for a period of up to 50 years, continued nourishment is pending further study of the area and appropriation of funds. Authorization for the beach nourishment project is provided through the Water Resources Development Act of 1976 (42 U.S.C. 1962d-5f).

Policy 18: To safeguard the vital interest of the State of New York and of its citizens regarding the waters and other valuable resources of the State's coastal area, all practicable steps shall be taken to ensure that such interests are accorded full consideration in the deliberations, decisions and actions of state and federal bodies with authority over those waters and resources.

The federal, state and local permitting processes, including SEQRA and CEQR, assure full opportunity for diverse coastal area interests to be considered and balanced. Along with the proposed action plan, an environmental impact statement (EIS) will be prepared to assess the impacts that may result in Arverne and its surrounding communities/environment as a result of the planned development. The EIS will address the Coastal Erosion Hazard Areas Act and the NYSDEC Management Regulations for protection of coastal resource areas.

The interests of the Arverne community as well as neighboring communities and other special interest groups will be considered in the planning process. There will be a public hearing and commenting period as part of the review process for the draft environmental impact statement (DEIS).

Policy 19: Protect, maintain and increase the level and types of access to public water-related recreation resources.

The proposed development of the Arverne URA will significantly improve access to the waterfront.

The design of the project will incorporate north-south mapped streets (approximately every three blocks) leading from the Rockaway line stations to the shore-front. Improved east-west highway access leading to the area will also be provided. A new 25-acre public park will be mapped, built, and provided with facilities in the control portion of the Site. Public parking facilities will be made available for beach users as well as for users of other recreational facilities. Additionally, development of the Arverne

URA will improve the area's image, making it a more attractive and desirable place.

Policy 20: Access to the publicly owned foreshore or water's edge, and to the publicly owned lands immediately adjacent to these areas shall be provided, in a manner compatible with adjoining uses. To ensure that such lands remain available for public use, they will be retained in public ownership.

Access to the publicly owned shore lands and to the immediately adjacent publicly owned lands will be improved after development of the Arverne URA (see Policy 19). There will be no development on and no acquisition of beach front property including, but not limited to, all lands seaward of the boardwalk.

Policy 21: Water-dependent and water-enhanced recreation will be encouraged and facilitated and will be given priority over non-water-related uses along the coast.

The principal water-dependent uses suitable for this location are beach and recreational uses such as swimming, fishing or surfing. Such uses will be encouraged by development of the Arverne URA. See also responses to Policies 2 and 19.

Policy 22: Development when located adjacent to the shore will provide for water-related recreation activities whenever such recreational use is appropriate in light of reasonably anticipated demand for such activities and with the primary purpose of the development.

Development of the Arverne URA is expected to enhance and increase demand for water-related activities such as swimming, fishing or surfing, as described in responses to Policies 2 and 19.

Policy 23: Protect, enhance and restore structures, districts, areas or sites that are of significance in the history, architecture, archaeology or culture of the state, its communities, or the nation.

A cultural resource survey determined that the Arverne URA is archaeologically "non-sensitive." Furthermore, the survey concluded that the development of the area will have no impact upon the archaeological resource base of the southern coastline of Long Island.

The architectural historian's analysis acknowledged one significant building, which is not currently listed on the city, state or national registers of historic places. This building, Congregation Derech Emunoh Synagogue located at 199 Beach 67th Street at the southwest corner of Rockaway Beach Boulevard, may be eligible for listing on the National Register of Historic Places, and, therefore, is also eligible for listing on the New York State Register of Historic Places. The building is also eligible for designation as a New York City Landmark, and was, in fact, so nominated in 1978; this nomination was rejected by the New York City Board of Estimate because the Synagogue is located in an urban renewal area.

Policy 25: Protect, restore and enhance the natural and man-made resources which are not identified as being of statewide significance but which contribute to the overall scenic quality of the coastal area.

Development in the area will be done in a manner that will protect, restore and enhance the area's natural resources and aesthetic qualities. As discussed in Section B.3, there will be no construction (development) in the coastal erosion hazard area or seaward of the the boardwalk. Furthermore, the Planning Development Principles for the project do not allow development in this area. The utmost care will be taken to preserve the area's natural or man-made features which contribute to the scenic quality of the coastal area. The major north-south streets will serve as view corridors to the beach and ocean. In addition, the planning Development Principles require 50-foot wide, north-south view corridors through the site on average every 400 feet, not to exceed 600 feet at any point. Landscaping in the Arverne URA will accentuate the seashore locale of the project area. Dune grass and other appropriate vegetation shall be planted to enhance and protect the primary and secondary dune areas. The state considers the area between the preliminary coastal erosion hazard area's line and the boardwalk to serve the function of a primary dune. These dunes shall be natural protective features. See responses to Policies 1, 2 and 19.

Policy 30: Municipal, industrial, and commercial discharge of pollutants, including but not limited to, toxic and hazardous substances, into coastal waters will conform to state water quality standards.

All sanitary sewage will be collected for treatment at the Rockaway Sanitary Treatment plant located at Beach 106th Street and Rockaway Beach Boulevard. The plant is currently operating at about half its design capacity of 45 million gallons per day (mgd). The anticipated rate of flow resulting from the redevelopment of the area is 16 mgd. Therefore, there is ample capacity at the Rockaway plant to accept and treat the additional flow.

Policy 32: Encourage the use of alternative or innovative sanitary waste systems in smaller communities where the cost of conventional facilities is unreasonably high, given the size of the existing tax base of these communities.

The Rockaway Sewage Treatment Plant has adequate design capacity for treating the projected sewage demand from a fully developed Arverne URA.

Policy 33: Best management practices will be used to ensure the control of stormwater runoff and combined sewer overflows draining into coastal waters.

Stormwater drainage will be separated from sanitary sewer flows using best management practices. Positive grading will be used to channel the stormwater flow from the Site to Jamaica Bay. The entire Site will be graded to prevent flooding, especially spot flooding, which could result from an uneven grade. The actual amount and placement of fill is dependent on a specific site plan. Flood and protection measures will be an integral part of the comprehensive drainage system. Stormwater pipes will be adequately sized to prevent possible overflow.

Policy 35: Dredging and dredge spoil disposal in coastal waters will be undertaken in a manner that meets existing state dredging permit requirements and protects significant fish and wildlife habitats, aesthetic resources, natural protective features, important agricultural lands and wetlands.

Dredging activities in the Arverne area can only be undertaken pursuant to permits from the USACOE. Dredging is also regulated under the NYSDEC's Coastal Erosion Management Regulations. In Arverne the land area adjacent to the shoreline is within the state designated natural protective features areas (detailed further on in this chapter). Any dredging activities would require state and city review.

Policy 37: Best management practices will be utilized to minimize the non-point discharge of excess nutrients, organics and eroded soils into coastal waters.

The development Site will be graded so as to facilitate the collection of all runoff from the Site in new storm sewers.

Policy 39: The transport, storage, treatment and disposal of solid wastes, particularly hazardous wastes, within coastal areas will be conducted in such a manner as to protect groundwater and surface water supplies, significant fish and wildlife habitats, recreation areas, important agricultural lands and scenic resources.

As envisioned, the redevelopment of the urban renewal area will focus on establishing a new residential community. As such, no significant amount of hazardous wastes should be generated in the area and the only handling of solid waste would be the pick-up of municipal garbage.

Policy 41: Land use or development in the coastal area will not cause national or state air quality standards to be violated.

The future development plan for the Arverne URA will be the subject of a comprehensive EIS prepared pursuant to CEQR regulations. As such, any element of the development plan which would cause a violation of a national or state air quality standard will be identified and suitable mitigation evaluated to correct this violation.

Policy 42: Coastal management policies will be considered if the State reclassifies land areas pursuant to the prevention of significant deterioration regulations of the Federal Clean Air Act.

The prevention of significant deterioration (PSD) regulations typically relate to large point source emissions in excess of 100 tons per year of pollutant. The Arverne URA will not include industrial sources in its development plan. Emissions from residential heating and air conditioning are not anticipated to exceed this threshold. An emissions inventory, however, will be prepared as part of the EIS for the development plan. Coastal management policies will be considered with respect to land area reclassification.

Policy 43: Land use or development in the coastal area must not cause the generation of significant amounts of the acid rain precursor such as nitrates and sulfates.

The proposed redevelopment of the Arverne URA is for residential use. The primary source of associated air pollution will be generated by vehicular emissions during daily commuting, shopping, etc. However, vehicular emissions are not significant contributors to regional nitrate and sulfate loading. These pollutants are largely emitted by industrial sources.

The type of emissions from residential space heating will depend upon the type of fuel source used. Natural gas and electricity are relatively clean whereas oil tends to increase emissions of sulfur. The selection of a fuel alternative is premature at this stage of development.

Policy 44: Preserve and protect tidal and freshwater wetlands and preserve the benefits derived from these areas.

The only mapped wetlands adjacent to the Arverne URA are the beach area seaward of the boardwalk which represents the "closest lawfully and presently existing functional man-made structure." Development seaward of the boardwalk is prohibited by state laws and regulations.

2.3 NYC WATERFRONT REVITALIZATION PROGRAM POLICIES

The following lettered policies are from the New York City Waterfront Revitalization Program.

New York City Policy E: Implement public and private structural flood and erosion control projects only when:

- Public economic and environmental benefits exceed public economic and environmental costs;
- Non-structural solutions are proven to be ineffective or cost prohibitive;
- Projects are compatible with other coastal management goals and objectives, including aesthetics, access and recreation;
- Adverse environmental impacts are minimized;
- Natural protective features are not impaired; and
- Adjacent (downdrift) shorelines are not adversely affected.

The public benefits of protecting the Arverne URA and the Rockaway Peninsula are difficult to quantitatively assess but they can be qualitatively discussed.

See Response to Policy 16.

New York City Policy F: Priority shall be given to the development of mapped parklands and appropriate open space where the opportunity exists to meet the recreational needs of:

- immobile user groups; and
- communities without adequate waterfront park space and/or facilities.

The primary and secondary study areas in the Rockaways contain a variety of open space and recreational resources, including beaches, playgrounds and unimproved open land and marshland. Using City guidelines, the needs of the present local population are met with respect to open space and parkland. Whereas the beach area and boardwalk are certainly the most obvious and seasonally used of these resources, there are also a number of park facilities between the boardwalk and Shore Front Parkway. Altogether the Rockaway beach front and inland park facilities account for 121 acres of mapped park space in the primary study area alone and 517 acres in the secondary study area. However, there is a recognized need for a better variety and improvement of existing recreational space. The Planning Development Principles for the Site require that a 25-acre public park be built on site with a range of active recreational facilities. In addition, a minimum of eight acres of neighborhood parks must be provided with the new development.

New York City Policy G: Maintain and protect New York City beaches to the fullest extent possible.

Since Rockaway Beach is one of New York City's most significant seasonal recreational resources, in planning the development project, all viable alternatives to afford the most efficient and practicable erosion control scheme will be considered. Rockaway Beach is a mapped city park and will be maintained, on a regular basis, by the NYC Department of Parks and Recreation. Chapter C provides an assessment of erosion control measures (structural and non-structural) that have been and are being used along the shoreline. In addition, several alternative erosion control methods which may be implemented are assessed. See response to State Policies 13 and 16.

New York City Policy H: Ensure ongoing maintenance of all waterfront parks and beaches to promote full use of secure, clean areas with fully operable facilities.

The development concept contemplates the consolidation of public recreational uses within a central core.

This concept will facilitate maintenance and security of new recreational facilities. In addition, a buffer zone will be provided running east-west along the boardwalk within the Arverne URA with vehicular access at both ends to provide park maintenance vehicles with easy access to the beach. The beach will be maintained by the NYC Department of Parks and Recreation.

New York City Policy K: Curtail illegal dumping throughout the coastal zone and restore areas scarred by this practice.

Debris, rubble and discarded junk, including furniture and automobile parts, lay strewn about the Arverne URA. This situation is almost unavoidable in an urban area when land is left vacant for a long time but will be corrected as the Site is developed and maintained. Coincident with the development, there will be more police patrol of the area, regular sanitation pick-ups and a resident population protective of its environs. These conditions will reduce illegal dumping in the remaining vacant lands.

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3. COASTAL EROSION HAZARD AREAS ACT

The Coastal Erosion Hazard Areas Act of the Environmental Conservation Law Article 34 was established to limit damage to people and property along sections of the New York State coastline which are prone to erosion from action of the adjacent water bodies. Such erosion can either be induced by nature (e.g., waves, currents, tides, wind) or man (e.g., construction and shipping) and can lead to extensive damage to public or private property and natural resources. The purpose of the Act is to minimize or prevent potential damage that could occur if land use in these areas were left unregulated.

The Coastal Erosion Hazard Areas Act empowers NYSDEC to identify and map coastal erosion hazard areas and to control those activities and development that could hasten coastal erosion or the displacement of land along the coast. The Act states: "Any activities, development or other actions in erosion hazard areas should be undertaken in such a manner as to minimize damage to property, and to prevent the exacerbation of erosion hazards. Such actions may be restricted or prohibited if necessary to protect natural protective features or to prevent or reduce erosion impacts." The policy discourages public actions which are likely to encourage new permanent activities or development within coastal erosion hazard areas. Under certain circumstances, an erosion hazard may be modified or reduced by erosion protection structures or by non-structural methods. All erosion protection structures or non-structural methods should be designed to minimize damage to other man-made property or to natural protective features or other natural resources.

As the lead agency of this Act, NYSDEC has developed regulations which contain standards for actions in coastal erosion hazard areas. However, any actions proposed in a hazard area must come under the review of either NYSDEC or the appropriate local government or both. The regulations are geared to have local governments enforce regulations in the coastal hazard zone. The method by which these projects will be reviewed and the regulations enforced has not yet been specified by the City and will not be until after the NYSDEC has finalized the Coastal Erosion Hazard Area maps (See Figure B-1). The City has six months from the date the maps are finalized to submit a managment plan to NYSDEC which must approve the plan. Enforcement options identified by the NYSDEC include review of actions through existing review procedures, development of new review procedures or establishment of a separate review system. NYSDEC enforces these regulations through a permit system.

As stated in NYSDEC's Management Regulations (6 NYCRR 505) erosion area permit applications must include the following information:

- A description of the proposed activity;
- A map drawn to a scale no smaller than 1:24,000, showing the location of the proposed activity; and
- Additional information NYSDEC may require to properly evaluate the proposed activity.

A permit will be issued only if it can be proved that the proposed activity:

a. Is reasonable and necessary, considering reasonable alternatives to the proposed activity and the extent to which the proposed activity requires a shoreline location;

b. Will not be likely to cause a measurable increase in erosion at the proposed site or at other locations;

c. Prevents, if possible, or minimizes adverse effects on natural protective features and their functions and protective values of existing erosion protection structures or natural resources including, but not limited to, significant fish and wildlife habitats and shellfish beds.

For regulatory purposes, NYSDEC has divided coastal erosion hazard areas into two types: structural hazard areas and natural protective feature areas. The entire Atlantic shoreline of the Rockaway Peninsula has been classified as a natural protective feature area, which is defined as "a land and/or water area containing natural protective features, the alteration of which might reduce or destroy the protection afforded other lands against erosion or high water."

By comparison, structural hazard areas are those lands whose fronting shorelines are experiencing a long-term average annual recession rate of one foot or more. The coastline of the Rockaway Peninsula, as the coastline of the southern shore of New York City, is in a constant state of flux (winter beach to summer beach and periodic nourishment projects) which does not, according to NYSDEC, allow for an accurate calculation of this type.

According to Section 505.3 of the Coastal Erosion Management Regulations, ". . . natural protective features function to protect coastal areas and human lives from wind and water erosion and storm-induced high water. Inappropriate activities of man may diminish or eliminate entirely the erosion buffering function of natural protective features." The specific functions and protective values of different types of natural protective features, such as beaches, bluffs, dunes and nearshore areas and the vegetation thereon, may vary. Inasmuch as their protective values vary, so do the permit regulations that apply to each of the above named features. For the purposes of the Rockaway Peninsula, and therefore the entire Arverne study area, the protective features of concern are: nearshore areas, beaches and primary dunes. The other features, bluffs and secondary dunes are not part of the Rockaway environment as defined by NYSDEC regulations.

The following are the restrictions on regulated activities for the three natural protective features (nearshore areas, beaches and primary dunes) that are part of the natural environment of the Rockaway Peninsula (Section 505.8, Coastal Erosion Management Regulations). The term "Department" refers to NYSDEC.

Nearshore Areas

The following restrictions and requirements apply to regulated activities in nearshore areas:

a. Excavating, mining, or dredging, which diminishes the erosion protection afforded by nearshore areas is prohibited. However, erosion area permits for dredging may be issued for constructing or maintaining navigation channels, bypassing sand around natural and man-made obstructions, or artificial beach nourishment.

b. All development is prohibited unless specifically allowed.

c. The normal maintenance of structures may be undertaken without a coastal erosion management permit.

d. Clean sand or gravel is the only material which may be deposited within nearshore areas. Any deposition will require an erosion area permit.

e. A coastal erosion management permit is required for new construction, modification, or restoration of docks, piers, wharves, groins, jetties, seawalls, bulkheads, breakwaters, revetments, and artificial beach nourishment.

This permit requirement does not apply to docks, piers, wharves or structures built on floats, columns, open timber, piles, or similar open-work supports having a top surface area of 200 square feet or less. Docks, piers, wharves, or other structures built on floats and which are removed in the fall of each year are similarly excepted.

Beaches

The following restrictions and requirements apply to regulated activities on beaches:

a. Excavating or mining which diminishes the erosion protection afforded by beaches is prohibited.

b. All development is prohibited on beaches unless specifically allowed.

c. The normal maintenance of structures may be undertaken without a coastal erosion managment permit.

d. The restoration of existing structures that are damaged or destroyed by events not related to coastal flooding and erosion may be undertaken without a coastal erosion management permit.

e. Non-major additions to existing structures may be allowed on beaches pursuant to a coastal erosion management permit.

f. The following restrictions apply to the use of motor vehicles on beaches:

- motor vehicles must operate seaward of the upper debris lines at all times. On those beaches where no debris line exists motor vehicles must operate seaward of the toe of the primary dune; and

- motor vehicles must not travel on vegetation.

g. An erosion area permit for deposition of material on beaches will be issued only for expansion or stabilization of beaches; clean sand or gravel of an equivalent or slightly larger grain size must be used.

h. Beach grooming or clean-up operations do not require a coastal erosion management permit.

i. A coastal erosion management permit is required for new construction, modifications, or restoration of docks, piers, wharves, boardwalks, groins, jetties, seawalls, bulkheads, breakwaters, revetments and artificial beach nourishment projects.

This permit requirement does not apply to docks, piers, wharves or structures built on floats, columns, open timber, piles or similar open-work surface areas of 200 square feet or less. Docks, piers, wharves, or other structures built on floats and which are removed in the fall of each year are similarly excepted.

j. Active bird nesting and breeding areas must not be disturbed unless such disturbance is pursuant to a specific wildlife management activity approved in writing by the Department.

Primary Dunes

NYSDEC considers the area between the boardwalk and the erosion hazard line to be an area of primary dunes. The following restrictions and requirements apply to regulated activites on primary dunes:

a. Excavating or mining of primary dunes is prohibited.

b. Vehicular traffic is prohibited on primary dunes, except in those areas designated by the Department for dune crossing.

c. Non-major additions to existing structures are allowed on primary dunes pursuant to a coastal erosion management permit and subject to permit conditions concerning the location, design and potential impacts of the structure on the primary dune.

d. Foot traffic which causes sufficient damage to primary dunes to diminish the erosion protection afforded by them is prohibited. Pedestrian passage across primary dunes must utilize elevated walkways and stairways or other specially designed dune crossing structures approved by the Department.

e. All development is prohibited on primary dunes unless specifically allowed.

f. The normal maintenance of structures may be undertaken without a coastal erosion management permit.

g. The restoration of existing structures that are damaged or destroyed by events not related to coastal flooding and erosion may be undertaken without a coastal erosion management permit.

h. A coastal erosion management permit is required for new construction, modification, or restoration of stone revetments or other erosion protection structures compatible with primary dunes. Such erosion protection structures will only be allowed at the seaward toe of primary dunes and must not interfere with the exchange of sand between primary dunes and their fronting beaches.

i. A coastal erosion management permit is required for new construction, modification, or restoration of elevated walkways or stairways. Elevated walkways or stairways constructed solely for pedestrian use and built by or for an individual property owner for the limited purpose of providing non-commercial access to the beach are excepted from this permit requirement.

j. Clean sand obtained from excavation, dredging or beach grading may be deposited on a primary dune to increase its size or may be used to restore it. Such deposition must be vegetatively stabilized using native species tolerant of salt spray and sand burial, e.g., American beach grass. Such deposition requires an erosion area permit.

k. Vegetative planting and sand fencing, to stabilize or entrap sand in order to maintain or increase the height and width of dunes, does not require an erosion area permit. Vegetative plantings must be of native species tolerant of salt spray and sand burial, e.g., American beach grass.

l. Active bird nesting and breeding areas must not be disturbed unless such disturbance is pursuant to a specific wildlife management activity approved in writing by the Department.

Erosion Protection Structures

The Coastal Erosion Management Regulations also detail the conditions under which an erosion protection structure would be allowed or required. As specified in the Management Regulations (Section 505.9), in those instances where properly designed and constructed erosion protection structures will be likely to minimize or prevent damage or destruction to man-made property, private and public property, natural protective features, and other natural resources, construction of erosion protection structures may be allowed. Chapter C provides a discussion of erosion protection structures (and non-structural methods) which may have a beneficial application in the study area. The implementation of these structures would be subject to the following requirements:

a. An erosion area permit is required for construction, modification, or restoration of erosion protection structures including the modification or restoration of erosion protection structures that were constructed without an erosion area permit. Normal maintenance of an erosion protection structure does not require a coastal erosion management permit.

b. All erosion protection structures must be designed and constructed according to generally accepted engineering principles, which have demonstrated success, or where sufficient data is not currently available there is a likelihood of success in controlling long-term erosion. The protective measures must have a reasonable probability of controlling erosion on the immediate site for at least 30 years.

c. A long-term maintenance program must be included with every permit application for construction, modification, or restoration of an erosion protection structure. That program must include specifications for normal maintenance of degradable materials and the periodic replacement of removable materials.

d. All materials used in such structures must be durable and capable of withstanding inundation, wave impacts, weathering and other effects of storm conditions. Individual component materials may have a working life of less than 30 years only when a maintenance program ensures that they will be regularly maintained and replaced as necessary to attain the required 30 years of erosion protection.

e. The construction, modification, or restoration of erosion protection structures must:

- Not be likely to cause any measurable increase in erosion at the development site or other locations; and,

- minimize, and if possible, prevent adverse effects to natural protective features, existing erosion protection structures, and natural resources such as significant fish and wildlife habitats.

Permissible Actions

Finally, it should be noted that any person who owns real property within a designated erosion area may appeal that designation. However, in the Site the sole acceptable basis for appeal of an erosion hazard area designation is technical information that would indicate that the area in dispute was erroneously identified as natural protective feature.

Development at the Arverne Site will comply with all requirements of the Coastal Erosion Hazard Areas Act. Firstly, there will be no development seaward of the coastal erosion hazard area line as specified in the Planning Development Principles. The implications of development seaward of this line are assesed in the Vulnerability Analysis, Chapter A. Secondly, any erosion control/protection measures implemented in this area will be consistent with the above specified requirements for both structural and non-structural erosion protection methods and requirements. An assessment of applicable shore protection plans are provided in Chapter C.

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4. FLOODPLAIN MANAGEMENT

The Flood Disaster Act of 1973 mandates flood insurance under certain conditions. The Federal Emergency Management Agency (FEMA) provides guidelines (43 Federal Register) for the purchase of flood insurance based upon the Flood Disaster Protection Act of 1973 (P.L. 93-234) as a condition of receipt of federally related financial assistance for acquisition and/or construction purposes for use within a special flood hazard area or community which is participating in the National Flood Insurance Program (NFIP). Community response to this requirement generally entails adoption of zoning, building code and development regulations and strategies that feature various damage mitigation measures for new construction and substantial improvements to existing structures in identified flood hazard areas.

Participation in the NFIP is not mandatory. However, in non-participating communities where flood hazard areas have been specifically identified (mapped), use of grants, loans or guarantees made by federal agencies, such as the Federal Housing Administration and Veterans Administration, are prohibited for acquisition or construction in designated flood-prone areas. If a flood disaster situation occurs in a non-participating flood-prone community, no federal assistance for acquisition or construction (insurable property) may be provided in flood hazard areas. Development in Arverne will be required to comply with NFIP and Local Law 33 of 1988 (formerly Local Law 58 of 1983) which implements NFIP in New York City.

There are two types or phases of the NFIP: the "emergency program" and the "regular program." A community enters an emergency program prior to the completion of an individual community flood insurance study. It is intended to provide a first layer of insurance at federally-subsidized rates on all existing structures and new construction begun prior to the effective date of a Flood Insurance Rate Map (FIRM) in return for the community's adoption of general floodplain management regulations. The regular program is the phase of the NFIP that makes available increased amounts of flood insurance after a community adopts a FIRM, with new and substantially improved structures being rated on an actuarial or actual risk basis. New York City participates in the regular program. Final FIRMs for New York City were prepared and have been effective as of November 16, 1983.

In response to the National Flood Insurance Program and other federal and state floodplain management programs, most local jurisdictions have implemented regulatory programs through their zoning, building code or other permit agencies. In New York City, Local Law 33 of 1988 implements floodplain management regulations. Local Law 33 is discussed later in this section.

4.1 NFIP REQUIREMENTS

The minimum standards for floodplain regulations as published by FEMA (44 C.F.R. Part 60) require that:

a. All new and substantial improvements to residential buildings have the lowest floor (including the basement) elevated to or above the base flood elevation (BFE);

b. All new or substantial improvements to non-residential buildings must have the lowest floor (including the basement) elevated or floodproofed to or above the BFE. Under the floodproofing option, structures must be made watertight, with walls substantially impermeable to the passage of water and with structural components that are able to resist floatation, collapse, lateral movement or other forces associated with a 100-year flood. Furthermore, specific floodproofing plans must be certified by a registered professional engineer or architect as meeting the minimum requirements of the National Flood Insurance Program.

The BFE is the elevation for which there is a one-percent chance in any given year that flood levels will equal or exceed that elevation. A detailed discussion of the BFE and how it was derived for the Arverne study area is given in Chapter A. In the primary study area, the BFEs range from eight to ten feet in the A-Zone and from 12 to 14 feet in the V-Zone.

The identification of those areas most prone to flooding is essential in that the boundaries define the regulatory floodplain, and the relative extent of flood hazard within various floodplain zones. Those areas that have been identified as having a one-percent or greater chance of flooding in any given year are termed "special flood hazard areas." (A one-percent probability flood is also known as the 100-year flood or the base flood.) Special Flood Hazard Areas are usually designated on the Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) (see Notes 1 and 2) as either Zone A or V. The locations of the A- and V-Zones in the primary impact area are shown on Figure B-2 as the dark gray areas. The other flood hazard zones shown in the impact area are Zones B, C and D. These zones, as defined by FEMA, represent areas of moderate to minimal flood hazard.

Since the V- and A-Zones are definitely the most flood prone areas, they are characterized as being the most hazardous and, therefore, are the most restrictive in terms of construction or development. Although the V- and A-Zones are both part of the 100-year coastal floodplain, they are differentiated by the degree of hazard present. The V-Zone describes that portion of the floodplain which is subject to a three-foot or greater breaking wave during the 100-year flood. The A-Zone describes that portion of the floodplain subject to less than a three-foot breaking wave. Wave and velocity action will occur in coastal A-Zones; however, the magnitude and inland extent of such phenomenon will vary according to the size of the storm surge, windspeed, topographic influences, presence of obstructions and other natural causes or man-made features. Generally, those areas closest to the V-Zone will experience the greatest velocity conditions, although it is not unusual in wide coastal floodplains for waves to regenerate to form inland velocity zones. In the study area all the land seaward (south) of the boardwalk is zoned either V or A. Landward (north) of the boardwalk there are no V-Zones, however; there are some designated A-Zones, especially in the western and easternmost sectors of the primary impact area.

As part of the Vulnerability Analysis (Chapter A), the Flood Insurance maps and the methodology used to generate these maps were reviewed (see Chapter A, section 4). Based on the review and on the vulnerability of the Arverne URA to flooding, it is recommended that development landward of the boardwalk be required to meet FEMA A-Zone construction standards. There will be no development seaward of the boardwalk.

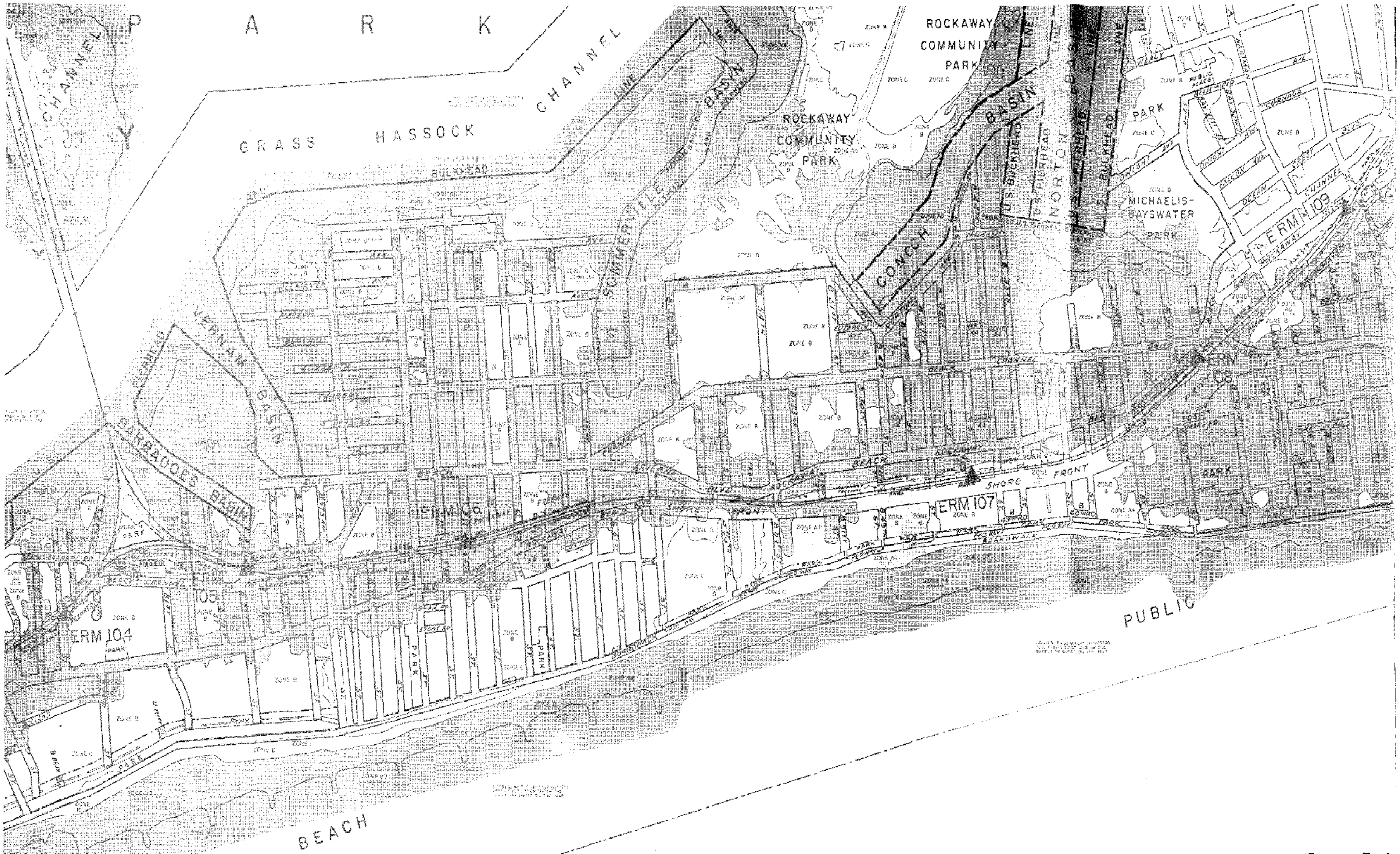


Figure B-2

ARVERNE URBAN RENEWAL AREA
Queens, New York

Flood Hazard Zones (FEMA)

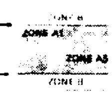
Department of City Planning

Dresdner, Robin & Associates, Inc.
Gruzen Samton Steinglass Architects, Planners
Edwards and Kelcey Engineers, Inc.
Allee Phillips Preiss & Shapiro, Inc.

Figure B-2

Key to Figure B-2: Flood Hazard Zones

100-Year Flood Boundary —— 500-Year Flood Boundary



Zone Designations*

100-Year Flood Boundary —— 500-Year Flood Boundary

Base Flood Elevation Line With Elevation In Feet**	~~~513~~~
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	ERM 7 ▲
Zone D Boundary	— — —
River Mile	•M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
AO	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

Coastal base flood elevations shown on this map include the effects of wave action.

Coastal base flood elevations apply only landward of the shoreline shown on this map.

INITIAL IDENTIFICATION:
JUNE 28, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS:
JUNE 11, 1976

V-Zones

The minimum requirements for construction in V-Zones differ significantly from the minimum requirements in coastal A-Zones. In V-Zones, all new construction and substantial improvements to existing structures must be elevated on adequately anchored pilings or columns so that the bottom of the lowest horizontal structural members of the lowest floor (excluding the pilings and columns) are at or above the BFE. A registered professional engineer or architect must certify that the structure is securely fastened to adequately anchored pilings or columns to with stand velocity waters and hurricane wave wash forces. In addition, the space below the lowest floor may be used solely for parking of vehicles, building access, or storage and must be free of obstructions, or may be enclosed with non-supporting breakaway walls, open wood lattice work, or insect screening intended to collapse under wind and water loads without damaging the elevated portion of the building or the foundation.

Additional NFIP standards for V-Zones require that fill not be used for the structural support of new or substantially improved structures, and that sand dunes may not be altered so as to increase the potential for flood damage. Floodproofing techniques are not allowed in V-Zones.

A-Zones

In coastal A-Zones, the FIRM identifies the appropriate 100-year flood elevation. The A-zone is that portion of the 100-year coastal floodplain subject to wave action of lesser severity. It is important to note that because of the forward momentum of breaking waves, water may be moving at high velocities in this zone, especially in the vicinity of the V-Zone/A-Zone interface. Construction in this interface area requires additional design consideration to insure that the structure will resist floatation, collapse and latteral movement. At a minimum, new construction or substantial improvements of residential structures in coastal A-Zones must be elevated so that the lowest floor (including basements) is at or above the BFE. This elevation may be accomplished through use of fill, raised foundations or piles or columns.

The objective of FEMA's floodplain management policies is to minimize the potential harm to or within the floodplain. Although it is preferred that structures be elevated above the base flood level, FEMA does make an allowance for certain reasonable uses such as parking of vehicles, below the base flood elevation, because the amount of damage caused by flooding to these areas can be kept to a minimum by following the design and construction requirements contained in the NFIP regulations. The conditions outlined below must be met whenever such enclosed space (e.g., vehicle parking areas, storage or building access) is located below the base flood elevation. These requirements include:

a. No machinery or equipment which services a building such as furnaces, air conditioners, heat pumps, hot water heaters, washers, dryers, elevator lift equipment, electrical junction and circuit breaker boxes, and food freezers are permitted below the base flood elevation.

b. All interior wall, floor and ceiling materials located below the base flood elevation must be unfinished and resistant to flood damage.

c. The walls of any enclosed area below the base flood elevation must be constructed in a manner to prevent floatation, collapse and lateral movement of the structure. The walls should be designed to prevent buildings of flood loads which could result in foundation failure or damage.

Any person who has reason to believe that their property has been erroneously included as a flood hazard area can appeal to FEMA. The appeal is through a Letter of Map Amendment, officially called a LOMA. The LOMA must be submitted with scientific, technical and legal documentation, such as information providing hydraulic and hydrologic analysis to support the appellant's claim or supporting data to prove mathematical or measurement error in the Flood Insurance Study. The data will be reviewed and, if warranted, a LOMA issued. It should, however, be noted that even though FEMA may issue a LOMA removing the property from the special flood hazard area, it is the lending institution's prerogative to require flood insurance as a condition of granting a loan or mortgage.

4.2 LOCAL LAW 33

In New York City, FEMA regulations have been incorporated into and are enforced through New York City Local Law 33, formerly Local Law 58 enacted in 1983, amended in 1988. Consistent with FEMA regulations, Local Law 33 restricts development in V- and A-Zones; in the ordinance these zones are referred to as "special flood hazard areas."

The occupancy and construction restrictions for special flood hazard areas as stipulated in Local Law 33 are as follows:

Within special flood hazard areas, no building in occupancy group classification J1, J2 or J3 (these are essentially institutional or residential buildings; see Note 3) shall be constructed or altered so as to have the lowest floor below the base flood elevation. New construction or substantial improvements of non-residential space within special flood hazard areas shall have the lowest floor elevated to or above the base flood elevation; or together with attendant utilities and sanitary facilities shall be floodproofed up to the level of the base flood elevation in accordance with FEMA's guidelines for floodproofing (see Note 4). Provided however, that new construction or substantial improvements of non-residential buildings within areas designated as Zone V shall meet the requirements specified under number three of this section.

Manufactured homes shall be anchored to resist floatation, collapse or lateral movement and shall be elevated on a permanent foundation to or above the base flood elevation or, when no base flood elevation has been determined, two feet above the highest adjacent grade. Methods of anchoring may include, but are not limited to use of over-the-top or frame ties to ground anchors. No (mobile homes) park trailers or travel trailers shall be permitted within special flood hazard areas.

All new construction and substantial improvements of buildings within Zone V shall be performed pursuant to FEMA's guidelines for floodproofing. Such construction and improvements shall have the lowest floor elevated on adequately anchored pilings or columns to prevent floatation, collapse or lateral movement resulting from the simultaneous action of wind and water loads on all building components, and the lowest portion of the structural members of the lowest floor, other than the pilings or columns, shall be elevated to or above the base flood elevation. Relevent to this requirement, wind and water loading values shall each have a one-percent chance of being equalled or exceeded in any given year (one hundred year mean recurrence interval). In addition:

- The installation of anchoring to anchored pilings or columns shall be subject to inspection.

- The space below the lowest floor shall be free of obstruction or shall be constructed with break-away walls of an open lattice-type construction which is intended to collapse under stress from abnormally high tides or wind-driven water without jeopardizing the support of the building. Such space shall not be used for human habitation.

- The use of fill for structural support of buildings within Zone V shall not be permitted.

- The man-made alteration of sand dunes within Zone V which would increase potential flood damage due to buildings shall not be permitted.

- All new construction within Zone V shall be located landward of the reach of the mean high tide.

All new construction and substantial improvements of buildings within Zone A shall be performed pursuant to the provisions of FEMA's guidelines for flood-proofing. Where such construction or improvement is not floodproofed, any fully enclosed space below the lowest floor that is subject to flooding shall be designed to equalize hydrostatic flood forces on exterior walls automatically (without human intervention) by allowing for the entry and exit of floodwaters. Design for meeting this requirement shall be certified by a registered architect or licensed professional engineer or shall meet or exceed the following minimum criteria:

- A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed space subject to flooding, shall be provided.

- The bottom of all openings shall be no higher than one foot above grade.

- Openings may be equipped with screens, louvers, valves or other coverings or devices provided that they permit the automatic entry and exit of floodwaters.

When used within special flood hazard areas, breakaway walls shall have a design safe loading resistance of not less than ten and no more than twenty pounds per square foot. Use of a breakaway wall which exceeds a design safe loading resistance of twenty pounds per square foot shall be permitted only if a registered architect or licensed professional engineer certifies that the proposed design meets the following conditions:

- Breakaway wall collapse will result from a water load less than that which would occur during the base flood; and

- the elevated portion of the building and supporting foundation system will not be subject to collapse, displacement, or other structural damage due to the effects of wind and water loads acting simultaneously on all building components (structural and non-structural). Maximum wind and water loading values used in this determination shall each have a one percent chance of being equalled or exceeded in any given year (one hundred year mean recurrence interval).

Local Law 33 is enforced through the NYC Buildings Department and/or the City Department of Ports, International Trade and Commerce. The Department of Ports, International Trade and Commerce reviews the construction plans for all those buildings or structures proposed to be located at the interface of land and water.

Analysis

The disposition agreement for construction at Arverne will require that all buildings conform to minimum A-Zone construction requirements as stipulated in Local Law 33.

NOTES

1. Flood Hazard Boundary Map (FHBM). An official map of a community, issued or approved by the Federal Emergency Management Agency, Federal Insurance Administration, on which the boundaries of the floodplain and special flood hazard areas have been designated. This map is prepared according to the best flood data available at the time of its preparation, and is superseded by the Flood Insurance Rate Map after more detailed studies have been completed.

2. Flood Insurance Rate Map (FIRM). An official map of a community issued or approved by the Federal Emergency Management Agency, Federal Insurance Administration, that delineates both the special hazard areas and the risk premium zones applicable to the community.

3. Definitions for occupancy group classifications:

J1 - Hotels, motels, lodging houses and rooming houses;

J2 - Apartment houses, apartment hotels and school dormitory buildings;

J3 - One and two-family dwelling units, rectories and convents.

4. The floodproofing guidelines referred to in this law were described in the following FEMA documents:

FEMA SS/February 1986-Design and Construction Manual for Residential Buildings in Coastal High Hazard Areas (Coastal Construction manual).

FEMA 85/September 1985 Manufactured home installation in flood hazard areas.

FEMA 102/May 1986 - Floodproofing non-residential structures.

Generally, FEMA's water-tight construction design stipulates that the walls below the base flood elevation of a floodproofed building or structure should be substantially impermeable to the passage of water. The structural components of the building(s) must be capable of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

C. ALTERNATIVE MEASURES

1. INTRODUCTION

The purpose of the Alternative Measures analysis presented herein is to examine a variety of nonstructural and structural alternatives that may be appropriate for protecting the Arverne shoreline. These alternatives are discussed as a supplement to beach fill operations - to reduce the volume of fill required and to provide a more economical long-term solution. This analysis includes an assessment of technical and institutional feasibility as well as cost considerations.

Past and present shore and flood protection systems in the Arverne URA have consisted of structural and nonstructural measures. The existing system consists of a series of groin fields combined with a periodic beach fill program.

The existing groin system in the Arverne URA has had some beneficial effect, particularly towards the west end of the area, where it has trapped littoral drift and reduced the rate of beach erosion. However, the groins by themselves are clearly inadequate in controlling overall erosion in the Arverne URA.

The performance of the groins could be improved through changes in their layout such as modifying their length and/or spacing.

The present beach fill program is costly and only moderately successful in stabilizing the Arverne beaches. This failure is not attributable to the design of the artificial beach itself, the borrow material used, or the design profile but rather to the local wave and current conditions, affected by the proximity to the jetty at East Rockaway Inlet. The result is that the Arverne URA is supplied with very little wave induced littoral drift, resulting in a major deficit in the sediment budget.

It should be noted that although the last scheduled beach nourishment action took place in 1988, the USACOE is authorized to continue beach nourishment for up to 50 years (see below). Continued nourishment is pending further study of the area and appropriation of funds. Authorization for the beach nourishment project is provided through the Water Resources Development Act of 1976 (42 U.S.C. 1962d-5f). The beach nourishment provision of this Act, as amended in 1986, reads:

"The Secretary of the Army, acting through the Chief of Engineers, is authorized to provide periodic beach nourishment in the case of each water resources development project where such nourishment has been authorized for a limited period for such additional period as determined necessary but in no event shall such additional period extend beyond the fiftieth year which begins after the date of initiation of construction of such project."

An ongoing beach fill program will be needed as part of any long-term beach stabilization program for this area. The current source of sand for beach fill is about one mile offshore. The possible alternative source for beach fill material is the shoal located off East Rockaway Inlet. This alternative would be lower in cost than the present beach nourishment operation, which utilizes offshore borrow sources, but would require detailed analysis of potential adverse environmental impacts.

The Alternative Measures analysis considers a variety of techniques and alternative shore protection systems for the purposes of establishing a long-term and economical system to stabilize the Arverne beachfront and minimize the effects of coastal erosion and flooding. The alternative measures for shore protection include: T-head groins, offshore breakwaters, sand bypassing system, beach nourishment from nearshore sources and beach nourishment from offshore sources. Each of these systems are assessed in terms of their relative effectiveness, costs and utilization.

---

2. STRUCTURAL EROSION & FLOODING PROTECTION SYSTEMS

Existing Groin System

Existing groins are located throughout most of the Arverne area, with the only major gap being a 2,700-

foot length between Beach 49th and Beach 60th Streets. The existing groin system includes:

Five Stone Groins

Located between Beach 36th Street and Beach 49th Street, constructed in 1956. Each groin has an overall length of about 600 feet; they are spaced about 800 feet apart. At the present time, with the beach fully replenished, the bases of the offshore ends are elevated about 2 feet above mean low water (MLW), and the exposed length is about 150 feet (450 feet is buried inshore), giving a groin spacing to length ratio of about 5:1.

Ten Stone Groins

Located between Beach 60th Street and Beach 86th Street, constructed between 1962 and 1965. These groins have overall lengths of 550 to 750 feet and are spaced at about 700-intervals. At present, the offshore ends are about 3 feet below MLW, and the exposed length is about 300 feet (250 to 450 feet is buried), giving a groin spacing to length ratio of about 2:1.

Deteriorated Timber Groins

Located along the entire waterfront, constructed in the years before 1928. Typically, the timber groins have overall lengths of 300 to 400 feet and are spaced at about 350-foot intervals. At present, these groins are totally buried under sand and are not visible.

An old timber bulkhead was also built in 1928, in the vicinity of the boardwalk between Beach 23rd Street and Beach 54th Street. Apparently, this bulkhead is also buried. Its condition is not known.

---

3. LAYOUT CRITERIA FOR GROIN SYSTEM

Proper length and spacing of the groins is essential if the groins are to behave efficiently.

Groins must be long enough and extend to a sufficient water depth to serve as an effective "trap" for the longshore littoral drift. In general, the groins should be extended through the normal limit of the surf zone to an elevation about 6 feet below MLW. The spacing between the groins is critical. Too wide a spacing causes excessive erosion on the leeward side of the groins while too small a spacing causes a diversion of much of the littoral drift further offshore. In current practice, groins are generally spaced at between two and three times the effective length of the groin from the berm crest to the seaward edge of the groin (USACOE, 1984).

Layout of Existing Groins

It is apparent that the existing groins in the Arverne URA have a variety of effective lengths and spacing ratios.

The five stone groins between Beach 36th Street and Beach 49th Street are clearly quite "short" and ineffective at the present time because of the recent beach replenishment. These groins only extend to about mid-tide level (2 feet above MLW). Also, they are widely spaced, with a groin spacing to length ratio of about 5:1. With subsequent erosion, these groins will eventually become more effective, as their length increases and the groins spacing to length ratio is reduced to about three. The improved efficiency will occur at the expense of eroded beach fill material in front.

At the present time, with the beach fully replenished, the ten stone groins between Beach 60th Street and Beach 86th Street are somewhat "short," because they extend into relatively shallow water (about 3 feet below MLW). On the other hand, they will be relatively "long" upon subsequent erosion of the shoreline. The groin spacing to length ratio for these groins is now about 2:1 but will be further reduced, as the shoreline erodes.

Possible Modifications to Groin Layout

The effective length and spacing of the groins in the Arverne URA is variable and often does not conform to accepted criteria for optimum performance. The performance of the groin fields could be improved by modifying their layout. For example, the length of the five stone groins to the east could be increased, and the spacing of the ten stone groins to the west could be increased by removing every other groin.

However, such modifications are not expected to be a cost effective solution. There is extensive experience with a wide variety of groin lengths and spacing on the Rockaway Beach Peninsula. At best, conventional shore-perpendicular groins are only moderately successful in stabilizing these beaches.

Much of the erosion loss here is due to onshore-offshore transport during storms; groins are essentially ineffective in controlling such losses.

Conventional shore-perpendicular groin systems do not appear to be effective structural solutions to the erosion problems in the study area.

Shore-parallel breakwater structures may provide a superior structural solution (see Section 5.3).

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4. BEACH FILL PROGRAM

Extensive beach fill has taken place along the Rockaway Peninsula, as detailed in Chapter A, Section 3.2. Between 1926 and 1962 more than 12,000,000 cubic yards of sand were placed on the beach. The present shore protection for the Rockaway Peninsula was designed by the U.S. Army Corps of Engineers (USACOE). It was authorized as a multi-purpose hurricane protection and erosion control project by the Flood Control Act of 1965. As part of this project, a ten-year program was established in 1976 by the U.S. Army Corps of Engineers to maintain two periodic beach fill programs in the study area: between Beach 25th Street and Beach 40th Street ("East Site"), and one between Beach 86th Street and Beach 110th Street ("West Site") at each site. At two-year intervals, fill quantities of about 500,000 cubic yards have been placed. The design beach profile consists of a 200-foot wide berm, with offshore slopes in the range of 1:20 to 1:30.

The beach fill program at the East Site overlaps the eastern limits of the Arverne URA and does help stabilize this beach to some degree. However, as described in Chapter A, the results have been somewhat disappointing. The USACOE is studying this area for possible future modification, including placement of additional groins. Section 5 describes alternatives for this area.

Wave refraction studies suggest that littoral drift is eastward at the east end of the Arverne URA. In contrast, westerly littoral drift dominates the remainder of the Rockaway Peninsula, to the west. This creates a serious erosion condition, in that:

a. The fill area is a "nodal point" between eastward and westward littoral drifts. There is a major deficit in the sediment budget since the area is not supplied with large quantities of littoral drift from either direction.

b. Artificially placed beach fill, installed to reduce this deficit, is moved eastward where it is eventually "lost" in East Rockaway Inlet. The result is that the beach fill placed at the East Site is not serving as an effective feeder beach for the western beaches in the Arverne URA.

The beach fill program at the West Site is located west of Arverne. It serves primarily as a feeder beach for beaches further west, due to the predominant east to west littoral drift in this area. Accordingly, the beach filling at this location has only a minor effect on beach stabilization in the Arverne URA.

Recently, beginning in 1987, the USACOE has been using the area offshore of Arverne as a disposal site for material dredged from East Rockaway Inlet. Approximately 170,000 cubic yards per year has been placed offshore as an underwater berm, at a water depth of 15 to 20 feet MLW. This disposal scheme could have a minor benefit in replenishing the Arverne beaches, but its effects have not been monitored by the USACOE.

Alternative Sources for Beach Fill

At present, beach fill is obtained from offshore sources. The sand is transferred hydraulically, from about one mile or more offshore.

The U.S. Army Corps of Engineers has made a detailed investigation of offshore borrow sources in the area (Nersesian, 1977). The offshore material is quite similar in composition to the natural beach sand (fine to medium sand) and is considered suitable as beach fill material. The offshore material is slightly finer and less well sorted than the natural beach sands, but these differences are not significant. For example, the mean grain diameter for the offshore borrow area is about 0.29 mm, compared to 0.32 mm for the beach sand (see Table C-1).

One alternative which may warrant further investigation is the offshore shoal or ebb tidal delta at East Rockaway Inlet. The shoal material is likely to be comparable to but may be coarser than the offshore sources; detailed investigations will be required to evaluate potential adverse environmental

Table C-1

GRAIN SIZE CLASSIFICATION FOR SEDIMENTS

Size Class	Minimum Diameter (mm)
Boulder	256
Cobble	64
Pebble	16
Granule	2
Very Coarse Sand	1
Coarse Sand	0.50
Medium Sand	0.25
Fine Sand	0.125
Very Fine Sand	0.062
Coarse Silt	0.031
Medium Silt	0.015
Fine Silt	0.008
Very Fine Silt	0.004
Clay	<0.004

* From R.L. Folk, Petrology of Sedimentary Rocks, Hemphill Publishing Co., Austin, Texas, 1974.

impacts from modifications to the natural wave patterns and the tidal hydraulics of the area.

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5. ALTERNATIVE TECHNIQUES FOR SHORE AND FLOOD PROTECTION

A variety of alternative techniques are discussed below as possible improvements to existing shore conditions. These include:

a. Implementing planning and design techniques to minimize damage associated with coastal erosion and flood hazard;

b. Providing shore-parallel breakwater elements with either T-head groins or a series of offshore breakwaters;

c. Reducing sand loss into East Rockaway Inlet with either a sand bypassing system or jetty construction;

d. Providing onshore sand reserves such as an artificial dune system;

e. Onshore revetments and bulkheads; and/or

f. Beach nourishment from nearshore or offshore sources.

Five possible alternate shore protection schemes are examined in detail and compared by costs for the Arverne URA. They include: T-head groins (Alternative A); offshore breakwaters (Alternative B); sand bypassing system (Alternative C); beach nourishment from nearshore sources (Alternative D); and beach nourishment from offshore sources (present scheme - Alternative E).

5.1 Planning and Design

Land use regulations or land use management techniques are frequently used in coastal states to preserve and protect environmental resources of the beach system from development activities and to mitigate the losses associated with coastal erosion and flooding. Four <u>land use management techniques</u> relevant to the Arverne URA are examined below:

- Establishing a setback line, seaward of which new construction, excavation and other activities are regulated or prohibited;

- Mandating building design criteria for development in flood hazard areas;
- Raising site grade elevations in combination with flood control measures; and
- Structural construction techniques to respond to flooding vulnerability (stilts/pilings).

Setback

The objective of a setback is to establish a distance from the sea at which development is conservatively distanced from the coastal erosion zone. The setback can either be static (constant) or rolling (changing).

The static setback establishes a fixed construction line, seaward of which construction is prohibited. The state Coastal Erosion Hazard Area line (see Chapter B) is a fixed setback line because although there are provisions for occasional modifications, the line will remain essentially unchanged. The landward or northern boundary of the preliminary coastal erosion hazard area has been adopted by the City of New York as the boundary seaward of which there will be no development or construction (see Chapter B). The principal difficulty with a static (fixed) setback line is that it may not fully consider natural processes such as erosion rates and sea-level rise. The protection area may be gradually reduced without human intervention. Based on the analysis provided in Chapter A, it is possible that, over time, the receding shoreline may move inland toward the setback line.

A rolling or "shifting" setback changes over time in response to natural shoreline processes. Under erosion, the setback would move inland preceding the advance of the mean high water line. The major disadvantage to a rolling setback is that recession caused by sea-level rise is a continous process. As demonstrated in Chapter A, the recession rate for the Rockaway Peninsula has been controlled through beach erosion control methods such as sand nourishment and groins. If beach control efforts were abandoned, the shoreline would recede at an accelerated rate. As the shoreline recedes, the rolling setback would have to be shifted further inland. The rolling setback would thus preclude permanent development in the Arverne URA and would threaten existing development along the Rockaway Peninsula. Thus, the rolling setback concept is not practical in this situation.

Design Standards

Design standards for shorefront communities are generally intended to insure the structural integrity of the building(s). These standards are designed to limit the probability, or amount, of property damage that would accompany continuing erosion or a major storm. For development of the Arverne URA the applicable building design standards are those required as minimum standards under the National Flood Insurance Program (NFIP) and NYC Local Law 33 of 1988. These standards, detailed in Chapter B, are:

a. All new and substantial improvements to residential buildings must have the lowest floor (including the basement) elevated to or above the base flood elevation (BFE); and

b. All new or substantial improvements to non-residential buildings must have the lowest floor (including the basement) elevated or floodproofed to or above the BFE. If floodproofing is used, structures must be made watertight, with walls substantially impermeable to the passage of water and with structural components able to resist floatation, collapse, lateral movement, or other forces associated with a 100-year flood. Specific floodproofing plans must be certified by a registered professional engineer or architect as meeting the minimum requirements of the NFIP.

All development in the Arverne URA must meet these minimum design standards. Based on previous storm experience, the BFE for the Arverne URA should be at least ten feet unless mapped at a higher level by FEMA.

Stilt-type building construction would meet these minimum design standards. With this technique, the first floor of the building is elevated above the base flood elevation, being supported directly on columns or piles rather than elevated fill. This approach is sometimes used in areas subject to coastal flooding, particularly to mitigate damage from wave attack. Stilt construction may be suitable for portions of the Arverne URA in combination with other flood management techniques.

Raising Site Grades

To mitigate flood hazards, consideration must also be given to raising site grades. As described in Chapters A and B, a large portion of the Arverne URA is subject to flooding, and it is recommended that development in the Arverne area comply with A-Zone standards for flood insurance purposes, in accordance with Figure A-2. Three possible alternative approaches for filling and regrading the Site are:

a. Raising the grade of the entire site above base flood level (ten feet above NGVD);

b. Raising grades locally, building site by building site; or,

c. Clustering the buildings, in areas raised to higher grades.

In any fill condition, drainage for the site and adjacent areas must be considered to avoid any adverse flooding elsewhere in the Arverne URA.

The lowest cost approach is to raise grades locally, for individual buildings. However, this may present issues of access for fire and other emergency vehicles, and issues of safe pedestrian and/or vehicular egress, from the building during a flood emergency. Short time frames are often associated with coastal flooding, wherein storm surge levels can raise quite rapidly in a matter of hours, with little warning. Any fill must be carefully coordinated with a comprehensive analysis of street grades and area-wide drainage. Legal grade requirements can be affected or altered as a result of fill requirements to ensure proper storm drainage.

<u>Flood Control Structures</u>

Flood control structures can also be considered, in combination with filling and regrading of the Site. Alternatives include structures such as sheetpile bulkheads, riprapped dikes, and artificial sand dunes. Structures such as these are most often placed at boardwalks or at the upland end of the setback areas. However, although such structures are beneficial in providing flooding and erosion protection from wave attack, it must be cautioned that the Arverne URA is prone to flooding from two directions, from Jamaica Bay as well as from the ocean side. Accordingly, flood control diking may inhibit floodwater runoff out to the ocean.

Therefore, these structures are an ineffective solution for overall flood protection, if located only along the ocean shoreline.

Summary of Planning and Design

While a fixed setback line, building design criteria and meeting base flood elevation regulations are proposed to be used for the Arverne URA, there is still a long-term need to minimize the effects of coastal erosion. This effort is required to maintain a recreational beach as well as to insure the continuing effectiveness of the setback line and the flood design criteria and areawide drainage. Any shore and flood protection measures should be carefully coordinated with street grades and comprehensive drainage concerns. The techniques for accomplishing shore protection are discussed below.

5.2 T-Head Groins

A shore-parallel breakwater component can be added to the existing groin system at the offshore ends of the groins, to form "T-head" groins. T-head groins are more effective than conventional shore-perpendicular groins in areas such as Arverne which are subject to storm wave attack from variable directions, with significant sediment transport in the offshore direction and longshore transport in either direction.

A T-head groin offers partial breakwater protection to the beach, reducing the magnitude of storm-induced erosion by reducing the intensity of wave energy concentrated on the beach. The T-head has a "trapping" effect, capturing eroded beach material that would otherwise be lost offshore. The accretion pattern behind a T-head groin is typically "U" shaped, due to the wave diffraction around the breakwater segment. This is in contrast to the straight "sawtooth" pattern associated with conventional groins which are perpendicular to the shore.

Field experience with T-head groins is rather limited due to their much higher construction costs compared to conventional perpendicular groins. Locally, they have been used successfully but on a limited basis in the Elberon and Asbury Park areas on the New Jersey coast since the late 1940s (Bruun, 1953). They have also been used extensively in Japan and Israel for a number of years (CIRIA, 1983 and Fried, 1965).

For the Arverne URA, T-head groins are likely to significantly reduce the present rate of shoreline recession and reduce the volume of material lost in the foreshore and surf zones. They would not, however, reduce the erosion of the shoreface seaward of the surf zone. The shoreface would continue to steepen seaward of the T-head groins, and beach fill would still be needed on a periodic basis to replenish the beach, maintain a stable shoreface slope and avoid undermining of the groins. However, beach fill requirements would be less frequent than at present and overall volume requirements would be reduced.

Advantages of locating the offshore segment of the T-head groins in relatively shallow water, about three feet below MLW, at the offshore ends of the existing groins would: 1) minimize construction costs, as less material is required than if the groins extend to deeper water; and 2) minimize risk of adverse erosion downdrift of the groins from bypassing the littoral drift in the shallow waters offshore of the T-head.

A possible drawback to constructing a closely spaced breakwater segment in shallow water is its impact on surfing and swimming conditions. A relatively small "embayment" would be created between the T-head groins, resulting in less water area but more beach area than is presently available. The permitted swimming area could be extended beyond the limits of the T-head groins, although this may be hazardous when wave conditions are moderately severe. However, swimming conditions within the T-groin embayments would be safer compared to an open coastline, due to the reduced wave action in areas behind the breakwater segments of the groins.

A T-head groin system constructed at the Arverne URA would significantly reduce the beach fill requirements at the USACOE East Site, located between Beach 25th Street and Beach 40th Street. It would have little if any effect on the USACOE West Site, located between Beach 86th Street and Beach 110th Street.

Considering the shorelines adjacent to the Site, it appears desirable to extend the T-head groin system further to the east, east of Beach 30th Street, to help reduce the rapid erosion losses in this area. However, west of the Site, west of Beach 83rd Street, the existing groin field is relatively effective, and the T-head groins are not required in this area.

Alternative A: T-Head Groin System

A T-head groin system is shown in Figure C-1. A typical plan two cross-sections of a T-head groin are shown in Figures C-2 and C-3. The construction would include T-head modifications to eight existing stone groins, plus one new T-head groin located in the vicinity of Beach 54th Street. T-head modifications should be of stone construction, similar to the

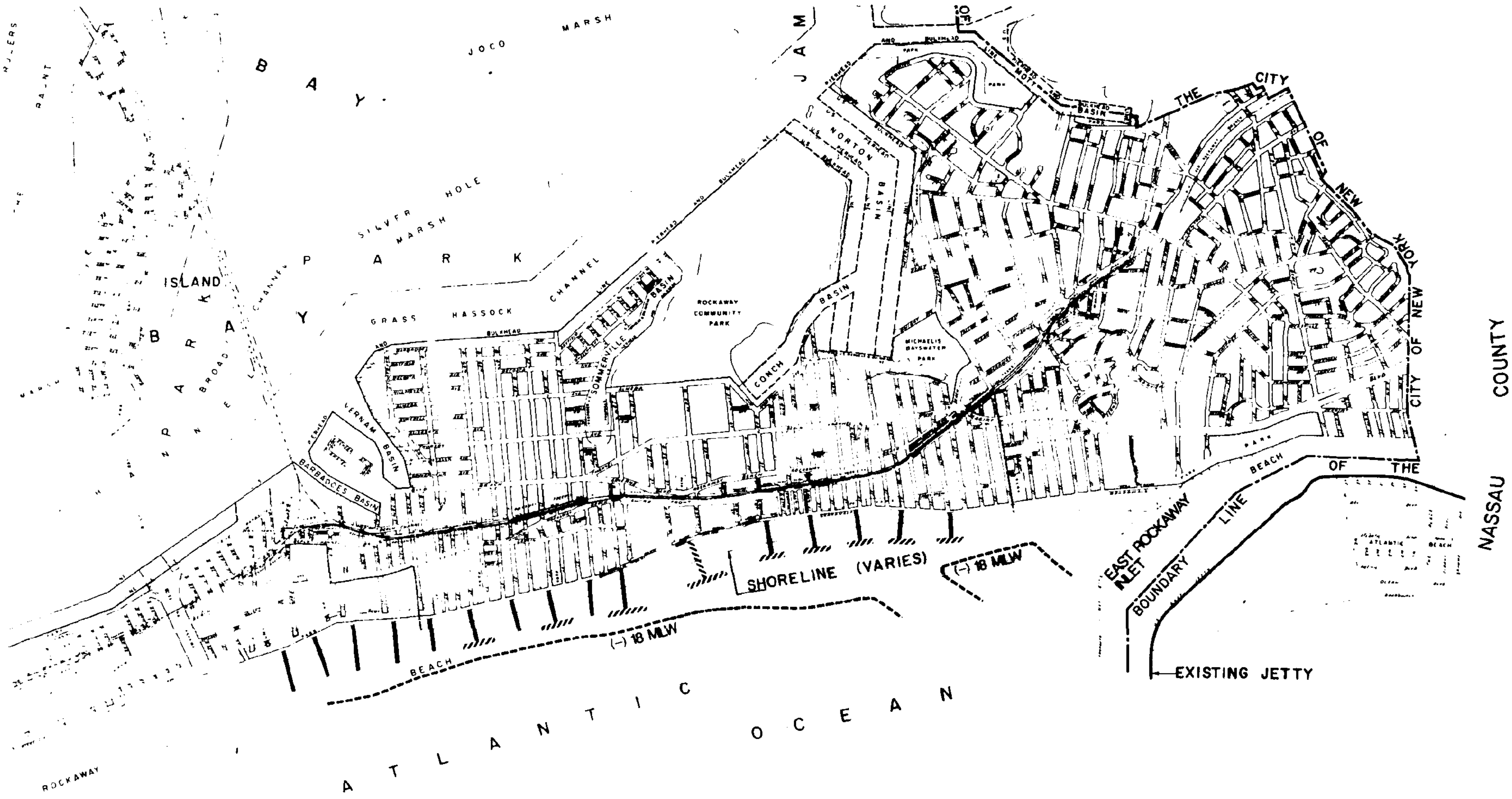


Figure C-1

ARVERNE URBAN RENEWAL AREA
Queens, New York

Department of City Planning

Dresdner, Robin & Associates, Inc.
Gruzen Samton Steinglass Architects, Planners
Edwards and Kelcey Engineers, Inc.
Abeles Phillips Preiss & Shapiro, Inc.

Shore Protection Plan—Alternative A (T-Head Groin System)

Existing Stone Groins
Proposed T-head Groins
(−)18 Ft. Below Mean Low Water
Note: Old timber groins, now buried, are not shown.

0 800 1600 2800ft

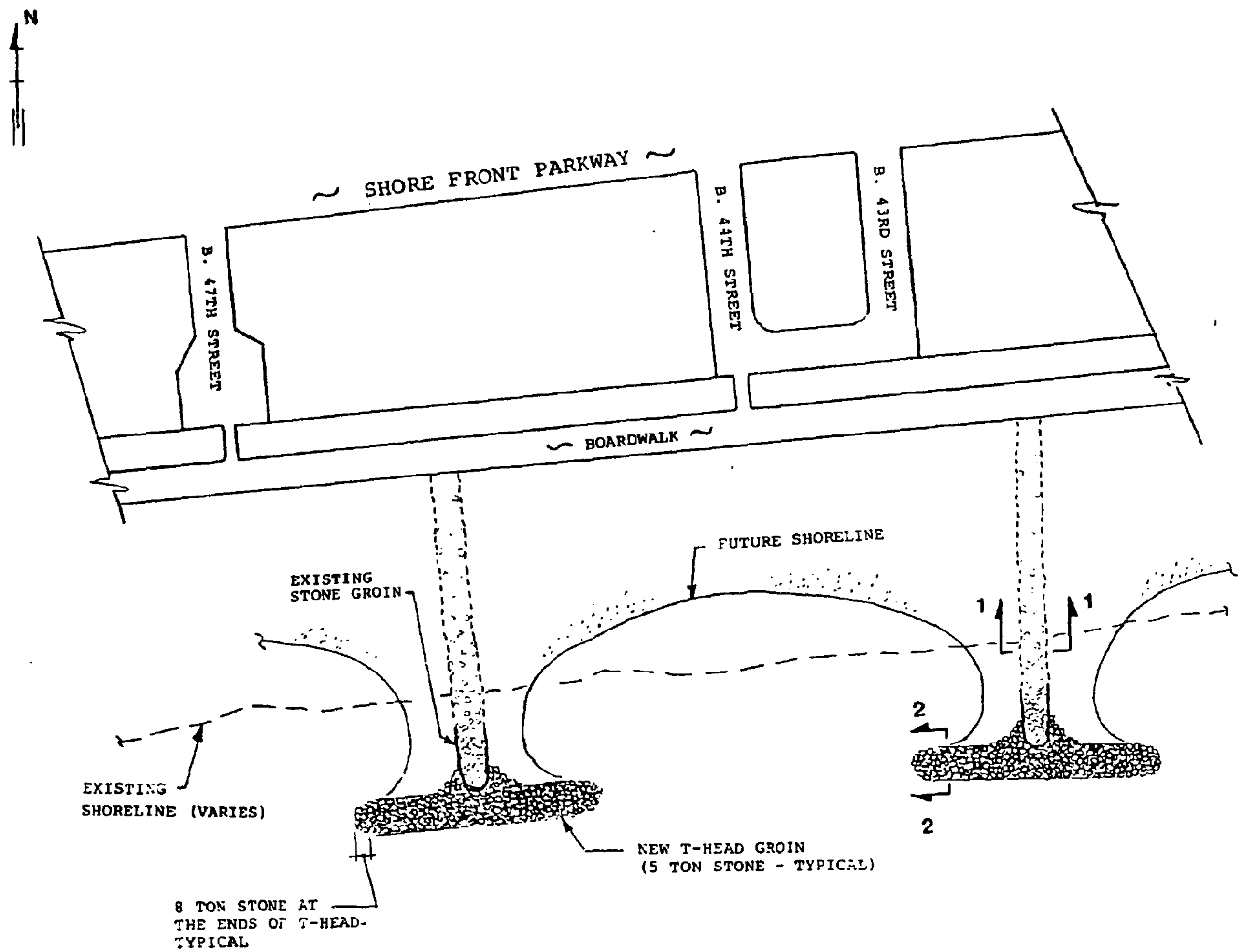
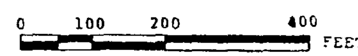


Figure C–2

ARVERNE URBAN RENEWAL AREA
Queens, New York

Typical Plan—Shore Protection
(T-Head Groin System)



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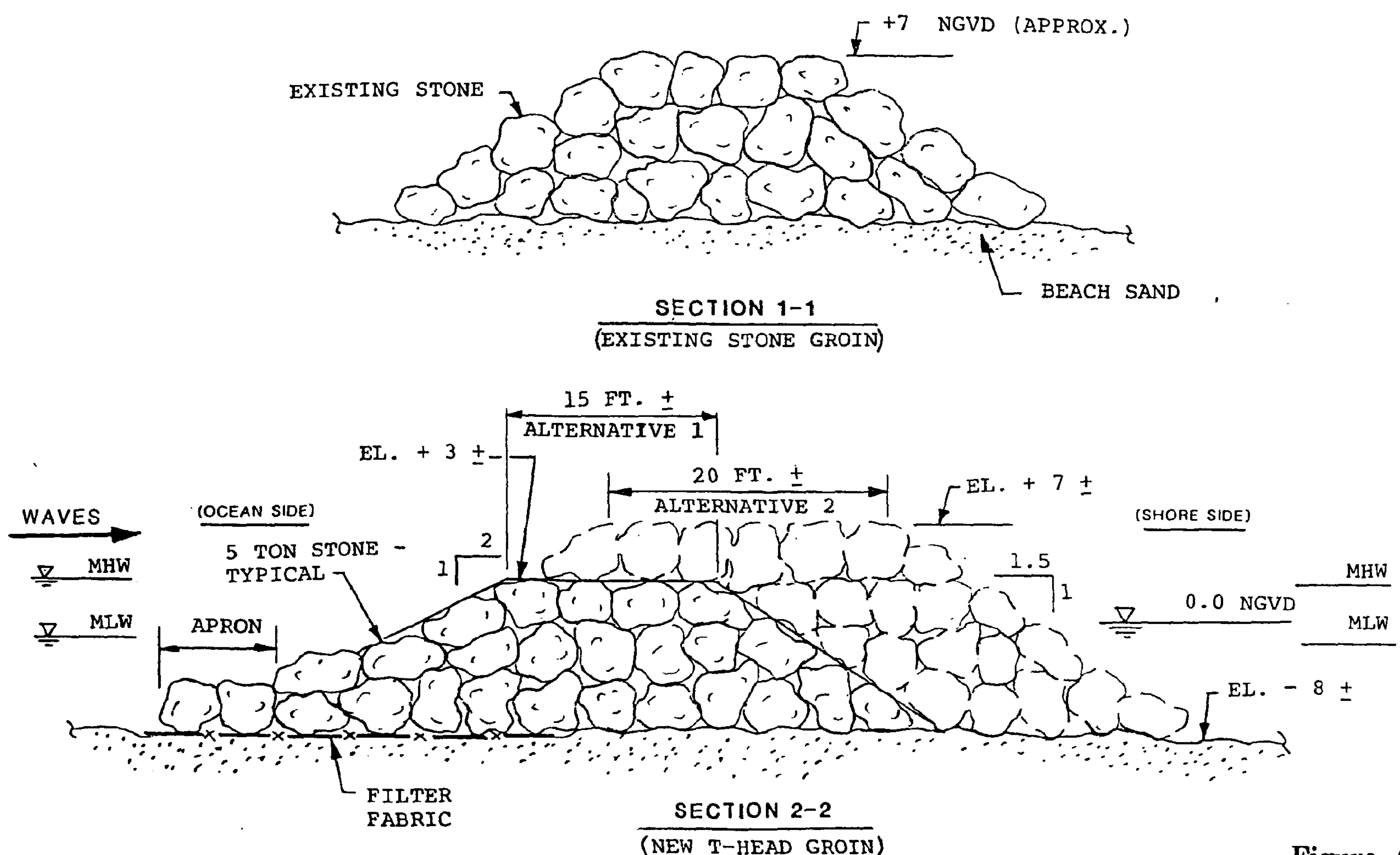

Figure C-3

ARVERNE URBAN RENEWAL AREA
Queens, New York

Department of City Planning

Dresdner, Robin & Associates, Inc.
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Edwards and Kelcey Engineers, Inc.
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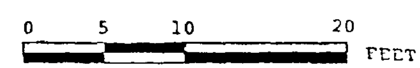
Cross-Sections of Two Alternative T-Head Groins



ALTERNATIVE 1 - WAVE OVERTOPPING ALLOWED - NO PUBLIC ACCESS

ALTERNATIVE 2 - PUBLIC ACCESS PERMITTED

existing groins. A complete new groin is required at the Beach 54th Street location since there is no existing shore-perpendicular groin in this area to serve as the nucleus for a new T-head groin.

Two alternatives are shown on Figure C-3, depending on whether public access is to be permitted at the offshore end of the T-head. If access is prohibited, the top elevation of the T-head can be kept low, at say elevation three feet NGVD (Alternative A1). However, if public access is permitted, the elevation must be raised to minimize danger from wave overtopping, and a larger structure is required (Alternative A2).

Alternative A1 requires about 56,000 cubic yards of stone, compared to Alternative A2, which requires about 100,000 cubic yards of stone. Assuming a unit price of $95 per cubic yard, this represents capital costs in the range of $5,220,000 to $9,500,000.

The scheme is expected to reduce the requirements for periodic beach fill by about 30 percent per year, reducing the annual replenishment rate by 75,000 cubic yards per year. Assuming a cost for beach fill of $8.50 per cubic yard, this represents a savings of about $640,000 per year.

5.3 Offshore Breakwaters

Offshore breakwaters are shore-parallel structures similar in concept to T-head groins, but on a much larger scale. They are generally fixed massive structures constructed in relatively deeper water, about 15 feet or more below MLW. Their main benefit is that, by greatly reducing the wave energy that reaches the beach, erosion losses during storms are reduced.

When offshore breakwaters are located close to the shoreline, a perpendicular spit or tombolo may develop connecting the shoreline and the offshore breakwater. This condition is extremely effective in stabilizing the beach immediately shoreward of the breakwater but can have adverse effects on the adjacent beaches by disrupting the supply of littoral drift.

In the past, offshore breakwaters have generally been used for port development projects but not generally for beach erosion control, due to their high construction costs. Offshore breakwaters can be quite effective in beach stabilization and the concept has received considerable interest and research (Institute of Civil Engineers, 1985). This is due in part to the escalating and recurring costs associated with beach fill projects, and in part to the relative ineffectiveness of other shore protection structures.

For example, the Japanese have recently increased their use of offshore breakwaters for beach stabilization applications (Toyoshima, 1982). More than 2,000 such structures have been built in Japan in the last ten years, more than the number of new groins built in the same period. In general, they are being used in critical erosion areas where "conventional" structures (mainly groins and sea walls) have proven ineffective.

A typical example of the use of offshore breakwaters is the Kaike coastline, located in northeast Japan (Toyoshima, 1982), on the Sea of Japan. The coastline here is a sand spit undergoing severe erosion attributed to a reduced supply of littoral drift caused by dam construction and sand mining activities on the adjacent Hino River. A groin system had been constructed about 35 years ago, but was ineffective in controlling erosion.

In the period 1971 to 1981, a total of 11 offshore breakwaters were constructed along a 2.2-kilometer stretch of the Kaike coast. The breakwaters were located parallel to the shore, in a water depth of about five meters, located about 200 meters from shore. The breakwater segments are typically 150 meters long, with a gap of 50 meters between adjacent segments. Wave exposure at the site is severe (similar to the Arverne URA), requiring 16-ton tetrapod armor units.

Large scale tombolo development occurred at each of the breakwater segments, immediately following construction. After several years, the beach profile and plan configuration had stabilized with only minor seasonal variations in contrast to the major seasonal fluctuations that occurred prior to the breakwater construction. Net sand accretion for the Kaike area, following the breakwater construction, was about 500,000 cubic meters (655,000 cubic yards).

The breakwater construction at Kaike coast was considered completely successful in stabilizing the beach, and no adverse impacts were reported. There were, however, higher construction and maintenance costs for the offshore breakwater construction.

Offshore breakwaters have also been used rather extensively on the Italian and Israeli coastlines (Institute of Civil Engineers, 1985 and Nir 1982). In general, these breakwaters are quite successful in stabilizing the coastline immediately behind them.

However, erosion problems have occurred along the downdrift beaches particularly at sites where full scale tombolo development has occurred. Water quality problems have developed in the relatively quiescent waters shoreward of the breakwaters; this was largely attributed to the nominal tide range of one foot in the Mediterranean; available tide range at Arverne is four feet.

Alternative B: Offshore Breakwaters

An offshore breakwater is shown schematically in Figure C-4. Construction would include three offshore breakwater units each 2,000 feet long at a water depth of about 25 feet below MLW. The easternmost unit is skewed slightly relative to the shoreline, to provide better protection against local wind waves from the southeast which affect the eastern segment of the shoreline.

The most economical offshore breakwater construction appears to be a rubble mound breakwater, constructed of stone. The crest elevation is assumed to be eight feet above MLW, with side slopes assumed to be in the ratio of 1 vertical to 1.5 horizontal. Armor stone needed would be about ten ton units.

The breakwater construction involves approximately 550,000 cubic yards of stone. Assuming a total installed unit price of $85 per cubic yard, this represents a capital cost of about $47,000,000.

The scheme would reduce the beach fill requirements by about 80 percent per year - reducing the annual replenishment rate by about 200,000 cubic yards per year. At $8.50 per cubic yard, this represents a savings of about $1,700,000 per year in the cost of beach fill.

Modified Offshore Breakwater Concepts

There are several variations on offshore breakwaters, which use different shore-parallel breakwater elements. These include:

Floating Breakwaters

The breakwaters are floating, barge-like structures, generally held in position by a system of mooring lines and anchors.

Floating breakwaters are suitable for relatively quiescent wave conditions, as in lakes and rivers, but are generally not feasible in areas with severe wave exposure. Large floating breakwater structures have

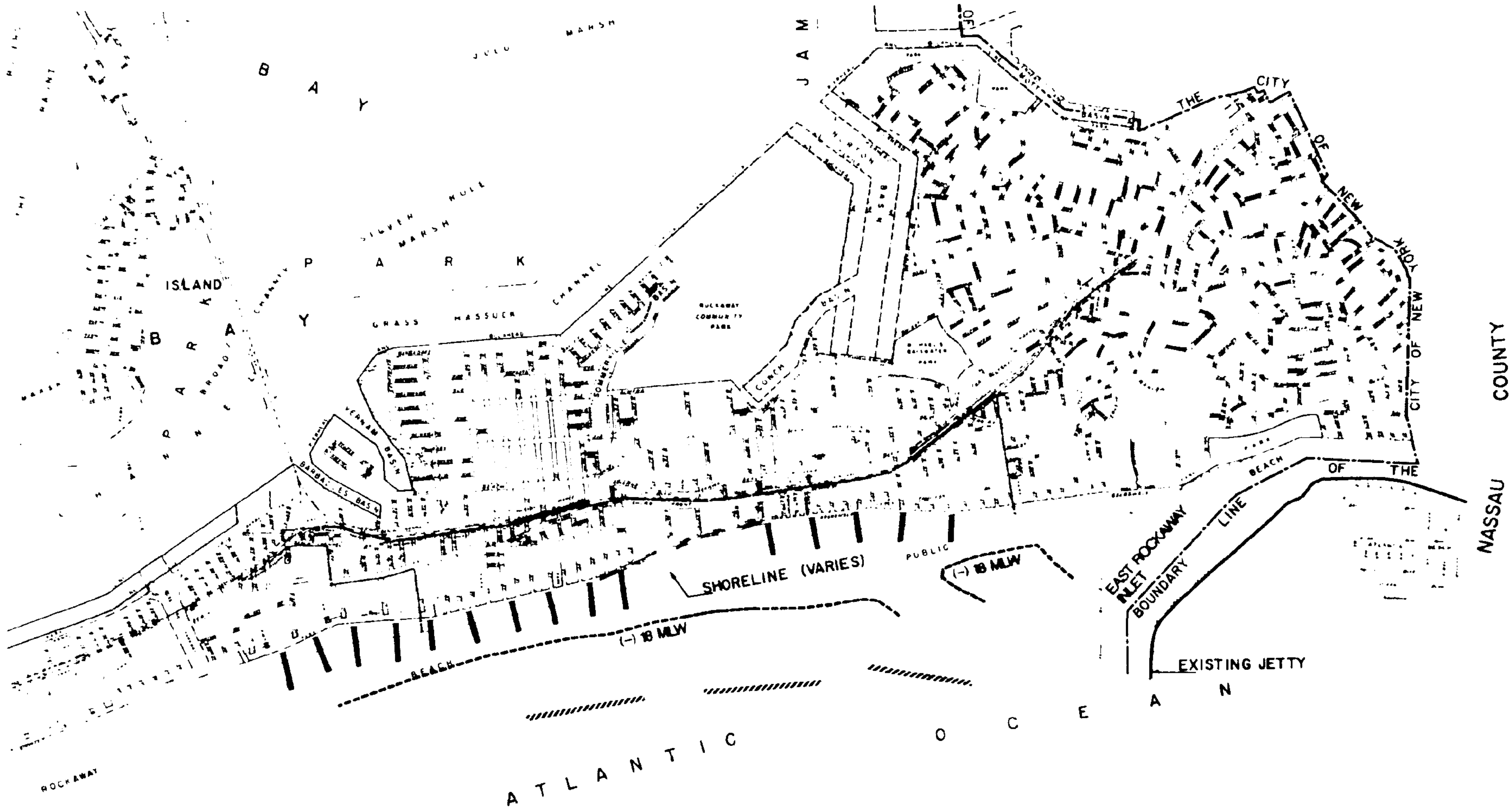


Figure C-4

ARVERNE URBAN RENEWAL AREA
Queens, New York

Department of City Planning

Dresdner, Robin & Associates, Inc.
Gruzen Samton Steinglass Architects, Planners
Edwards and Kelcey Engineers, Inc.
Abeles Phillips Preiss & Shapiro, Inc.

Shore Protection Plan—Alternative B (Offshore Breakwaters)

- Existing Stone Groins
- Proposed Offshore Breakwater (Stone)
- (–)18 Ft. Below Mean Low Water

Note: Old timber groins, now buried, are not shown

0 800 1600 2400 ft

been used for port development in areas with moderate wave exposure such as the Falkland Islands and Valdez, Alaska, and as platforms for offshore oil development. Floating breakwater construction might be technically feasible along the open coast at Arverne, but is not a realistic and environmentally acceptable solution. Apart from the severe design requirements for the open coast wave exposure, large floating breakwaters would pose an unacceptable risk in the New York City area if the mooring system were to fail during a storm.

Submerged Breakwaters

The crest elevation of a fixed offshore breakwater is below the water level, allowing waves to break over the structure.

Submerged breakwaters are technically feasible and would be lower in cost than conventional floating breakwaters. However, they could pose a hazard to navigation, and proper safeguards would be required.

Perched Beach

This relatively new concept locates a small, submerged breakwater or "sill" near shore, to break the waves and trap sediment, creating an elevated ("perched") beach profile.

The "perched beach" is similar in concept to the T-head groin, but involves a continuous submerged breakwater in lieu of larger detached elements. Although a prototype "perched beach" project is now being planned in New Jersey, there is no reliable field experience with this technique. The concept holds promise but cannot be recommended at this time.

Artificial Headlands

This alternative utilizes breakwaters as artificial headlands to create more stable crescent ("crenulate") shaped beaches. The breakwaters are located nearshore and are widely spaced (one-half mile or more).

The "artificial headlands" concept would be lower in cost than a conventional offshore breakwater since the breakwater elements are rather widely spaced. The concept has been investigated experimentally and has been used on a limited basis along the Singapore coastline (Silvester, 1976 and Dolan, 1973). The technique involves major realignments of the natural coastline, which cannot be accurately predicted, based on the limited empirical data that are available, particularly where wave exposure is variable, as in the Arverne URA. This concept is not recommended at the present time.

5.4 Sand Bypassing at East Rockaway Inlet

Beach processes in the Arverne area are interrelated with the tidal inlet system at East Rockaway Inlet and the jetty located on the east side of this inlet. The effects are particularly significant at the east end of the Site, where erosion is most critical.

A direct effect of the jetty and the artificially deep channel maintained by dredging within the inlet has been to block the natural supply of littoral drift moving westward from Atlantic Beach. Substantial accretion has developed on the eastside of the jetty, and to some degree this has occurred at the expense of the downdrift beaches in the Arverne URA, which were previously supplied with sand bypassed across shoals within the inlet. Such downdrift erosion is a common condition at jettied inlets and is sometimes remedied by an artificial sand bypassing system. Sand accumulated behind the jetty would be transferred across the inlet, on a continual basis with a pumping system.

In effect, sand bypassing is an alternative means of beach nourishment; its effectiveness would be similar to the present beach nourishment program at the east end of the Site. Although the present accretion at Atlantic Beach would cease, the beach could be maintained in an equilibrium condition without net erosion.

Alternative C: Sand Bypassing System

Potential sources of sand for a sand bypassing system (see Figure C-5) at East Rockaway Inlet are: a) the beach area east (updrift) of the jetty; b) shoals located immediately west (downdrift) of the jetty; or c) shoals located within the Inlet itself.

The most suitable source of sand appears to be the Atlantic Beach area east of the jetty. The shoals located within the Inlet or immediately west of the jetty are limited in size, with inadequate capacity for a long-term sand bypassing operation. In addition, dredging of Inlet-related shoals could significantly alter the hydraulics of East Rockaway Inlet, with adverse results. Dredging of Inlet shoals is likely to produce shoaling elsewhere (probably within the navigation channel itself), as the Inlet attempts to maintain a stable cross sectional area.

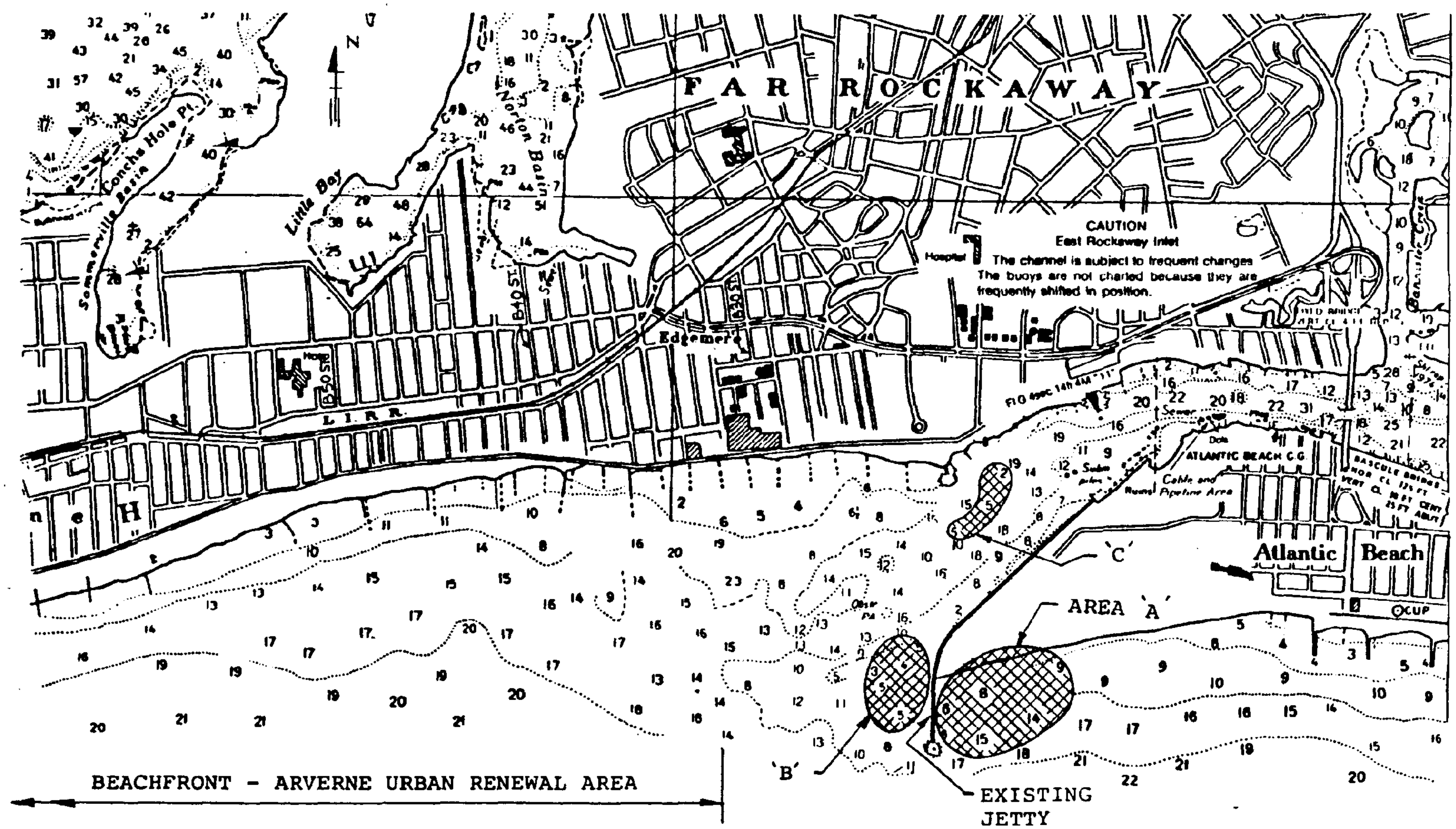


Figure C–5

ARVERNE URBAN RENEWAL AREA
Queens, New York

Department of City Planning

Dresdner, Robin & Associates, Inc.
Gruzen Samton Steinglass Architects, Planners
Edwards and Kelcey Engineers, Inc.
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Shore Protection Plan – Alternative C (Sand Bypassing, with Alternative Sources for Sand)

0 1000 2000 3000 FT.

ALTERNATIVE SOURCE AREAS SHOWN

A. Shoal and beach east of jetty
B. Shoal west of jetty
C. Shoal in East Rockaway Inlet

For analysis, the sand bypassing system is assumed to include the following:

- An offshore breakwater east of the jetty, to provide a sheltered area suitable for the dredging operations.

- Two mobile dredge plants located east of the jetty, consisting of jet pumps located offshore, operated from buoys or floating platforms, and driven by centrifugal pumps located onshore.

- Intake and discharge pipelines to connect the centrifugal pumps, the jet pumps, the intake water source (in East Rockaway Inlet) and the discharge points (at Arverne beaches).

The capital cost for the sand bypassing system is estimated at $6,400,000, including $5,500,000 for the breakwater construction and $900,000 for the dredging equipment and pipelines.

The amount of fill required under the sand bypassing alternative is 250,000 cubic yards, the same as is required with the present beach fill program. The dredging costs are estimated at $8.50 per cubic yard, including all operating/maintenance expenses associated with the sand bypassing system.

Jetty at East Rockaway Inlet

The existing jetty on the east side of East Rockaway Inlet significantly modifies the wave and tidal current conditions in the shallow area behind the jetty. This has apparently caused a local reversal in the dominant westward littoral drift along the coastline, seriously aggravating erosion conditions in the Arverne area.

This condition might be remedied by constructing a second jetty, along the west side of East Rockaway Inlet, to trap fill material moved by eastward littoral drift and tidal current. This jetty would help stabilize the beach in this area and reduce the maintenance dredging requirements within the channel.

However, such jetty construction would be extremely costly with minimal benefits from the viewpoint of the Arverne URA. The sand accretion caused by the jetty would be most pronounced in the immediate vicinity of the jetty, aiding beaches to the east of the Arverne URA. Beach fill placed at Arverne would continue to be lost, both offshore and eastward, at a rapid rate and would serve as a feeder beach for beaches located east of the Site. This would be beneficial for the Rockaway Beach Peninsula as a whole but is certainly not cost effective in terms of stabilizing the Arverne area beach. In any event, artificially deposited sand would be required, as the natural westward littoral drift along the south shore of Long Island would be impeded by the two jetties.

5.5 Artificial Dune Development

Sand dunes are natural features located at the landward edge of many barrier beaches. They serve as a "line of defense" during severe storms by providing a reservoir of sand to replenish eroding beaches and reducing wave induced damage to backshore areas. Natural sand dunes are lacking in the Arverne area but could be created artificially with sand fill placed behind the boardwalk area and stabilized by vegetation and sand fencing.

In the vicinity of the project, several miles of artificial sand dunes have been constructed since 1973 by the Town of Hempstead, 11 miles east of Arverne, at the east end of Long Beach barrier island. The dunes were constructed using sand fill, sand fencing and plantings of American Beach Grass.

The dunes are typically 8 to 12 feet high, with a base width of about 30 feet. The dunes are reported to be relatively stable and have required only minor maintenance for storm damage. They are intended to:

- Provide storm protection for the developed landward area during periods of high storm surge and wave attack.

- Trap wind-blown sand that would otherwise be lost from the beach area.

- Help stabilize the beach, providing a sand source to replenish the eroding beaches during severe storms.

- Provide habitat area for beach flora and fauna.

Overall, the Town of Hempstead considers their artificial dune program to be successful (Dolan, 1983). However, from a beach stabilization aspect it is unlikely that the dunes have had a very significant effect. Since erosion losses from the dunes during storms are apparently minor, the dunes are not serving as a major source of replenishment for the eroding beaches. Also, the small size of the dunes (about five cubic yards per linear foot of beach) greatly limits their potential as a source of beach fill. The beach in this area continues to erode and is maintained by a beach nourishment program using sand provided by periodic maintenance dredging of the adjacent Jones Inlet.

Another example of an artificial dune system, but on a much larger scale, is that at Cape Hatteras National Park, on the North Carolina coastline (Dolan, 1973 and Godfrey, 1973). Beginning in the 1930s, a major effort to construct a continuous barrier of artificial sand dunes was undertaken for the primary purpose of protecting the roadway and structures, landward of the dunes. The dunes are typically 12 to 15 feet high, with a base width of about 75 feet and an overall length of 50 miles.

The artificial dunes at Cape Hatteras have thus far been successful in protecting the landside facilities, but at enormous construction and maintenance costs and beachfront degradation. Artificially maintaining a dune line (similar to a revetment or bulkhead line) prevents the natural retreat of the barrier island resulting in a narrower, eroding beach in front. Despite the large size of the Cape Hatteras sand dunes, they are a minimal source of beach nourishment during storms.

Prior to the artificial dune construction, beach width at Cape Hatteras was typically about 200 meters. After construction, the beaches are typically less than 50 meters wide, and are continuing to erode rapidly. In contrast, the Cape Lookout National Seashore, located immediately south of Cape Hatteras, is a barrier island left in its natural state, not "stabilized" by artificial dunes or other structures. Here, the beach is not eroding, and its width has remained constant at about 200 meters over the same period.

It is generally more useful and cost effective to place fill material directly on the beach rather than using it to develop artificial dunes. To provide a last "line of defense," a more appropriate solution at Arverne is to establish suitable setbacks for construction and ensure that the onshore structures are adequately storm-proofed and flood-proofed.

5.6 Revetments and Bulkheads

Revetments and bulkheads are commonly used to stabilize shorelines against wave attack and flooding.

Bulkheads are vertical structures generally used in areas with minimum wave exposure (rivers, protected harbors, etc.). Revetments (seawalls) are sloped structures usually constructed of riprap stone, which offer substantial dissipation of wave energy and can be used in an open coast environment.

When properly designed, these structures can provide adequate protection against wave and flood damage. However, they only protect the land area immediately behind them, offering no benefit to stabilizing the beachfront. Revetments are only temporary solutions to eroding coastlines, as they themselves will eventually be undermined by erosion (in 50 to 100 years). In a long-term shore protection program, they are appropriate only in combination with other techniques which stablilize or promote development of the beach itself.

At Arverne, onshore revetment or bulkhead construction is not warranted at this time, provided adequate construction setbacks are maintained.

5.7 Alternative D: Beach Nourishment from Nearshore Sources

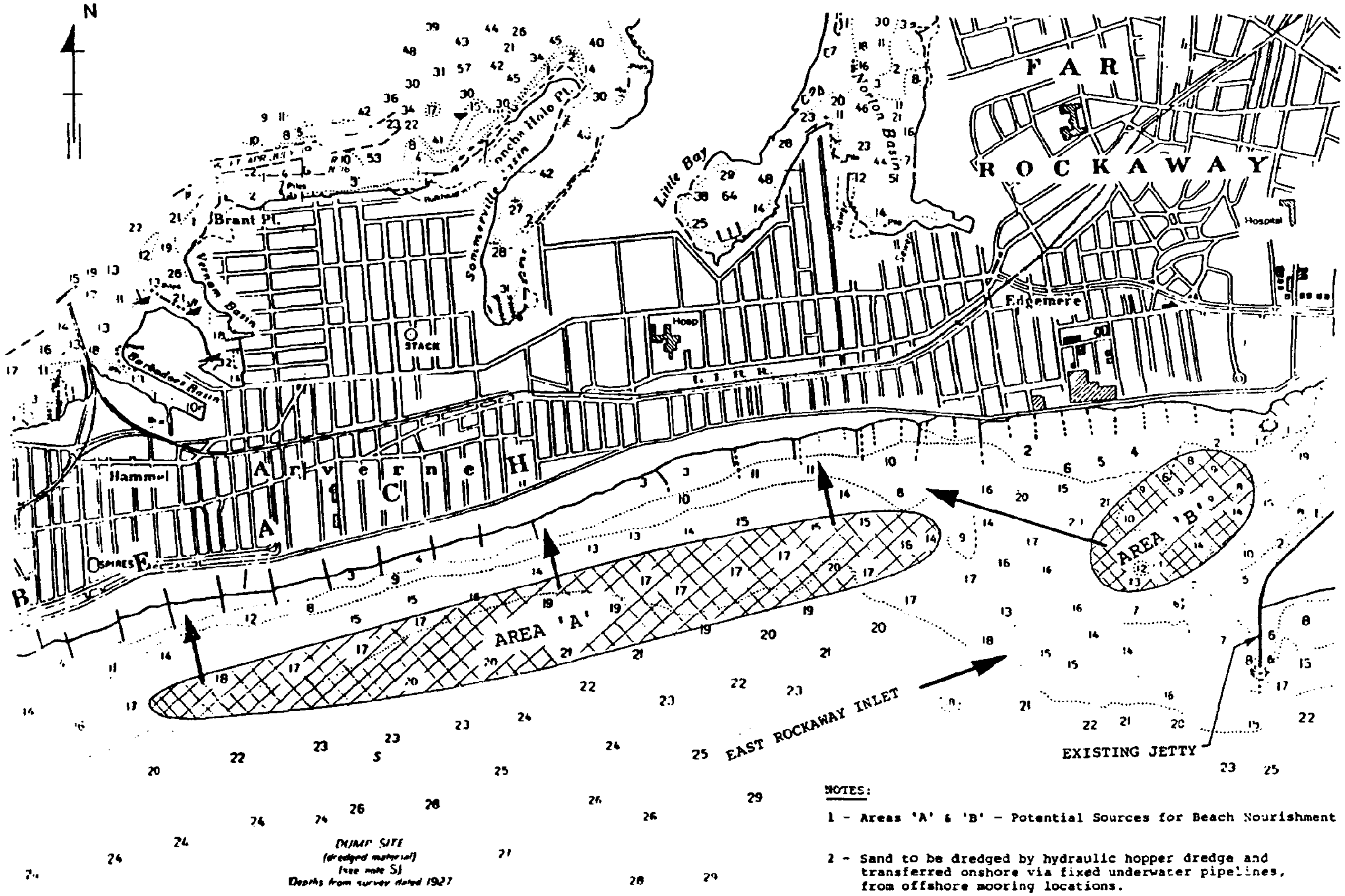
There are two potential sources for beach nourishment from nearshore locations. One possibility is to dredge the adjacent shoreface, at a distance of, say, one-half to one mile offshore (Figure C-6, Area "A"). Another possibility is to use the large shoal in the vicinity of East Rockaway Inlet (Figure C-6, Area "B").

Additional investigations would be required to verify the suitability of the material (e.g., appropriate grain size characteristics) and potential adverse impacts on wave conditions by creating shallow offshore "holes." For Area "B," studies would also be required to evaluate the effects of removing the shoals or altering the hydraulics and stability of East Rockaway Inlet.

The dredging costs for this alternative are estimated at $8.50 per cubic yard.

5.8 Alternative E: Beach Nourishment from Offshore Sources

Another beach nourishment alternative is the present beach fill program which uses offshore resources, amounting to an annual replenishment rate of about 250,000 cubic yards per year. The total price for the fill is assumed to be $10.00 per cubic yard.



NOTES:

1 - Areas 'A' & 'B' - Potential Sources for Beach Nourishment

2 - Sand to be dredged by hydraulic hopper dredge and transferred onshore via fixed underwater pipelines, from offshore mooring locations.

Figure C-6

ARVERNE URBAN RENEWAL AREA
Queens, New York

Shore Protection Plan – Alternative D (Beach Nourishment)

0 900 1800 2700 FEET

Department of City Planning

Dresdner, Robin & Associates, Inc.
Gruzen Samton Steinglass Architects, Planners
Edwards and Kelcey Engineers, Inc.
Abeles Phillips Preiss & Shapiro, Inc.

6. LIFE CYCLE COST ANALYSIS

The present value method of life cycle cost analysis is used, assuming a 50-year time frame and an effective discount rate (including inflation) of ten percent.

Maintenance for the breakwater and groin construction will consist primarily of resetting and replacing stones which become dislodged during storms. Maintenance of these structures will not be a problem provided that the foundations are not undermined by erosion. This assumes that a periodic beach nourishment program will still be required to avoid excessive offshore erosion losses that could undermine these structures.

Maintenance repair costs for the T-head groin system (Alternative A) are assumed to be $1.5 million, at 15-year intervals. For the offshore breakwaters (Alternative B) a $6 million repair cost is assumed after 25 years. Finally, $1 million is assumed for the existing shore-perpendicular system (used in Alternatives C, D and E), required at 15-year intervals.

On this basis, the 50-year life cycle costs, including all capital and maintenance costs, are:

Alternative A1:	T-Head Groin System with Low Berms	$20,500,000
Alternative A2:	T-Head Groin System with High Berms	$24,700,000
Alternative B:	Offshore Breakwaters	$51,500,000
Alternative C:	Sand Bypassing System	$27,800,000
Alternative D:	Beach Nourishment Nearshore Sources	$21,400,000
Alternative E:	Beach Nourishment Offshore Sources	$25,100,000

For comparison, if a 25-year time frame is considered, the life cycle costs are:

Alternative A1:	T-Head Groin System with Low Berms	$19,200,000
Alternative A2:	T-Head Groin System with High Berms	$23,400,000

Alternative B:	Offshore Breakwaters	$50,600,000
Alternative C:	Sand Bypassing System	$25,900,000
Alternative D:	Beach Nourishment Nearshore Sources	$19,500,000
Alternative E:	Beach Nourishment Offshore Sources	$19,500,000

---

7. SUMMARY OF CONCLUSIONS

A number of alternative shore protection measures have been considered for stabilization of the Arverne beachfront. The studies included various structural and nonstructural measures, as well as the "do nothing" approach.

As described in Chapter A, the "do nothing" approach is not feasible. The high natural beach recession rates, if left unabated, would preclude permanent development in the Arverne URA.

Experience has shown that the existing conventional shore-perpendicular protection structures at Arverne have not been very effective in stabilizing the shoreline in this area. A more effective long-term approach may be to use shore-parallel breakwater elements, such as T-head groins or offshore breakwaters.

Offshore breakwaters would be very effective in stabilizing the beach but involve extremely high construction costs. In addition, they would interrupt the supply of littoral drift and could result in accelerated erosion of the downdrift beaches.

T-head groins would have a lesser stabilizing effect than offshore breakwaters but are more cost effective because of their much lower capital costs. T-head groins would provide sufficient and adequate containment of littoral drift in the project area. Offshore breakwaters have the potential to retain more sand than T-head groins; however, the downdrift beach erosion would be more severe.

Artificial beach nourishment presently used at Arverne is the preferred "non-structural" shore protection measure over artificial sand dune development. Potential sources for beach fill material include: 1) offshore sources (currently being used); 2) nearshore sources (Figure C-6); or 3) Atlantic Beach, east of the jetty at East Rockaway Inlet (using a sand bypassing system). Nearshore sources are lowest in cost, but could involve environmental issues. Additional studies would be required to verify the suitability (grain size characteristics) of the material and to evaluate the effects of removing the shoal on the patterns of wave refraction patterns and tidal currents.

Preliminary analysis indicates that a sand bypassing system from Atlantic Beach has life cycle costs similar to the present use of offshore sources. More detailed analysis is warranted to evaluate the viability of this scheme.

Considering all structural and nonstructural options, the lowest cost alternatives are:

- Beach Nourishment/Nearshore Sources (Figure C-6) - $21.1 Million (50-Year Life Cycle).

- T-Head Groins with low berms (Figures C-1 to C-3) - $20.5 Million (50-Year Life Cycle).

However, life-cycle cost should not be the sole financial consideration. Life-cycle cost calculations are strongly biased towards projects with low capital, but high maintenance, costs (beach nourishment programs), as opposed to projects with high capital costs but lower maintenance costs (T-head groins or offshore breakwaters). This assumes, of course, that a continuous source of funding is available to cover the high maintenance costs of beach nourishment programs.

Through the Water Resources Development Act of 1976 (42 U.S.C. 1962d-5f), the Secretary of the Army acting through the Chief of Engineers is authorized to provide periodic beach nourishment for already approved projects as determined necessary for a period not to extend beyond 50 years. As discussed in this Report, a federally sponsored beach fill project was completed in 1976, followed by a ten-year period of beach nourishment; the last scheduled beach nourishment was completed in 1988. At this time long-term federal funding of the beach nourishment program is being evaluated. Based on the analysis conducted for this Report, it is concluded that long-term maintenance costs could be reduced, if possible, with modest capital investment.

The T-head groins may have to be used on a trial basis, in phases, since field experience with this design is somewhat limited. However, considering that the development will be constructed over a period of time (5 to 20 years), construction of shore protection structures, if carefully programmed to avoid any downdrift impacts, could be implemented incrementally.

Artificial beach nourishment would still be needed in combination with the T-head groins, but less fill quantities would be required. Alternative lower cost sources for the beach fill, meriting additional investigation, are shown in Figure C-5.

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EDWARDS AND KELCEY, INC.

Appendix A

TEST BORING LOG

SHEET 1 OF 2

PROJECT: Arverne — BORING/~~PIT~~ NO.: B-1

LOCATION: Between B74th & B75th St., 15 North of curb & hyd. of R.B.Blvd. — ELEVATION:

BORINGS BY: Walsh — DATE STARTED: 11/12/86 — ELEV. G.W.L.: — DATE:

INSPECTOR: George Aswad — DATE FINISHED: 11/12/86 — ELEV. G.W.L.: 4'-9" below ground surface — DATE: 11/12/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 12/18	SPOON BLOWS 6/12 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-				
S-1	0.0'	2.0'	16"	3	9	0	Misc. FILL (concrete, bricks, brown f	12
				11	14	1	Sand, roots & fibers)	41
						2		29
						3		52
						4		48
A-1	5.0'	7.0'	24"	5	7	5	Brown f SAND, trace Silt	5
				11	12	6		12
						7		14
						8		22
						9		16
S-3	10.0'	12.0'	22"	3	6	10	Gray mf SAND, trace (-) Silt	4
				8	12	1		8
						2		25
						3		39
						4		44
S-4	15.0'	17.0'	24"	6	11	5	Gray mf SAND, trace (-) Silt	6
				15	13	6		12
						7		14
						8		19
						9		26
S-5	20.0'	22.0'	22"	6	12	20	Gray mf SAND, trace Silt, trace (-) mf	8
				16	21	1	Gravel	13
						2		22
						3		27
						4		43
S-6	25.0'	27.0'	18"	11	26	5	Gray mf SAND, trace (-) Silt	16
				38	34	6		44
						7		55
						8		62
						9		100
						30		

I.D. Casing 2-1/4"	Wgt. Hammer on Casing 300 lb.
I.D. Spoon 1-3/8"	Wgt. Hammer on Spoon 140 lb.
Type Core Drill -	Drop Hammer on Casing 18"
Core Dia. -	Drop Hammer on Spoon 30"

Proportions % by Wgt.	and	some	little	trace	
	35 to 50	20 to 35	10 to 20	1 to 10	

Density Blows/ft.	very loose	loose	med. dense	dense	very dense
	0-5	5-10	10-30	30-50	> 50

Consistency Blows/ft.	very soft	soft	medium	stiff	very stiff	hard
	< 2	2-4	4-8	8-15	15-30	> 30

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, Edwards and Kelcey, Inc. if he finds that the actual conditions do not conform those indicated by this log.

EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 2 OF 2

PROJECT: Arverne — BORING/~~...~~ NO.: B-1

LOCATION: Between B74th & B75th St., 15 North of curb & hyd. of R.B.Blvd — ELEVATION:

BORINGS BY: Walsh — DATE STARTED: 11/12/86 — ELEV. G.W.L.: ____ — DATE: 11/12/86

INSPECTOR: George Aswad — DATE FINISHED: 11/12/86 — ELEV. G.W.L.: 4'-9" below ground surface — DATE: 11/12/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 12/18	SPOON BLOWS 6/12 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-		30		
S-7	30.0'	32.0'	18"	10	17	1	Gray f SAND, little (-) Silt	22
				22	21	2		23
						3		40
						4		63
						35		98
S-8	35.0'	37.0'	24"	11	17	6	Gray f SAND, trace Silt	
				29	24	7	B.O.H. 37'	
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

I.D. Casing 2-1/4"	Wgt. Hammer on Casing 300 lb.
I.D. Spoon 1-3/8"	Wgt. Hammer on Spoon 140 lb.
Type Core Drill -	Drop Hammer on Casing 18"
Core Dia. -	Drop Hammer on Spoon 30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10		
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, Edwards and Kelcey, Inc. if he finds that the actual conditions do not conform those indicated by this log.

EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 1 OF 2

PROJECT: Arverne BORING/~~ ~~ NO.: B-2

LOCATION: Between B70th & 69th St.(10' North of curb & hydrand on R.B.B ELEVATION: ______

BORINGS BY: Walsh DATE STARTED: 11/11/86 ELEV. G.W.L.: ______ DATE: ______

INSPECTOR: George Aswad DATE FINISHED: 11/11/86 ELEV. G.W.L.: 3'-2" below ground surface DATE: 11/11/86

SAMPLE NO.	DEPTH (from)	DEPTH (to)	REC	SPOON BLOWS 0/6 – 12/18	SPOON BLOWS 6/12 – 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-				
S-1	0.0'	2.0'	16"	1	1	0	Brown f SAND, trace Silt, w/Peat, roots & fibers	3
				1	2	1		2
						2		300+
						3		10
						4		75
S-2	5.0'	7.0'	12"	8	10	5	Brown mf SAND, little Silt	3
				15	16	6		6
						7		22
						8		34
						9		51
S-3	10.0'	12.0'	18"	7	16	10	Gray mf SAND, trace Silt	7
				20	24	1		11
						2		27
						3		31
						4		33
S-4	15.0'	17.0'	22"	4	4	5	Gray cf SAND, little (+) f Gravel	7
				9	12	6		12
						7		16
						8		22
						9		29
S-5	20.0'	22.0'	16"	3	6	20	Gray mf SAND, trace (+) f Gravel, trace Silt	8
				8	11	1		12
						2		29
						3		35
						4		31
S-6	25.0'	27.0'	24"	2	1	5	Black Organic Clayey SILT	25
				1	1	6		29
						7		28
						8		26
						9		30
						30		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10	
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30 / hard > 30

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The Information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, Edwards and Kelcey, Inc. if he finds that the actual conditions do not conform those indicated by this log.

EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 2 OF 2

PROJECT: Arverne BORING/~~[illegible]~~ NO.: B-2

LOCATION: Between B70th & 69th(10' from curb & hydrant) ELEVATION:

BORINGS BY: Walsh DATE STARTED: 11/11/86 ELEV. G.W.L.: DATE:

INSPECTOR: George Aswad DATE FINISHED: 11/11/86 ELEV. G.W.L.: 3'-2" below ground surface DATE: 11/11/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 12/18	6/12 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-		30		
S-7	30.0'	32.0'	18"	21	29	1	Gray-black f SAND, little (-) Silt	45
					36	2	47	70
						3		84
						4		92
						5		99
S-8	35.0'	37.0'	22"	19	30	6	Gray-black f SAND, trace (+) Silt	
				42	49	7		
						8	B.O.H. 37'	
						9		
						40		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.		and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10	
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The Information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, Edwards and Kelcey, Inc. if he finds that the actual conditions do not conform those indicated by this log.

EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 1 OF 2

PROJECT: Arverne BORING/~~PIT~~ NO.: B-3

LOCATION: B65 & Larkin Ave. (10' West of fire hydrant & curb) ELEVATION:

BORINGS BY: Walsh DATE STARTED: 11/10/86 ELEV. G.W.L.: DATE:

INSPECTOR: George Aswad DATE FINISHED: 11/10/86 ELEV. G.W.L.: 3'-0" below ground surface DATE: 11/10/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 / 12/18	SPOON BLOWS 6/12 / 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-				
S-1	0.0'	2.0'	20"	2	2	0	Brown-tan mf SAND, trace Silt, trace (-) f Gravel	2
				4	4	1		5
						2		6
						3		9
						4		11
S-2	5.0'	7.0'	22"	3	3	5	Brown-tan mf SAND, trace (-) Silt	2
				6	9	6		5
						7		16
						8		30
						9		47
S-3	10.0'	12.0'	18"	9	18	10	Gray f SAND, trace (-) Silt	4
				38	39	1		11
						2		34
						3		57
						4		106
S-4	15.0'	17.0'	24"	15	28	5	Gray-tan mf SAND, trace f Gravel, trace (-) Silt	14
				40	49	6		21
						7		50
						8		80
						9		159
S-5	20.0'	22.0'	16"	20	39	20	Gray-tan mf SAND, trace (-) f Gravel	20
				55	72	1		25
						2		48
						3		89
						4		184
S-6	25.0'	27.0'	18"	14	29	5	Gray-tan mf SAND, trace (-) f Gravel	22
				31	36	6		39
						7		54
						8		127
						9		153
						30		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10		
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, Edwards and Kelcey, Inc. if he finds that the actual conditions do not conform those indicated by this log.

EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 2 OF 2

PROJECT: Arverne — BORING/~~???~~ NO.: B-3

LOCATION: B65 & Larkin Ave. (10' West of fire hydrant & curb) — ELEVATION:

BORINGS BY: Walsh — DATE STARTED: 11/10/86 — ELEV. G.W.L.: — DATE:

INSPECTOR: George Aswad — DATE FINISHED: 11/10/86 — ELEV. G.W.L.: 3'-0" below ground surface — DATE: 11/10/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 12/18	SPOON BLOWS 6/12 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-		30		
S-7	30.0'	32.0'	18"	12	22	1	Gray f SAND, trace (-) Silt	35
				18	18	2		40
						3		61
						4		92
						5		158
S-8	35.0'	37.0'	22"	6	14	6	Gray mf SAND, trace (+) f Gravel &	
				24	34	7		
						8	B.O.H. 37.'	
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10		
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, Edwards and Kelcey, Inc. if he finds that the actual conditions do not conform those indicated by this log.

EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 1 OF 2

PROJECT: Arverne — BORING/[redacted] NO.: B-4P
LOCATION: B 62 & Rockaway Beach Blvd.(8' West of curb & fire hydrand) — ELEVATION:
BORINGS BY: Walsh — DATE STARTED: 11/6/86 — ELEV. G.W.L.: — DATE:
INSPECTOR: George Aswad — DATE FINISHED: 11/7/86 — ELEV. G.W.L.: 3'-8" below ground surface — DATE: 11/7/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 12/18	SPOON BLOWS 6/12 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-				
S-1	0.0'	2.0'	18"	1	2	0	Tan f SAND	2
				2	5	1		3
						2		9
						3	(Permeability test performed)	10
S-2	5.0'	7.0'	20"	2	4	4	km = 1.1×10^{-2} cm/sec	11
				7	7	5	Gray-black f SAND, trace Silt	2
						6		3
						7		11
						8		10
						9	(Permeability test performed)	5
						10	Permeability is very low. (A) Gray-black Clayey SILT	4
S-3A	10.0'	12.0'	24"	1	1	1	(B) Gray mf SAND, trace Silt	11
				11	17	2		23
S-3B						3	(Permeability test performed)	28
						4	km = 5.08×10^{-4} cm/sec	34
S-4	15.0'	17.0'	18"	9	16	5	Gray-black f SAND, trace (+) Silt	11
				18	16	6		16
						7		26
						8		26
						9		25
S-5	20.0'	22.0'	20"	8	9	20	(Permeability test performed)	16
				10	12	1	km = 4.3×10^{-4} cm/sec	19
						2	Gray-black f SAND, trace (+) Silt	27
						3		34
						4		29
S-6	25.0'	27.0'	22"	7	12	5	(Permeability test performed)	20
				18	23	6	km = 1.1×10^{-3} cm/sec	34
						7	Gray-black mf SAND, trace (+) Silt	55
						8		68
						9		94
						30		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10		
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

The Contractor shall make his own subsurface investigations in order to satisfy himself of the actual subsurface conditions. The information contained on this log is not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, Edwards and Kelcey, Inc. if he finds that the actual conditions do not conform those indicated by this log.

EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 2 OF 2

PROJECT: Arverne BORING/~~PIT~~ NO.: B-4P

LOCATION: B 62 & Rockaway Beach Blvd.(8' West of curb & fire hydrant) ELEVATION:

BORINGS BY: Walsh DATE STARTED: 11/6/86 ELEV. G.W.L.: DATE:

INSPECTOR: George Aswad DATE FINISHED: 11/7/86 ELEV. G.W.L.: 3'-8" below ground surface DATE: 11/7/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 12/18	6/12 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-		30	(Permeability test performed)	
S-7	30.0'	32.0'	18"	4	9	1	km = 2.3×10^{-4} cm/sec	22
				12	16	2	Gray f SAND, trace Silt	31
						3		49
						4		38
						5		45
S-8	35.0'	37.0'	20"	2	3	6	Permeability test performed)	
				5	9	7	km = 1.5×10^{-4} cm/sec	
						8	Gray-black mf SAND, little Silt, trace (-) f Gravel.	
						9		
						40		
S-9	40.0'	42.0'	18"	5	9	1	Black-gray cf SAND, trace (-) Silt	
				14	22	2		
						3	B.O.H. 42.'	
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

I.D. Casing 2-1/4"	Wgt. Hammer on Casing 300 lb	Proportions % by Wgt.	and 35 to 50; some 20 to 35; little 10 to 20; trace 1 to 10
I.D. Spoon 1-3/8"	Wgt. Hammer on Spoon 140 lb	Density Blows/ft.	very loose 0-5; loose 5-10; med. dense 10-30; dense 30-50; very dense > 50
Type Core Drill —	Drop Hammer on Casing 18"	Consistency Blows/ft.	very soft < 2; soft 2-4; medium 4-8; stiff 8-15; very stiff 15-30; hard > 30
Core Dia. —	Drop Hammer on Spoon 30"		

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EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 1 OF 2

PROJECT: Arverne — BORING/~~R11~~ NO.: B-5

LOCATION: B 42 & Edgemere Ave.(10' from fire hydrant & curb) — ELEVATION:

BORINGS BY: Walsh — DATE STARTED: 11/10/86 — ELEV. G.W.L.: — DATE:

INSPECTOR: George Aswad — DATE FINISHED: 11/10/86 — ELEV. G.W.L.: 6'-10" below ground surface — DATE: 11/10/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 12/18	SPOON BLOWS 6/12 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-				
S-1	0.0'	2.0'	18"	1	2	0	Brown mf SAND, little (-) Silt, trace c-m Gravel	1
				3	4	1		6
						2		4
						3		7
						4		9
S-2	5.0'	7.0'	22"	3	4	5	Brown mf SAND, trace Silt	2
				12	13	6		9
						7		18
						8		17
						9		26
S-3	10.0'	12.0'	24"	10	20	10	Tan mf SAND, trace (-) Silt	5
				35	49	1		23
						2		55
						3		111
						4		179
S-4	15.0'	17.0'	18"	8	19	5	Gray f SAND, trace Silt	16
				33	62	6		27
						7		60
						8		141
						9		170
S-5	20.0'	22.0'	20"	15	34	20	Gray f SAND, trace (-) Silt	23
				48	70	1		34
						2		73
						3		115
						4		129
S-6	25.0'	27.0'	18"	7	15	5	SAME	30
				22	28	6		44
						7		52
						8		62
						9		62
						30		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10		
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

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EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 2 OF 2

PROJECT: Arverne BORING/~~PIT~~ NO.: B-5

LOCATION: B 42 & Adgemere Ave.(10' from fire hydrant & curb) ELEVATION:

BORINGS BY: Walsh DATE STARTED: 11/10/86 ELEV. G.W.L.: DATE:

INSPECTOR: George Aswad DATE FINISHED: 11/10/86 ELEV. G.W.L.: 6'-10" DATE: 11/10/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 12/18	6/12 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-		30		
S-7	30.0'	32.0'	18"	5	12	1	Gray f SAND, little (+) Silt (w/layers of Black Clayey Silt)	30
				20	25	2		36
						3		49
						4		48
						5		57
S-8	35.0'	37.0'	24"	9	17	6	Gray f SAND, trace Silt	
				34	49	7		
						8	B.O.H. 37.'	
						9		
						40		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10		
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

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EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 1 OF 2

PROJECT: Arverne — BORING/~~PIT~~ NO.: B-6P

LOCATION: B 36 & Edgemere Ave.(15' from curb & fire hydrant) — ELEVATION:

BORINGS BY: Walsh — DATE STARTED: 11/7/86 — ELEV. G.W.L.: — DATE:

INSPECTOR: George Aswad — DATE FINISHED: 11/7/86 — ELEV. G.W.L.: 5'-00" below ground surface — DATE: 11/7/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 / 12/18	SPOON BLOWS 6/12 / 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-		0		
S-1	0.0'	2.0'	20"	1	2	1	Brown f SAND, little Silt, trace (-) Gravel	1
				3	5	2		4
						3		14
						4		20
						5		25
S-2	5.0'	7.0'	22"	2	4	6	(Permeability test performed) km = 7.25×10^{-3} cm/sec Gray-black f SAND, trace Silt	2
				5	5	7		4
						8		11
						9		15
						10		16
S-3	10.0'	12.0'	24"	5	7	1	(Permeability test performed) km = 4.2×10^{-3} cm/sec Gray f SAND, trace Silt (w/layers of black f SAND, some (-) Silt)	3
				6	4	2		2
						3		4
						4		12
						5		20
S-4	15.0'	17.0'	16"	5	8	6	(Permeability test performed) km = 1.36×10^{-2} cm/sec Gray-black f SAND, trace (+) Silt	11
				8	6	7		10
						8		12
						9		11
						20		13
						1	(Permeability test performed) km = 1.9×10^{-3} cm/sec Gray-black f SAND, little (-) Silt	13
S-5	20.0'	22.0'	22"	8	10	2		14
				10	9	3		20
						4		21
						5		32
S-6	25.0'	27.0'	18"	3	5	6	(Permeability test performed) km = 9.9×10^{-4} cm/sec Gray mf SAND	13
				9	11	7		16
						8		26
						9		35
						30		44

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill		Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10		
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

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EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 2 OF 2

PROJECT: Arverne — BORING/~~PIT~~ NO.: B-6P

LOCATION: B 36 & Edgemere Ave. (15' from curb & fire hydrant) — ELEVATION:

BORINGS BY: Walsh — DATE STARTED: 11/7/86 — ELEV. G.W.L.: — DATE:

INSPECTOR: George Aswad — DATE FINISHED: 11/7/86 — ELEV. G.W.L.: 5'-00" below ground level — DATE: 11/7/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6, 12/18	SPOON BLOWS 6/12, 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-				
						30		
S-7	30.0'	32.0'	18"	5	11	1	(Permeability test performed)	18
				16	16		km = 5.33×10^{-4} cm/sec	19
						2	Brown mf SAND, trace Silt	34
						3		40
						4		39
						5		
S-8	35.0'	37.0'	22"	5	9	6	(Permeability test performed)	
				15	18		km = 8.78×10^{-5} cm/sec	
						7	Brown f SAND, trace (+) Silt	
						8	B.O.H. 37.'	
						9		
						40		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and	some	little	trace	
	35 to 50	20 to 35	10 to 20	1 to 10	
Density Blows/ft.	very loose	loose	med. dense	dense	very dense
	0-5	5-10	10-30	30-50	> 50
Consistency Blows/ft.	very soft	soft	medium	stiff	very stiff	hard
	< 2	2-4	4-8	8-15	15-30	> 30

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EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 1 OF 2

PROJECT: Arverne — BORING/ NO.: B-7P

LOCATION: Between 77th & 73th (15' North of Curb & Arv/…on R.B. Bld. — ELEVATION:

BORINGS BY: Walsh — DATE STARTED: 11/5/86 — ELEV. G.W.L.: — DATE:

INSPECTOR: George Aswad — DATE FINISHED: 11/8/86 — ELEV. G.W.L.: 4' below ground level — DATE: 11/6/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 - 12/18	SPOON BLOWS 6/12 - 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-				
						0		
S-1	0.0'	2.0'	18"	1	2	1	Gray-brown mf SAND, little (-) Silt, w/roots & fibers	3
				5	4	2		7
						3		7
						4		19
						5	(Permeability test performed)	22
S-2	5.0'	7.0'	16"	8	12	6	km = 3.5×10^{-2} cm/sec	5
				19	26	7	Gray mf SAND, trace Silt	8
						8		13
						9		33
						10	(Permeability test performed)	35
						1	km = 3.4×10^{-3} cm/sec	5
S-3	10.0'	12.0'	18"	7	8	2	Gray mf SAND, trace Silt	10
				12	13	3		12
						4		15
						5	(Permeability test performed)	26
S-4	15.0'	17.00'	20"	3	9	6	km = 1.8×10^{-3} cm/sec	10
				16	18	7	Gray mf SAND, trace (-) Silt	10
						8		22
						9		35
						20	(Permeability test performed)	49
S-5	20.0'	22.0'	22"	6	14	1	km = 1.1×10^{-3} cm/sec	11
				24	29	2	Gray mf SAND, trace Silt	23
						3		55
						4		71
						5	(Permeability test performed)	86
S-6	25.0'	27.0'	24"	4	9	6	km = 1.1×10^{-3} cm/sec	28
				17	22	7	Gray mf SAND, trace (+) Silt	38
						8		63
						9		90
						30		104

I.D. Casing 2-1/4"	Wgt. Hammer on Casing	300 lb
I.D. Spoon 1-3/8"	Wgt. Hammer on Spoon	140 lb
Type Core Drill -	Drop Hammer on Casing	18"
Core Dia. -	Drop Hammer on Spoon	30"

Proportions by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10	
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

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EDWARDS AND KELCEY, INC.

TEST BORING LOG

SHEET 2 OF 2

PROJECT: Arverne — BORING NO.: B-7P
LOCATION: Between 77th & 79th (15' North of Curb & ~~[illegible]~~ on R.B. Bld.) — ELEVATION:
BORINGS BY: Walsh — DATE STARTED: 11/5/86 — ELEV. G.W.L.: — DATE:
INSPECTOR: George Aswad — DATE FINISHED: 11/6/86 — ELEV. G.W.L.: 4' below ground level — DATE: 11/6/86

SAMPLE NO.	DEPTH		REC	SPOON BLOWS 0/6 – 12/18	SPOON BLOWS 6/12 – 18/24	SAMPLED DEPTH (FEET)	SAMPLE IDENTIFICATION & PROFILE CHANGE	CASING BLOWS
				-		30	(Permeability test performed)	
S-7	30.0'	32.0'	22"	9	13	1	km = 8.78×10⁻⁴ cm/sec	31
				23	30	2	Gray mf SAND, trace Silt	61
						3		88
						4	(Permeability test performed)	81
						5	km = 5.73×10⁻⁴ cm/sec	120
S-8	35.0'	37.0'	18"	10	17	6	Gray mf SAND, trace Silt	
				26	46	7	B.O.H. 37'	
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						0		

I.D. Casing	2-1/4"	Wgt. Hammer on Casing	300 lb.
I.D. Spoon	1-3/8"	Wgt. Hammer on Spoon	140 lb.
Type Core Drill	-	Drop Hammer on Casing	18"
Core Dia.	-	Drop Hammer on Spoon	30"

Proportions % by Wgt.	and 35 to 50	some 20 to 35	little 10 to 20	trace 1 to 10		
Density Blows/ft.	very loose 0-5	loose 5-10	med. dense 10-30	dense 30-50	very dense > 50	
Consistency Blows/ft.	very soft < 2	soft 2-4	medium 4-8	stiff 8-15	very stiff 15-30	hard > 30

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GLOSSARY OF TERMS

A-ZONE

Area of the 100-year flood.

ACCRETION

May be either natural or artificial. Natural accretion is the buildup of land, solely by the action of the forces of nature, on a beach by deposition of waterborne or airborne material. Artificial accretion is a similar buildup of land by reason of an act of man, such as the accretion formed by a groin, breakwater, or beach fill deposited by mechanical means.

B-ZONE

(1) Area between limits of the 100-year and 500-year flood. (2) Area subject to 100-year flooding with average depths less than one foot or where the contributing drainage area is less than one square mile. (3) Area protected by levees from the base flood.

BACKSHORE

That zone of the shore or beach lying between the foreshore and the coastline and acted upon by waves only during severe storms, especially when combined with exceptionally high water.

BARRIER ISLAND

A coast-parallel littoral sand body consisting of a shoreface maintained by the prevailing hydraulic regime and attached washover fans whose surfaces are modified by aeolian (wind) and biological (including human) activity.

BASE FLOOD

A term used in the National Flood Insurance Program to indicate the minimum size flood to be used by a community as a basis for its floodplain management regulations.

BASE FLOOD ELEVATION (BFE)

The elevation for which there is a one-percent chance in any given year that flood levels will equal or exceed it.

BEACH

The zone of unconsolidated material that extends landward from the low water line to the place where there is marked change in material or physiographic form, or to the line of permanent vegetation usually the effective limit of storm waves). The seaward limit of a beach - unless otherwise specified - is the mean low water line. A beach includes FORESHORE and BACKSHORE.

BEACH BERM

A nearly horizontal part of the beach or backshore formed by the deposit of material by wave action. Some beaches have no berms, others have one or several.

BEACH NORISHMENT

The process of replenishing a beach with material (usually sand) obtained from another location.

BEAKER

A wave meeting a shore, reef, sandbar, or rock and collapsing.

BREAKWATER

A fixed or floating structure that protects a shore area, harbor, anchorage, or basin by intercepting waves.

BULKHEAD

A class of vertical structures constructed of steel, concrete sheet piling or of timber usually placed parallel or nearly parallel to the shoreline to retain or prevent sliding of the land and afford protection against damage by wave action.

C-ZONE

Area of minimal flooding.

CENTRAL PRESURE INDEX (CPI)

The estimated minimum barometric pressure in the eye (approximate center) of a particular hurricane. The CPI is considered the most stable index to intensity of hurricane wind velocities in the periphery of the storm; the highest wind speeds are associated with storms having the lowest CPI.

CURRENT, EBB

The tidal current away from shore or down a tidal stream. Usually associated with the decrease in the height of the tide.

CURRENT, FLOOD

The tidal current toward shore or up a tidal stream. Usually associated with the increase in the height of the tide.

CURRENT, LONGSHORE

The littoral current in the breaker zone moving essentially parallel to the shore, usually generated by waves breaking at an angle to the shoreline.

DOWNDRIFT

The direction of predominant movement of littoral material.

DUNES

Ridges or mounds of loose, wind-blown material, usually sand.

EROSION

The wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents littoral currents, or by deflation.

EROSION CONTROL STRUCTURES

Any groin jetty, breakwater, seawall, revetment, artificial nourishment or other deposition of beach material or other structure of a solid or highly impermeable design, when same is located, or is proposed to be located below the mean high water line of any tidal waters.

FLOOD OR FLOODING

Temporary inundation of normally dry land areas from the overflow of inland or tidal waters, or from the unusual and rapid accumulation or runoff of surface waters from any source. The rise in water may be caused by excessive rainfall, snowmelt, natural stream blockages, wind storms over a lake or any combination or such conditions.

FLOOD CONTROL

Keeping flood waters away from specific developments or populated areas by the construction of flood storage reservoirs, channel alterations, dikes and levees, bypass channels, or other engineering works.

FLOOD FREQUENCY

A statistical expression of the average time period between floods equaling or exceeding a given magnitude.

FLOOD INSURANCE RATE MAP (FIRM)

A official map of a community issued or approved by the Federal Emergency Management Agency, Federal Insurance Administration, that delineates both the special hazard areas and the risk premium zones applicable to the community.

FLOODPLAIN

Any normally dry land area that is susceptible to being inudated by water from any natural source. This area is usually low land adjacent to a river, stream, watercource, ocean or lake.

FLOODPROOFING

Any combination of structural and nonstructural additions, changes, or adjustments to properties and structures which reduce or eliminate flood damage to lands, water and sanitary facilities, structures, and contents of buildings.

FORESHORE

The part of the shore lying between the crest of the seaward berm (or upper limit of wave wash at high tide) and the ordinary low water mark, that is ordinarily traversed by the uprush and backrush of the waves as the tides rise and fall.

GROIN

A shore protection structure built (usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore.

GROIN SYSTEM

A series of groins acting together to protect a section of beach.

HYDROGRAPH

A graph that charts the passage of water as a function of time. It shows flood stages, depicted in feet above mean sea level or gage height, plotted against stated time intervals

INLET

A short, narrow tidally influenced, waterway connecting a bay, lagoon, or similar body of water with the ocean.

JETTY

On open seacoast, a structure extending into a body of water, and designed to prevent shoaling of a channel by littoral materials, and to direct and confine the stream or tidal flow. Jetties are built at the mouth of a river or tidal inlet to help deepen and stabilize a channel.

LITTORAL

Of or pertaining to a shore.

LITTORAL DRIFT

The sedimentary material moved along the shoreline under the influence of waves and currents.

LITTORAL TRANSPORT

The movement of littoral drift along the shoreline by waves and currents. Includes movement parallel (longshore transport) and perpendicular (on-offshore transport) to the shore.

LITTORAL ZONE

An indefinite zone extending seaward from the shoreline to just beyond the breaker zone.

LONGSHORE

Parallel to and near the shoreline.

LOWER SHOREFACE

The zone seaward of the breakers over which sediment is transported by waves and currents only during storms.

LOWEST FLOOR

The lowest floor of the lowest enclosed area (including basement). The lowest floor is required to be placed at or above the Base Flood Elevation if elevated foundation construction techniques are employed.

MEAN SEA LEVEL

The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings. Not necessarily equal to MEAN TIDE LEVEL.

MEAN TIDE LEVEL

A plane midway between mean high water and mean low water. Not necessarily equal to MEAN SEA LEVEL.

MEDIAN DIAMETER

The diameter which marks the division of a given sand sample into two equal parts by weight, one part containing all grains larger than that diameter and the other part containing all grains smaller.

NATURAL AREA

Land that support native plant and animal communities and provide habitat conditions and characteristics that have remained essentially unchanged by human activity.

NGVD (NATIONAL GEODETIC VERTICAL DATUM)

National vertical tidal datum established by National Ocean Survey.

NEARSHORE (ZONE)

An indefinite zone extending seaward from the shoreline well beyond the breaker zone.

NEARSHORE CURRENT

A current generated in the nearshore zone primarily by wave action, e.g., longshore current, nearshore current.

NEARSHORE CURRENT SYSTEM

The current system caused primarily by wave action in and near the breaker zone, and which consisits of four parts: the shoreward mass transport of water; longshore currents; seaward return flow, including rip currents; and the longshore movement of the expanding heads of rip currents.

PERCHED BEACH

A beach or fillet of sand retained above the otherwise normal profile level by submerged dike.

PILE

A long, heavy timber or section of concrete or metal that is driven or jetted into the earth or bottom of a water body to serve as a structural support or protection.

PROFILE, BEACH

The intersection of the ground surface with a vertical plan; may extend from the top of the dune line to the seaward limit of sand movement.

RECESSION (OF A BEACH)

(1) A continuing landward movement of the shoreline. (2) A net landward movement of the shoreline over a specified time.

REFRACTION (OF WATER WAVES)

(1) The process by which the direction of a wave moving in shallow water at an angle to the contours is changed. The part of the wave advancing in shallower water moves more slowly than that part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours. (2) The bending of wave crests by currents.

REVETMENT

A facing placed on a bank or bluff of stone to protect a slope, embankment, or shore structure against erosion by wave action currents.

RIP CURRENT

A strong surface current flowing seaward from the shore. It usually appears as a visible band of agitated water and is the return movement of water piled up on the shore by incoming waves and wind.

SEDIMENT BUDGET

Within a specified area the balance between the amount of sediment entering and exiting the area, usually on a yearly basis.

SETBACK

Required horizontal distance between a building, road or other form of construction and a beach, bluff, drive, shoreline or similar erosion prone area, established as a buffer to limit erosion damage.

SETBACK LINE

The line seaward of which construction or excavation is prohibited under the provisions set forth by state or local government statutes.

SHOREFACE

The narrow zone seaward from the low tide SHORELINE covered by water over which the beach sands and gravels actively oscillated with changing wave conditions.

SHORELINE RECESSION

The landward retreat of the shoreline caused by action of winds, waves, currents, and a rising sea level.

STORM SURGE

A rise above normal water level on the open coast due to the action of wind stress on the water surface. Storm surge resulting from a hurricane also includes that rise in level due to atmospheric pressure reduction as well as that due to wind stress.

SUBAERIAL BEACH

The section of the beach that extends landward from the high water line to the base of the dunes.

SURF ZONE

The area between the outermost breaker and the limit of wave uprush.

TOMBOLO

An area of unconsolidated material (sand) such as a bar or spit, deposited by wave action or currents, that connects a rock, island, or offshore structure, etc., to the mainland or to another island.

V-ZONE

Area of 100-year coastal flood with velocity (wave action).

WAVE CLIMATE

The nature of incident waves including the characteristic wave height, period, length, and direction.

DATE DUE

GAYLORD No. 2333 PRINTED IN U.S.A.