FLOOD INSURANCE STUDY

SUPPLEMENT-

WAVE HEIGHT ANALYSIS

CITY OF MARGATE CITY, NEW JERSEY

ATLANTIC COUNTY

APRIL 18, 1983

Federal Emergency Management Agency

COMMUNITY NUMBER - 345304

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1.0 INTRODUCTION

1.1 Background and Purpose

The Federal Emergency Management Agency (FEMA) recently adopted recommendations by the National Academy of Sciences to include prediction of wave heights in Flood Insurance Studies for coastal communities subject to storm surge flooding, and to report the estimated wave crest elevations as the base flood elevations on Flood Insurance Rate Maps (FIRMs).

Previously, FIRMs were produced showing only the stillwater elevations due to the lack of a suitable and generally applicable methodology for estimating the wave crest elevations associated with storm surges. These stillwater elevations were subsequently stipulated in community flood plain management ordinances as the minimum elevation of the lowest floor, including basement, of new construction. Communities and individuals had to consider the additional hazards of velocity waters and wave action on an ad hoc basis. Because there has been a pronounced tendency for buildings to be constructed only to meet minimum standards, without consideration of the additional hazard due to wave height, increasing numbers of people could unknowingly be accepting a high degree of flood-related personal and property risk in coastal areas subject to wave action. Therefore, the FEMA has pursued the development of a suitable methodology for estimating the wave crest elevations associated with storm surges. The recent development of such a methodology by the National Academy of Sciences has led to the adoption of wave crest elevations for use as the base flood elevations in coastal communities (Reference 1).

The City of Margate City is located on Absecon Island along with the Cities of Atlantic City and Ventnor and the Borough of Longport. Gaging stations located at Atlantic City give an accurate record of past flooding on the island since 1911 (with the exception of a period from December 1920 to December 1922). The highest recorded storm tide along the Atlantic Ocean shoreline at Atlantic City was 7.6 feet as recorded during the September 1944 hurricane. Other high tides occurred during storms on November 10, 1932, November 1, 1947, November 24, 1950, October 23, 1953, March 6-7, 1962, and September 12, 1960 (Reference 2).

The northeaster of March 1962 was an unusually severe storm. The outstanding feature of the storm was the series of five successive high tides and destructive waves generated by gale force winds. The storm surge covered most of Absecon Island. Floodwaters reached an elevation of 5 feet over the streets of the northeastern section of Atlantic City, necessitating the evacuation of residents. On the island, approximately 11,750 dwellings and 729 commercial establishments, including boardwalks, sustained damage from flooding and wave action. Three persons lost their lives in Atlantic City as a direct result of the storm (Reference 3).

The purpose of this study is to revise the FIRM for the City of Margate City to include the effects of wave action for the following flooding source: Atlantic Ocean.

The wave height analysis for this study was prepared by Dewberry & Davis for the FEMA under contract No. EMW-C-0543. This work was completed in September 1982.

2.0 INVESTIGATIONS

2.1 Previous Studies

Stillwater elevations used in this analysis were developed by Dewberry & Davis of Fairfax, Virginia (Reference 4). In that analysis, an elevation-frequency curve was developed by combining data from ESSA Technical Memorandum WBTM Hydro 11 with a gage analysis performed in 1963 by the Philadelphia District of the U. S. Army Corps of Engineers (COE) using the Atlantic City gage records for the period 1941 through 1959 (References 5 and 6). This analysis supersedes the previous Flood Insurance Study for the City of Margate City (Reference 7).

2.2 Data Collection and Review

All available source data applicable for the wave height analysis were collected and reviewed. Because wave height calculations are based on such parameters as the size and density of vegetation, natural barriers (sand dunes), buildings, and other manmade structures, it was necessary to obtain detailed information on the physical and cultural features of the study area.

During the course of this analysis, the Atlantic County Sewage Authority, the City of Margate City, Keystone Aerial Surveys Incorporated, the New Jersey Department of Environmental Protection, the New Jersey Highway Authority, and the COE were contacted for data.

The principal source materials used for the wave height analysis are described below.

1. Aerial photographs (stereoscopic coverage) of the City of Margate City were obtained from Keystone Surveys of Philadelphia, Pennsylvania (Reference 8). They were used to determine the type, size, and density of vegetation and physical features.

2. U. S. Geological Survey (USGS) topographic quadrangles at a scale of 1:24,000 of Atlantic City and Ocean City were used as base maps and work maps for wave height calculations and for plotting wave elevations and boundaries of the Flood Hazard Zones (Section 3.1). They were also used for the placement of transects and for fetch calculations (Reference 9).

3. An atlas of tidal floods for Atlantic City and vicinity at a scale of 1:12,000 and a contour interval of 2 feet was obtained from the USGS (Reference 2). The atlas contains the flood boundaries from the September 1960 and March 1962 storms and was used to supplement the work maps.

4. Bulkhead elevations for Margate City were taken from location plans supplied by the city engineer through the New Jersey Department of Environmental Protection (NJDEP) (Reference 10). These elevations were updated by the NJDEP by field inspection performed in June 1982.

5. Stillwater elevations for the storm surges were obtained from profiles developed by Dewberry & Davis (Reference 4).

2.3 Wave Height Analysis

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 1). This method is based on three major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions such as sand dunes, dikes and seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures described in Reference 1. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Wave heights were computed along transects (cross section lines) that were located along the coastal areas, as illustrated in Figure 1, in accordance with the Users Manual for Wave Height Analysis (Reference 11). The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Each transect was taken perpendicular to the shoreline and extended inland to a point where wave action ceased. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The

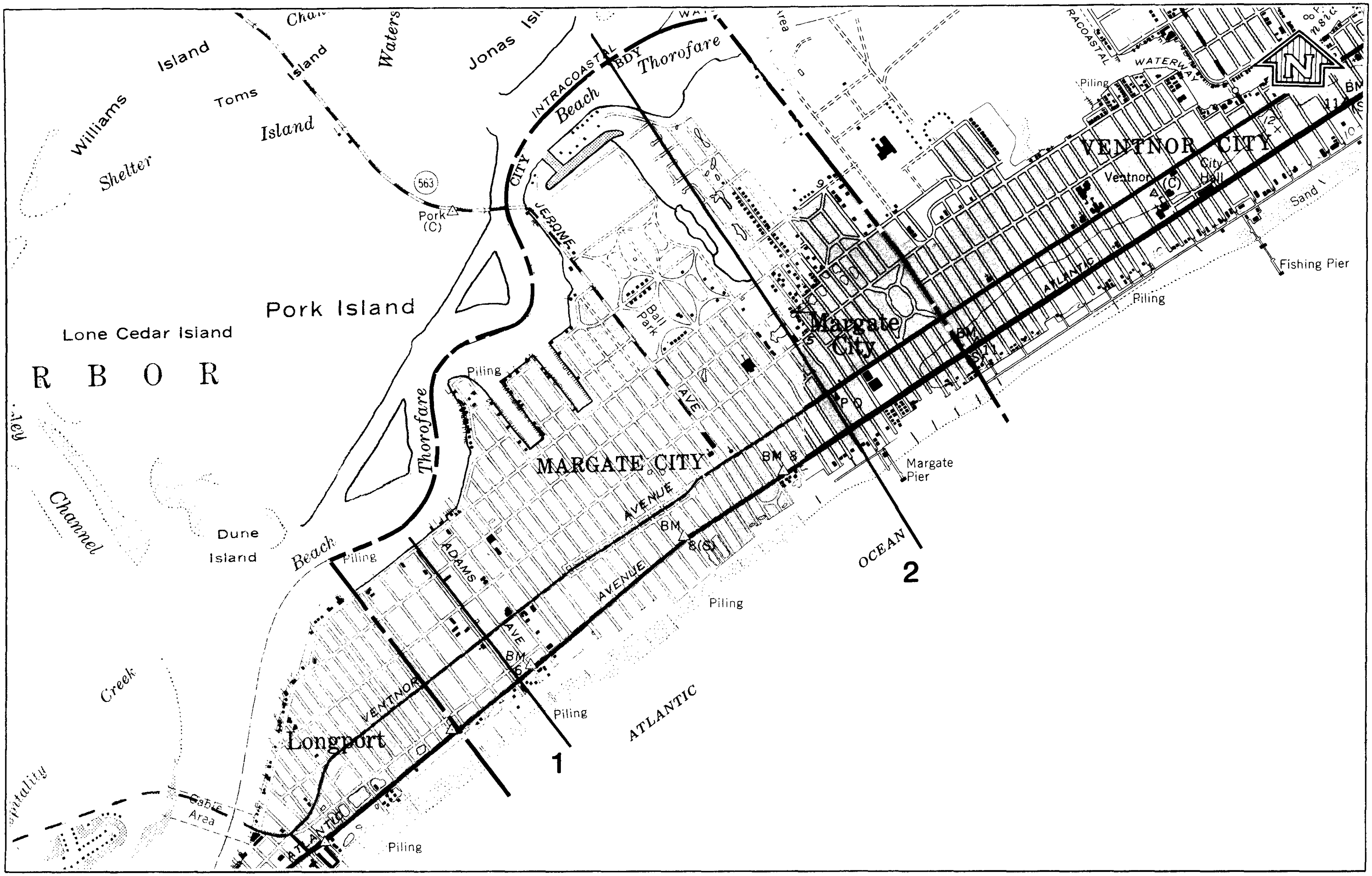

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MARGATE CITY, NJ
(ATLANTIC CO.)

APPROXIMATE SCALE
2000 0 2000 4000 6000 FEET

TRANSECT LOCATION MAP

stillwater elevations for the 100-year flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. The location of the 3-foot breaking wave for determining the terminus of the V Zone (area with velocity wave action) was also computed at each transect. Table 1 provides a listing of the transect location and stillwater starting elevations, as well as maximum wave crest elevations. It was assumed that the beach would erode up to the bulkheads during a major storm and, therefore, is considered ineffective in decreasing wave heights.

TABLE 1 - TRANSECT DESCRIPTIONS

Transect	Location	Elevation (feet) Stillwater 100-year	Elevation (feet) Maximum Wave Crest 100-year
1	Southwest corporate limits to Osborne Avenue, extended	9.5	15
2	Osborne Avenue, extended, to southeast corporate limits	9.5	15

Figure 2 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in the City of Margate City may not include all the situations illustrated in Figure 2.

After analyzing wave heights along each transect, wave elevations were interpolated between transects. Various source data were used in the interpolation, including the topographic work maps, aerial photographs, bulkhead plans, field inspection of bulkheads, historical evidence, and engineering judgment. Controlling features affecting the elevations were identified and considered in relation to their positions at a particular transect and their variation between transects.

2.4 Results

Computed wave heights and elevations associated with the 100-year storm surge are summarized below for various reaches in the study area.

Atlantic Ocean (Transects 1-2)

The maximum wave crest elevation from the Atlantic Ocean affecting Margate City is 15 feet. Waves greater than 3 feet propagate across the beach area up to the bulkheads. The bulkheads along the shore protect

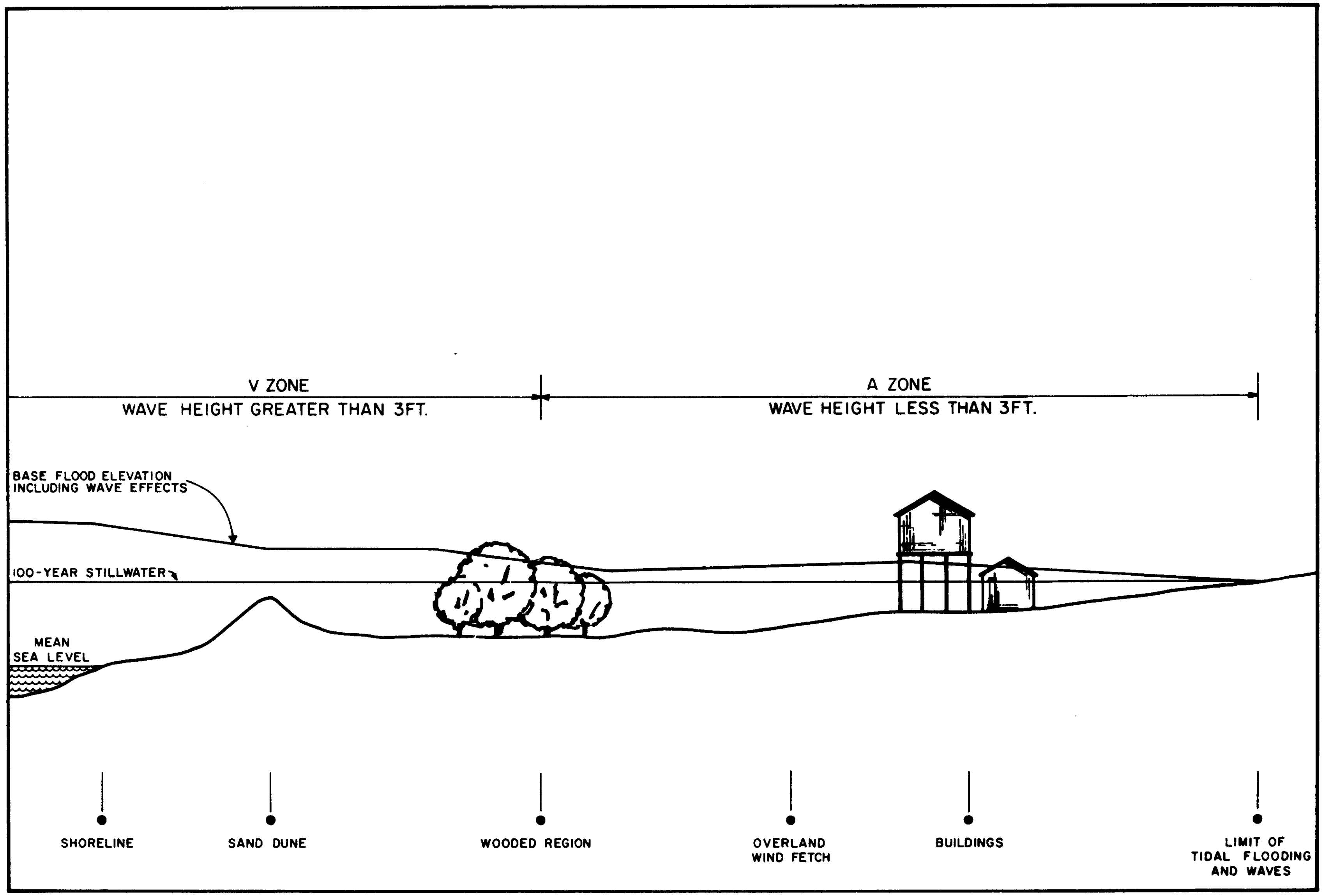

FIGURE 2
TYPICAL TRANSECT SCHEMATIC

the community from wave action. Except for an isolated area above the 100-year surge level, the area of the community behind the bulkheads is inundated with little or no wave action.

On October 7, 1982, the results of the study were reviewed at a final Consultation and Coordination Officer's (CCO) meeting attended by representatives of the FEMA, the City of Margate City, and Dewberry & Davis.

3.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage local governments to adopt sound flood plain management programs designed to reduce future flood losses. The FIRM for the City of Margate City has been revised to incorporate the latest available information, including wave height data, to assist these communities in developing the most appropriate and effective flood plain management measures.

3.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FEMA as the base flood for purposes of flood plain management. This flood has a 1 percent chance of being equalled or exceeded each year and is expected to be exceeded once on the average during any 100-year period. The risk of having a flood of this magnitude or greater increases when periods longer than 1 year are considered. For example, over a 30-year period, there is a 26 percent chance of experiencing a flood equal to or greater than the 100-year flood. The 500-year flood plain is also shown on the FIRM to indicate areas of moderate flood hazards.

Areas inundated by the 100-year flood are shown as A and V Zones on the community's FIRM. It is in these areas that the FEMA requires local communities to exercise flood plain management measures as a condition for participation in the National Flood Insurance Program.

3.2 Base Flood Elevations

Areas within the communities studied by detailed engineering methods have base flood elevations established in A and V Zones. These are the elevations of the base (100-year) flood relative to the National Geodetic Vertical Datum (mean sea level) of 1929. In coastal areas affected by wave action, base flood elevations are generally maximum at the normal open shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in base flood elevations have been shown in 1-foot increments on the FIRMs. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. Base flood elevations shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is above the base flood elevation in A and V Zones.

3.3 Velocity Zones

The U. S. Army Corps of Engineers has established the 3-foot breaking wave as the criterion for identifying coastal high hazard zones (Reference 12). This was based on a study of wave action effects on structures. This criterion has been adopted by the FEMA for the determination of V Zones. Because of the additional hazards associated with high-energy waves, the National Flood Insurance Program regulations require much more stringent flood plain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in V Zones are higher than those in A Zones with similar numerical designations.

The location of the V Zone is determined by the 3-foot breaking wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the V Zone to be established. The V Zone generally extends inland to the point where the 100-year flood depth is insufficient to support a 3-foot breaking wave.

4.0 INSURANCE APPLICATIONS

The assignment of proper actuarial insurance rates requires that frequency and depth of flooding be estimated as accurately as possible. Because waves can add considerably to expected flood depths, it is important that insurance rates consider this additional hazard. The FEMA has developed a process to transform the data from this study into flood insurance criteria. This process includes the determination of Flood Hazard Factors and the designation of flood insurance zones.

4.1 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables.

The FHF is shown as a three-digit code that expresses the difference between the 10- and 100-year flood elevations to the nearest 0.5 foot. For example, if the difference between water-surface elevations of the

10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, the FHF is computed to the nearest foot.

4.2 Flood Insurance Zones

After wave elevations for the 100-year storm surge were determined and mapped, the study areas were divided into zones, each having a specific flood potential and FHF. Each zone was assigned one of the following flood insurance zone designations:

Zone V10: Special Flood Hazard Areas along coasts inundated by the 100-year flood as determined by detailed methods, and that have additional hazards due to velocity (wave action); base flood elevations shown, and zones subdivided according to FHFs.

Zone A8: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHF.

Zone B: Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also, areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Table 2, "Flood Insurance Zone Data", summarizes the FHFs, flood insurance zones, and base flood elevations for the flooding source in the study area.

TABLE 2 - FLOOD INSURANCE ZONE DATA

Flooding Source	Stillwater Elevation 10-Year	50-Year	100-Year	500-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean Transects 1-2	6.3	8.5	9.5	11.8	050	V10	12-15
					040	A8	10-12

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

4.3 Flood Insurance Rate Map

After flood insurance zones were established for the study area, the FIRM for the City of Margate City was revised to incorporate the new zone information. This map contains the official delineation of flood insurance zones and base flood elevations.

5.0 OTHER STUDIES

Flood Insurance Rate Maps for the Borough of Longport and the City of Ventnor are being revised concurrently with this study to include wave height analyses (References 13 and 14). The revised studies will be in agreement with this study.

No wave height analysis for the Township of Egg Harbor is being conducted at this time. Therefore, the Flood Insurance Rate Maps in the Flood Insurance Study for that community will not be in agreement with the maps in this study (Reference 15).

6.0 REFERENCES

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