FLOODING
TEMPE QUADRANGLE, MARICOPA COUNTY, ARIZONA

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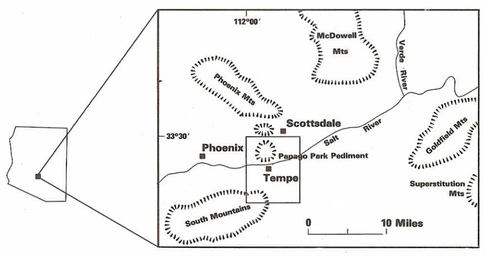

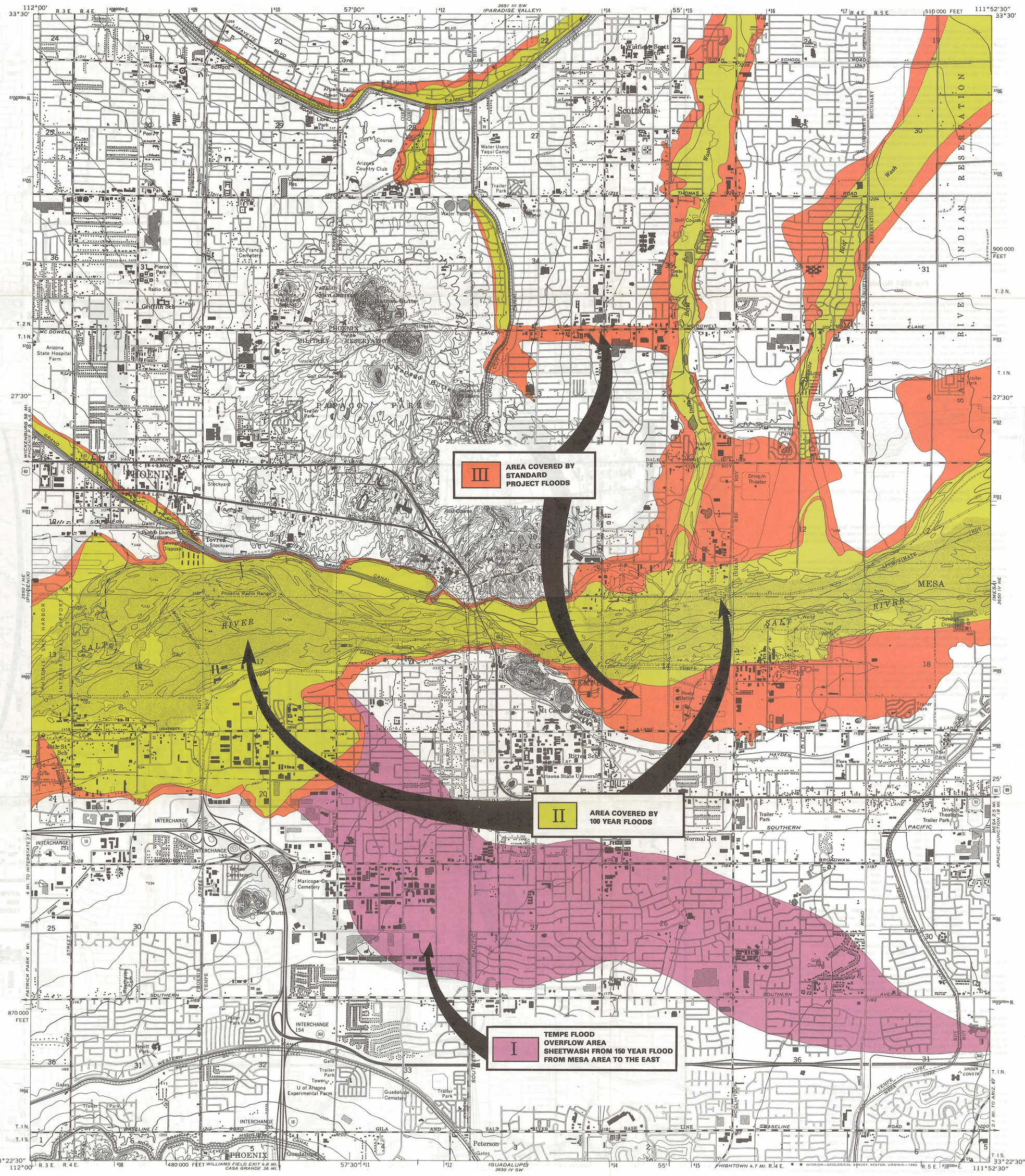

BASE MAP FROM U.S. GEOLOGICAL SURVEY
TOPOGRAPHIC MAP, 1:24,000 SERIES
TEMPE QUADRANGLE (1952, PHOTOREVISED 1967)
Additional revisions compiled by the Geological Survey from aerial photographs taken 1978 and other sources. This information not field checked. Map edited 1982.

Source of flood outlines:
United States Army Corps of Engineers, 1972, 1977, 1979b
United States Army Corps of Engineers, unpub. data, 1978

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Introductory Statement

Contrary to common opinion, severe floods do occur in the desert. The relative absence of vegetation and the combinations of a sloping surface, with either a slightly armored or loose, dry soil are important contributing factors to the high flooding potential in the desert. An understanding of weather patterns, drainage basin characteristics, and ephemeral stream characteristics permit prediction of potential overbank flooding of the typical dry washes and normally dry river beds of the desert. The causes of flooding along the Salt River, the major drainage-way through the Tempe Quadrangle, are varied, with some being very complex. Not all causes are the result of geologic processes alone.

Severe thunderstorms are generally the cause of flooding within the Tempe Quadrangle, except along the floodplain of the Salt River (indicated on the map). The high rate and large quantities of precipitation are only slightly absorbed because the slope and the sparse ground cover are generally unable to reduce the runoff velocity sufficiently to permit the water to soak beneath the surface. Steep slopes of 15% or more funnel the runoff into channels and rapidly transfer relatively high volumes of debris-laden water downslope. Developments adjacent to steep slopes may become inundated with water and mud. Away from the steeper slopes, flooding spreads water and mud over broad areas, often covering streets, roads, lawns, and partially filling basements, pools, and garages. Indian Bend Wash and Granite Reef Wash drainages represent special flooding examples for the area north of the Salt River. The overflow area inundated by the breaching of the Tempe Canal just north of the Superstition Freeway represents a special flooding example for the area south of the Salt River.

Indian Bend Wash and Granite Reef Wash

Indian Bend and Granite Reef washes are the principal drainage-ways for Scottsdale and the northeastern part of the Tempe Quadrangle. Both are tributaries of the Salt River. Several severe local thunderstorms in the past have resulted in flooding of one or both washes and their adjacent areas. The most recent damaging event, a 70 year flood, occurred along Indian Bend Wash in June 1972 (Corps of Engineers, 1972). Rapid development by man in the washes and their floodplains has enhanced the potential flood damage. Outlines of the 100 year flood and the Standard Project Flood are plotted on the map, indicating the areas expected to be wetted during floods of those magnitudes. (Corps of Engineers, 1972).

Most of the runoff is derived from north and northeast of the Tempe Quadrangle, including the surfaces of the southern and southwestern slopes of the McDowell Mountains and the northeastern slopes of the Phoenix Mountains. The Paradise Valley Detention Dike, designed to keep floodwaters out of the Central Arizona Project (CAP) Canal, (north of the Tempe Quadrangle, Fig. 1) should greatly reduce sheetwash flooding in the area drained by Indian Bend Wash and therefore reduce floodflow through it.

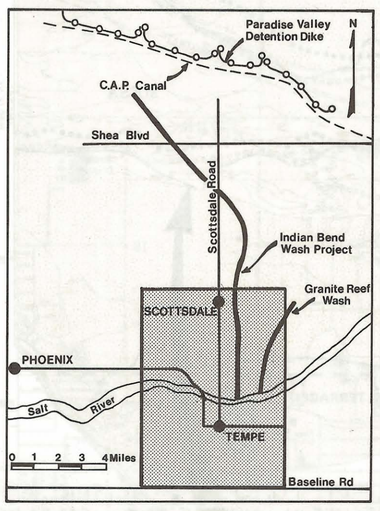

Figure 1. Location of the Tempe Quadrangle and major drainage ways.

The outlines of the two magnitudes of flooding along Granite Reef Wash within the Pima Salt River Indian Reservation are tentative, are generally based on the topographic conditions of 1979, and are indicated on the map by dashed lines.

The Indian Bend Wash Project, completed by the Corps of Engineers, was designed to limit damage from flooding along the wash, especially south of the Arizona Canal. The project is planned to safely carry the 100 year floodflow of 30,000 cubic feet per second (cfs) (850 cubic meters per second; cms), and the Standard Project Floodflow of 65,000 cfs (1841 cms) (Corps of Engineers, 1975). The project incorporates various flood control elements for funneling floodwaters into the Salt River through interceptor channels and non-residential areas such as golf courses and parks.

Ponding is a flood runoff problem which may pose a hazard to areas adjacent to through canals within the Tempe Quadrangle. Ponding generally results from sheetwash runoff collecting in low basins below large, sloping areas. One such important area is north of the Arizona Canal where runoff from the southern slope of Camelback Mountain collects between Scottsdale Road and 48th Street. Another is west of the Cross Cut Canal, between Thomas and McDowell Roads. The third area of ponding will occur north of the Grand Canal westward from 48th Street to 38th Street, and probably even further west (Corps of Engineers, 1979b).

Tempe flood overflow area

An area approximately 1 mile (1.6 km) wide, crossing the central part of the city of Tempe, is here called the Tempe flood overflow area. Waters which overflow through the area are expected to be generated when the runoff of a very severe flood east of Tempe overtops the banks of the Tempe Canal just north of the Superstition Freeway (Corps of Engineers, 1977). Those canal banks may be able to contain floodflows up to a magnitude of about the 150 year flood. Once those canal banks are breached, a flow of approximately 9 inches (22 cm) depth is calculated to move in a sheetwash fashion toward the northwest (see map), probably entering the Salt River between Hardy Drive and 48th Street north of University Avenue. North of University and west of Hardy Drive, the tentative path of the overflow, indicated on the map by dashed lines, is based on the topography of that area as of 1979. Continuing development along this tentative overflow exit will probably further change its configuration.

Salt River

The Salt River drains an area of about 13,100 square miles (33,500 square km) to the north and east of the Tempe Quadrangle (Fig. 2). The river ceased flowing as a perennial stream within the quadrangle in 1939. Since then it only flows during occasional influx of runoff from local washes, or during release of water from the reservoirs upstream.

In its present configuration, the Salt River upstream from the Tempe Quadrangle has no dedicated flood control space (Corps of Engineers and Bureau of Reclamation, 1979a). Its six large reservoirs (see Table 1) and one diversion dam do afford some degree of flood protection, however the chief functions of the Salt River Project (SRP) reservoirs are to store water for irrigation purposes, and to generate electrical power when irrigation water is being released. Any storage of runoff which reduces the amount of floodwaters reaching the Tempe Quadrangle is the result of the efforts by SRP, which controls operations of those reservoirs.

Unregulated floodflow refers to uncontrolled flood runoff in water basins which have no dams built across their major streams. Conversely, regulated floodflow is used to indicate controlled flood runoff within a basin which has one or more flood control dams. The Salt River Basin may be considered to have a modified regulated floodflow, because there are six major reservoirs built on its streams, but none have dedicated flood storage space. Therefore, if the total runoff less irrigation water released during one rainy season should exceed the storage space available at the end of the previous irrigation season, all excess water must pass through the reservoirs. Such uncertain storage conditions make predictions of the flood frequency in the Salt River basin extremely difficult, if not invalid. This adversely effects the accuracy of data used for decision making in land-use planning along the river.

The storage space available in Roosevelt Lake is critical to any flood control benefits which SRP may be able to provide. Roosevelt Dam can store more than 65% of the total water retained by SRP. But even when Roosevelt is filled to its spillway crest or lip (80% of its capacity), only slightly more than 4000 cfs (113 cms) may be released to provide more storage for future runoff. For comparison, a dam specifically designed for flood control might release about 100,000 cfs (2832 cms) from its almost filled reservoir to provide storage for possible runoff from a forecast large flood; also, runoff into Roosevelt Lake from a large flood may exceed 200,000 cfs (5663 cms) (Aldridge, 1970). Very large flood runoff into the Roosevelt reservoir when the water level is at or above the bottom of the spillway gates would probably dictate that the SRP operators open wide all gates and release floodwaters in an unregulated manner. Opening the spillway gates would be necessary to prevent possible dam failure.

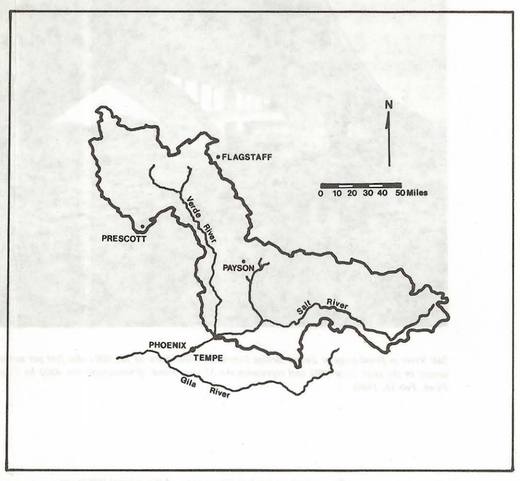

Figure 2. The watershed of the Salt River upstream from the Tempe Quadrangle.

Table 1. Salt River Project Dams

River	Name	Reservoir capacity (acre feet)	Year completed
Salt			
	Roosevelt	1,381,580	1911
	Horse Mesa (Apache)	245,138	1927
	Mormon Flat (Canyon)	57,852	1925
	Steward Mt. (Saguaro)	79,765	1930
Verde			
	Horseshoe	131,427	1946
	Bartlett	178,186	1939
	TOTAL	2,063,948	

Source: Salt River Project

Table 2. Flow rates (cfs) for floods of certain recurrence intervals

Recurrence Year	Granite Reef +	Tempe Bridge	Gila River
5 yr	45,000	40,000	36,000
10 yr	102,000	93,000	85,000
20 yr	141,000	135,000	125,000
50 yr	175,000	160,000	145,000
100 yr	245,000	215,000	185,000
200 yr	290,000	275,000	250,000
500 yr	360,000	330,000	310,000
Standard Project Flood (SPF)	295,000	289,000	281,000

+ Below the confluence with the Verde River

Source: U.S. Army Corps of Engineers, 1982

Flood frequency

The rate at which floods of different severities, or of different magnitudes may be expected to occur along a river is its flood frequency. The probable occurrence of floods of various magnitudes may be determined by a statistical analysis of the annual peak water flow, if flow occurred, for all the years of record at the site, whether or not all were serious flooding events. Peak flow is the highest rate of flow of the stream at the measuring point chosen, and is generally concurrent with the highest level of flooding. The longer the record, the more accurate the projection of the frequency of floods.

The objective of a flood frequency analysis is to determine statistically how often we can expect to have floods of various magnitudes. By obtaining stream flow records and applying formulas given in most environmental geology or hydrology books, one can calculate the flood frequency probability. It is important to know the statistical recurrence intervals for a range of flood magnitudes if one is going to design bridges of any type or to make rational land-use planning guidelines for floodplains.

A flood that has a 2% (1 in 50) chance or probability of occurring in any year is termed the 50 year flood, while a flood that has a 1% (1 in 100) chance is the 100 year flood. This means that such a flood has a probability of recurrence on the average of once in 100 years. Such a flood may occur, however, more than once in 100 years, and could possibly occur in two successive years.

Table 2 indicates the flow predicted for floods of the selected years of recurrence, based on published data from the Corps of Engineers. Table 2 might be called a modified regulated frequency/floodflow table. The data have been recorded for a 91 year period, which includes several years of unregulated floodflows before Roosevelt Dam was completed in 1911. Data of this type are utilized by engineers and planners to obtain the predicted amounts of flow for floods of different recurrence years, or different years of floods. These data are important constraints for determining bridge size to be constructed, or in determining the type of floodproofing recommended to reduce flood losses near the river. There are three measuring points on Table 2, and floodflow rates are presented for each point for the recurrence year shown. Because of groundwater recharge, evaporation, and transpiration, a floodflow rate measured at a specific point will be greater than the flow rate of the same year flood measured at some point downstream.

For the Salt River, the flow of the 100 year flood has been calculated statistically to be 215,000 cfs (6088 cms) if measured at the Tempe Bridge. The Standard Project Flood (SPF) is defined as the most severe flood that can reasonably be expected to occur in a region, based on its meteorologic and geographic characteristics. For the Salt River, its SPF has been calculated to have a peak flow of 289,000 cfs (8184 cms) if measured at the Tempe Bridge (Table 2); and it has a probability of recurrence of approximately 0.43% (1 in 266) which makes it about a 266 year flood. The SPF flow is almost identical to that of the 1891 flood. It has been estimated that a SPF occurring along the Salt River under present conditions would cause damages of more than $252,000,000 (Corps of Engineers and Bureau of Reclamation, 1979a).

The magnitude of the 100 year flood has been chosen as the flow on which many important decisions concerning flood-proofing and construction constraints are based. The Federal Emergency Management Agency (FEMA) generally considers the area inundated by the 100 year flood as an area having very high risks. FEMA makes its most careful and comprehensive adjustments to the rates for insurance within the area of the 100 year flood. To participate in the National Flood Insurance Program, local governments usually require commercial developments built within the area of the 100 year flood to accomplish special flood-proofing, commensurate with the type of building and enterprise involved.

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This map represents a general evaluation and does not preclude the necessity of site investigation.

For references, see the reverse side of this sheet.