# THE PASSAIC RIVER FLOOD PLAIN AND BASIN IN NEW JERSEY —

# PROBLEMS OF ENCROACHMENT


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The field experience follows parts of the Passaic River and its tributaries beginning at the Newark Campus of Rutgers University. The trip parallels the course of the River. It then continues along U.S. Route 46 West to Wayne, Oakland, Lincoln Park and Fairfield in Passaic and Essex Counties near the confluence of the major tributaries; the Pequannock, Ramapo and Pompton Rivers and returns to Newark.

**The Passaic River Basin**

Created during the Wisconsin age, the present drainage basin of the Passaic River trends in a generally east-to-southeast direction in the Passaic-Essex County Region. The River, rising in Mendham Township, N.J. in Morris County, receives major tributaries as the Saddle River, Mahwah River, Third River, Rockaway River, Whippany River, Pequannock River, Pompton River, Ramapo River, and Wanaque River. All these tributaries drain a natural retention basin formed in the swamp made up of the Black Brook, Troy, Little Piece and Great Piece Meadows. These are part of the remnants of ancient Lake Passaic formed as an empoundment when the Wisconsin glacial advance closed a water gap at Short Hills and subsequently opened another in the Little Falls-Great Notch area.

**Description of the Basin**

The Passaic River Basin is a 56 mile long by 26 mile wide watershed with an area of 935 square miles; 84% (787 square miles) is located in Northeast New Jersey, the remaining 16% (148 square miles) is in southern New York State. The basin occupies three regions—the Highlands, the Central Basins, and the lower Valley. See figure 1.

Two major physiographic provinces are part of the Passaic River Basin. The New Englands Uplands Province forms the Western Highlands. The Central Basins and Lower Valley are Triassic Lowlands in the Piedmont Province. See figure 2.

The "Jersey" Highlands extends from Pennsylvania's Reading Hills through New Jersey and beyond New York State. The Reading Prong, composed partially of the Highlands, is a series of crystalline gneiss ridges trending in a Northeast to Southwest direction. These crystalline ridges are nearly parallel throughout most of their length. In the upper western portion, sandstones and conglomerates are common with a veneer of glacial till dominant in the region. See figure 3 and table 1.

Predominantly, shales and sandstones underlie the Triassic lowlands. These units trend Northeast-Southwest along extrusions and exposed intrusives of basaltic origin. Both the sedimentary and igneous units of the Triassic Lowlands dip toward the Northwest at angles generally between 3-18 degrees. The Ramapo Fault designates the boundary between the Jersey Highlands and the Triassic Lowlands. The principal soil types of the central basin are glacially deposited silty clays and sands.

These combinations, along with rocky outcrops and thin soils results in poor drainage and impervious local regions. Steep terrain in most of the basin adds to the drainage problem leading to many large lakes and impoundments in the area. Man-made impervious surface and changes in topography and the retention basins formed naturally are compounding the problem in recent decades.

**The Highlands.** 489 square miles, the Highlands are in the northwest half of the watershed that is known as the Passaic River Basin.The major tributaries, the Mahwah, Wanaque, Ramapo, Pequannock, Pompton, Whippany, and Rockaway Rivers, originate in this region. In the Highlands, gradients are extremely high, 1:3 to 1:100 with stream flow reflecting bedrock trends. These are primarily characterized by ridges and narrow, steep valleys between the ridges. The stream flow is generally southwest in the north and northeast in the southern regions. The Highlands contain many lakes

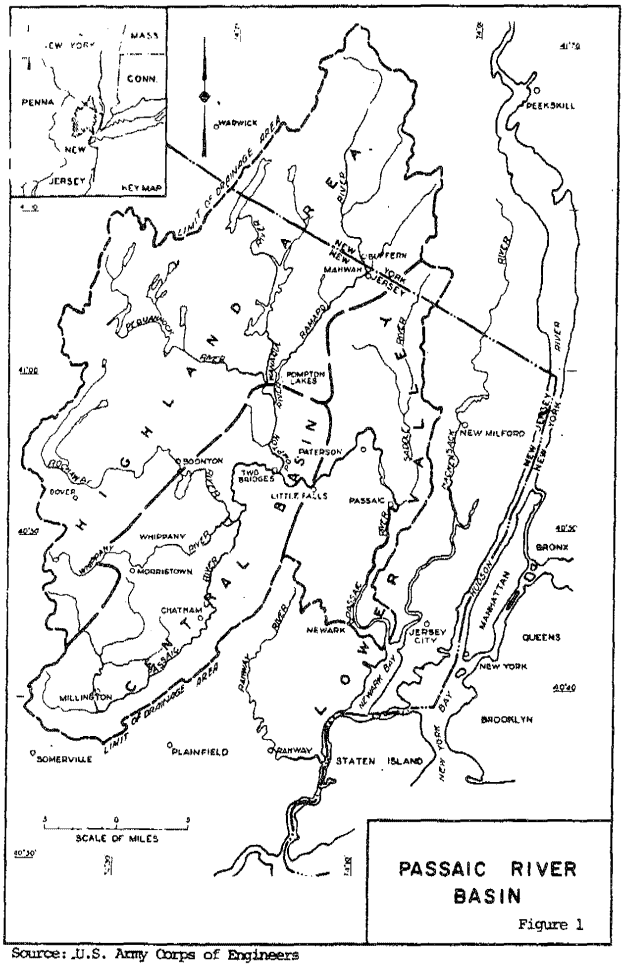
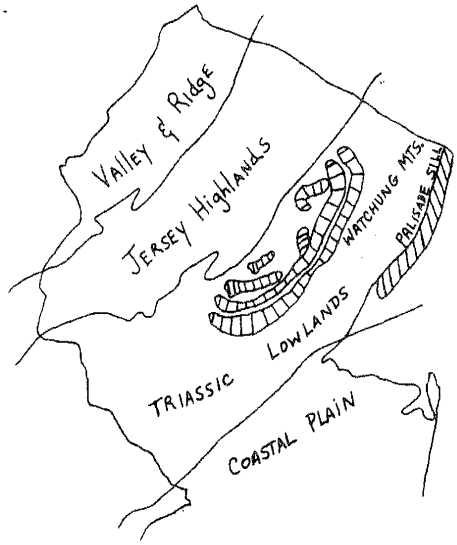



Figure 1

Source: U.S. Army Corps of Engineers

Generalized sketch map of Northern New Jersey showing the four physiographic provinces of the state.




and reservoirs in an area that ranges in elevation from 1200 to 1400 feet mean sea level in the west to 300 mean sea level in the east.

**The Central Basin.** Drainage in the 252 square mile central basin is controlled by the remains of the ancient glacial Lake Passaic bed. In this region, 43 square miles form swamp. The swamp is known as the Great Meadows and the Great Swamp. The Great Meadows is comprised of lowlands known locally by various names such as Troy Meadows, Black Brook Meadow, Great Piece Meadow and others. This oval shaped depression forming the central basin is elevated at 500 feet mean sea level in its southwestern borders to 160 feet mean sea level in the northwest.

Stream flow is controlled largely by the Watchung Mountains with gradients ranging from 1:10 to 1:2000.

**The Lower Valley.** The Lower Valley is a flattened region of about 190 square miles. The drainage pattern extends from the central valley to the lower valley through the water gap at Little Falls. It then continues to Newark Bay which receives the Passaic River flow. Elevation ranges from 500 feet mean sea level to sea level at the mouth in the bay.

**The History of the Basin.**

The Passaic River Basin is almost entirely the result of glacial erosion and depositon. Glacial Lake Passaic formed when the original water gap in the Second Watchungs was dammed by glacial debris. The original stream flow was diverted from this point of departure into the present system when a second outlet at Little Falls opened. This gap is at a higher elevation than the former gap and flow. Stream flow formerly South and East shifted in a Northern direction toward this second gap and then East to Newark Bay. The clay and silt deposited in the Central Basin are glacial in origin. Together with the thin soil and rocky surface, these soils are a major hindrance to drainage and modern sewerage disposal. Many swamps and meadows formed as the water reached the natural retention basin formed on the lake bed. The lakes and swamps today form a vast natural retention basin system comprising about 20.0 square miles in the region of the glacial lake bed. This occured as the original gap closed approximately 20,000 years B.P. and prior to the opening of the second gap.

**Glacial Lake Passaic**

New Jersey possesses a number of glacial lakes formed when streams were dammed by glacial ice. Glacial Lake Passaic occupied the region between the Highlands and the Second Watchung Mountains.

TABLE 1

SOIL ASSOCIATIONS IN THE PASSAIC RIVER BASIN

| Map Symbol | Association Name | Drainage Description | Depth to Bedrock | Limitation for Development |
|---|---|---|---|---|
| RHU | Rockaway-Hibernia-Urban Land | Well to somewhat poorly | 4-10 | Steep slopes where present |
| RR | Rockaway-Rock Outcrop | Well to moderately well | 0-10 | Poorly suited due to rock outcrops |
| NR | Netcong-Rockaway | Well to moderately well | 10+ | Erosion control on steeper slopes |
| HHE | Holyoke-Haledon-Boonton | Well to somewhat poorly | 0-10+ | Rock outcrops and poor drainage-low density only |
| HUB | Haledon-Urban Land | Well to somewhat poorly | 10+ | Poor drainage-unsuited for on-site sewage disposal |
| CPP | Carlisle-Parsippany-Preakness | Poorly to very poorly | 10+ | Poor drainage-unsuited for development |
| PBW | Parsippany-Biddeford-Whippany | Somewhat poorly to very poorly | 10+ | Unsuited due to poor drainage & frequent flooding |
| NE | Neshaminy-Ellington | Well to somewhat poorly | 0-10+ | Poorly suited due to shallow bedrock & poor drainage |
| PRU | Penn-Peaville-Urban Land | Well to somewhat poorly | 1-4 | Steep slopes & depth to bedrock where present |
| EPC | Edneyville-Parker-Califon | Excessive to somewhat poorly | 10 | Suitable on gentle slopes |
| PE | Parker-Edneyville | Excessive to well | 4-10 | Steep slopes - unsuitable |
| RUP | Riverhead-Urban Land-Pompton | well to somewhat poorly | 10+ | Steep slopes & poor drainage where present. |

Glacial Lake Passaic at its greatest extent, was 30 miles long by 10 miles wide and averaged about 200 feet deep. It has left a series of deltas in Morris County as well as outwash and ridges throughout the entire lower part of the county.

The water level in glacial Lake Passaic oscillated as the ice alternated in thickness. The final drainage however, was through the Little Falls gap replacing the gaps in the First and Second Watchungs at Short Hills. These were blocked by a moraine with the addition of ice damming. Some of the oscillation in water level may have been the result of other outlets which opened and closed throughout the glacial period.

## The Passaic River

The Passaic River is 87 miles long. It rises in Mendham Township in Morris County. The stream flows South-to-East to the Great Swamp near Millington—a distance of about 11 miles. The stream then flows through trap rock ridges and is confined to intermontane valleys Northeast as a result of the Second Watchung Mountain. Below this region the stream flows for 40 miles northerly to Great Meadows in the Fairfield area (Essex County bordering Passaic and Morris Counties). After flowing through the ridges of the Second Watchung, stream flow is east-northeast through Little Falls and then to Newark Bay 25 miles to the Southeast.

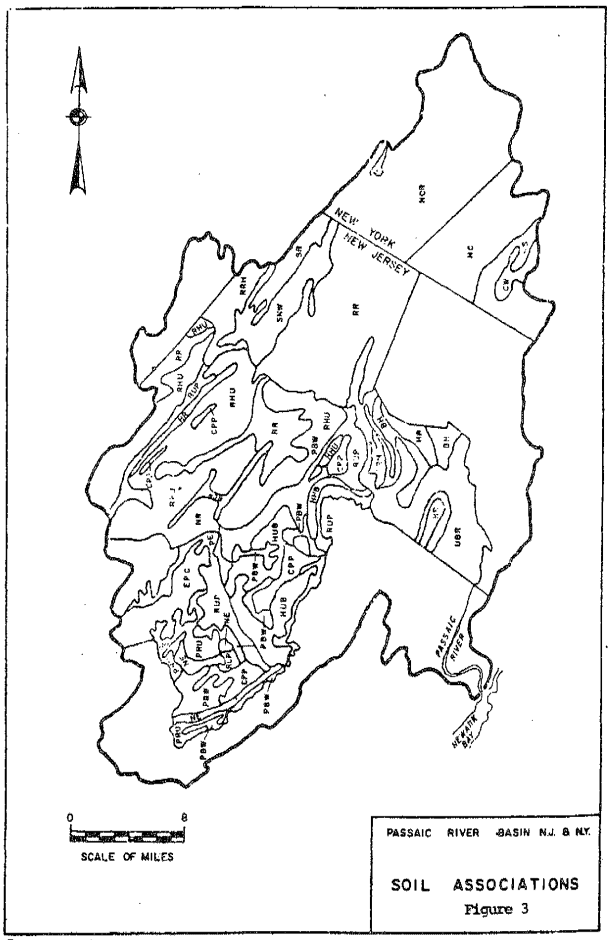



Figure 3

Source: U.S. Army Corps of Engineers

The Passaic River varies from 165 feet to 800 feet in width and 8-45 feet in depth. Tributaries range from 80-510 feet in width to 7-24 feet in depth. The Passaic streambed ranges from 37.3 feet wide at the source to 7.9 miles wide at its mouth. Other tributaries range from 33.0-34.8 feet wide for the Ramapo River to 21-24.5 feet wide for the Pompton, through 33.0-34.6 feet wide for the Wanaque River, and 25.1-34.8 feet wide for the Ramapo River.

Located in a wet area for the United States, average precipitation is 47.3 inches per year. The rainfall throughout the Passaic River Basin is rather uniformly distributed. The Passaic River has a discharge capacity of 2900 cubic feet per second, the Pompton is 4,400 cubic feet per second, the Pequannock, Ramapo and Whippany Rivers are 600, 500 and 400 cubic feet per second, respectively.

**The Problems of Flooding**

The action that opened the second gap draining the Lake Passaic bed at Little Falls increased the drainage area for the Passaic River from 413 square miles to 762 square miles. This water, entering a constricted channel consisting largely of trap rock, leads to recurrent flooding with major and serious consequences. Among the sites of critical flood problems are the Lower Valley regions below Little Falls. The flood plain extends as much as 1000 feet beyond the river banks and the channel has insufficient capacity to retain large amounts of runoff, especially below the Great Falls in Paterson. In the Central Basin, over 5000 acres of flood prone land are present with about 1600 acres being swampland. The primary areas of drainage are along the Pompton River including much of the bottom land within the flood plain. The flood plain in the south central basin extends from one to four miles in width along the Rockaway River and the Whippany River. The flood plain narrows above the region of Two Bridges which is the confluence of the Passaic, Pompton and Pequannock Rivers. In the Highlands, the Ramapo River, Rockaway River, Mahwah River, and Whippany River are major flood producers with narrow flood plains of less than one mile. These upstream floods cause frequent flash flooding with serious erosional damage. Debris jams at a number of river crossings adding to the problem.

**Major Floods**

The record flood for most communities in the area is the flood of 1903. More recent floods serve as the flood of record for certain tributaries in the Passaic River Basin. Floods of major proportions have been experienced in 1917, 1936, 1938, 1945, 1951, 1955, 1960, 1968, 1971, 1972, 1973, 1975, 1977 and 1979. While precipitation rates vary, it appears that flood frequency increases as development continues to encroach the region.

In October of 1903, headwater runoff from the Ramapo River, Wanaque River and Pequannock River entered the confluence at Pompton. Regions of Wayne Township were flooded with 8-10 feet of water. In Paterson, 10 feet of water entered the lower city streets. In the meadows, all swamps and farms comprising 31,000 acres of land were inundated. Crops were destroyed along with the natural grasses and other flora in the region. The Ramapo River contributed the greatest amount of water. Along its length, nearly all dams, bridges, and many villages and industrial facilities were destroyed. In Paterson, the Passaic River discharged 33,700 cubic feet of water per second, in Clifton, the measured discharge was 35,800 feet of water per second while the Ramapo River discharged 15,800 cubic feet per second at Pompton Lakes. In Paterson the flood stage was 124.6 feet mean sea level and in Clifton it was 334 feet mean sea level.

In each successive flood, major damage was incurred by industrial plants facilities. Evacuations of hundreds of people were necessitated. Major disruptions to transportations were the result of flooding as numerous county, state and federal highways bisect the region. These are important truck routes for goods moving along the Eastern seabord. See figure 4.

**The Nature of the Basin**

The population of the basin has shown a dramatic increase in the last few decades. Population has shifted from the urban centers of New York City and the surrounding industrial sites of the central and lower parts of the basin into residential areas in the upper portion of the Lower Valley and Central Basin. Almost all are zoned single family housing with supplemental industrial and commercial development.

The Lower Valley is the area with most urban centers and higher densities of dwelling units and population. Dwelling units per acre are 5 to 10 times denser than in the upper regions. Heavy industry dominates this part of the basin.

The Central Basin is the region in which most potentially developable land is located. The increasing development is placing pressure on the wetlands and meadows of the basin. In the Highlands, extremely low population densities are likely to remain as the topography does not readily lend itself to urbanization.

This part of the United States has been, for the most part, a high-income, relatively active economic region. Manufacturing and commercial enterprises are a major

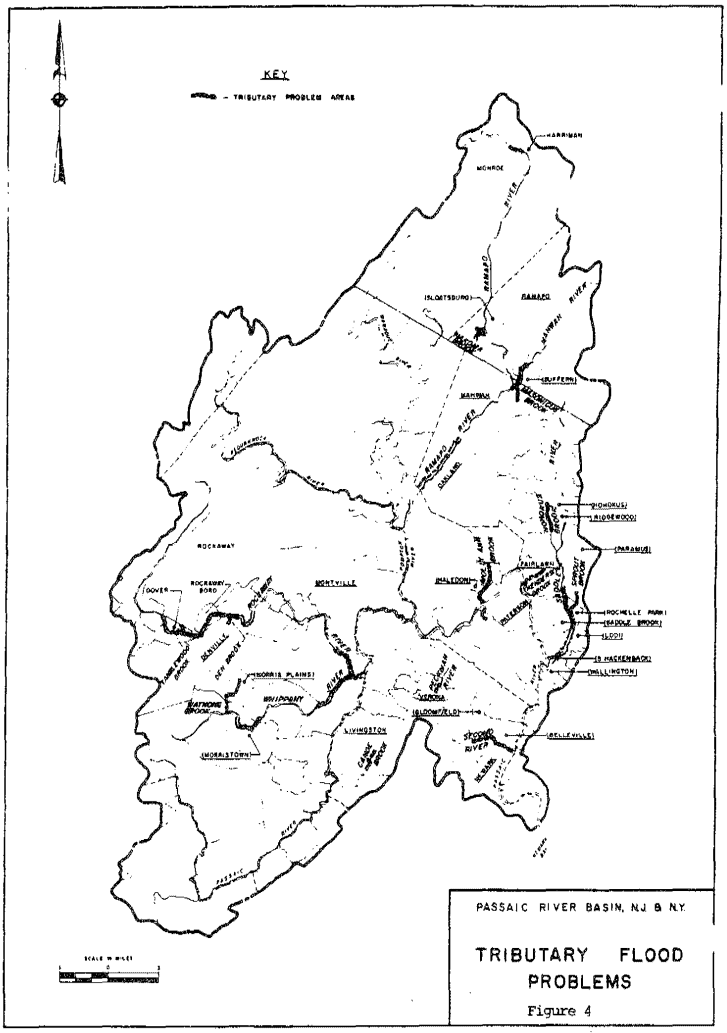


Figure 4

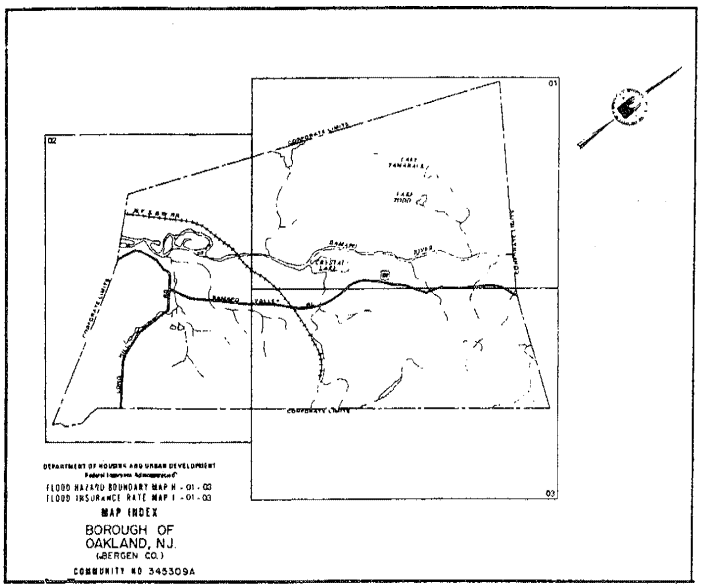
part of the region and population density remains high. While much land is being acquired for the preservation of habitations, unique geologic contribution (Dinosaur fossil sites are now parkland in Roseland), and recreational sites; it also represents a region that experiences severe droughts periodically; this is now viewed paradoxically, perhaps as an area important for water conservation and supply.

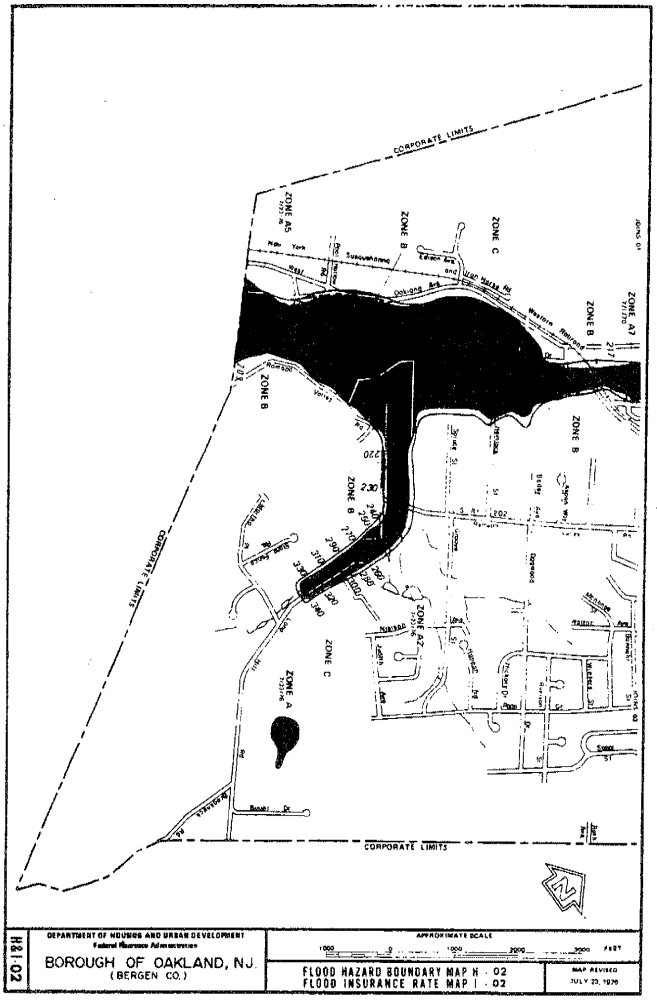
About 50 % of the precipitation runs off into streams or enters the ground water system. Much of the discharge is used for water supply and the flow rate is sensitive to this need and withdrawal of water. Water is also needed for the preservation of natural habitates to the south. A state Water Supply Master Plan is presently being developed for future water supplies in the region.

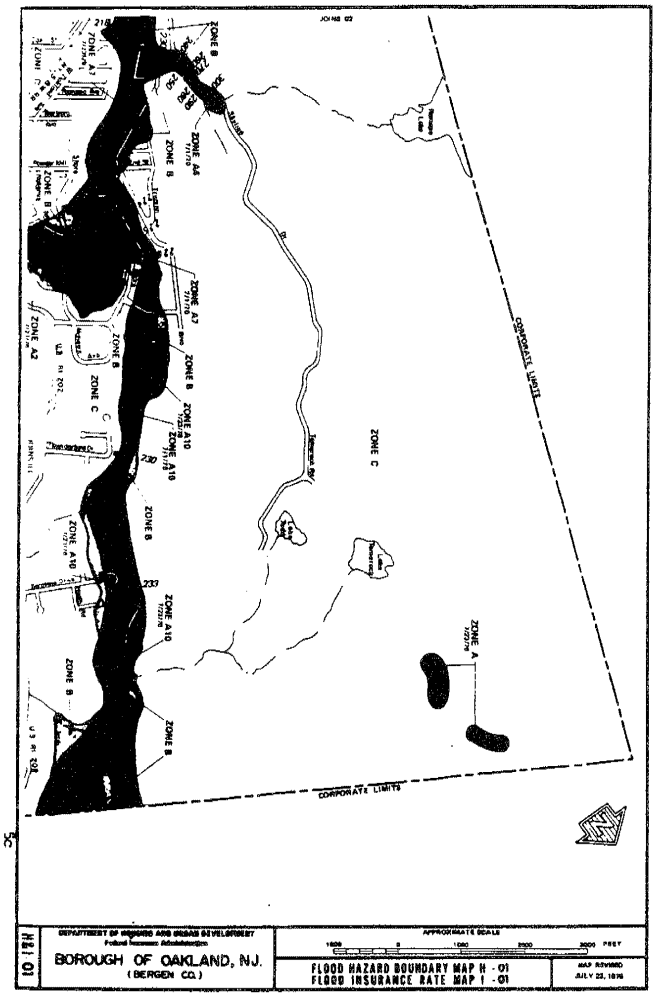
In the Central Basin and Highlands area, surface water and groundwater are used for public water supply. The Lower Valley has the greatest utilization of water and the water of poorest quality.

At present, the Army Corps of Engineers is working with the New Jersey Department of Environmental Protection on a Congressionally mandated Plan of Study for flood management and control. Both structural and nonstructural solution and interim measures are being developed for the basin. Floodway maps are being developed for all communities in the region. See figures 5, a, b, c, and d as samples.

In the Passaic River Basin, population now ranges from 147 people per square mile to 12,933 people per square mile. The population has been shifting to the flood prone Central Basin. As man-made structures intrude into this region, discharge peaks show a concurrent increase. Peak flood discharges would show a 56 % increase for the 100 year flood and a 44 % increase for a 25 year flood. The Corps of Engineers is charged with developing plans for retention of water and control of flow throughout the basin.



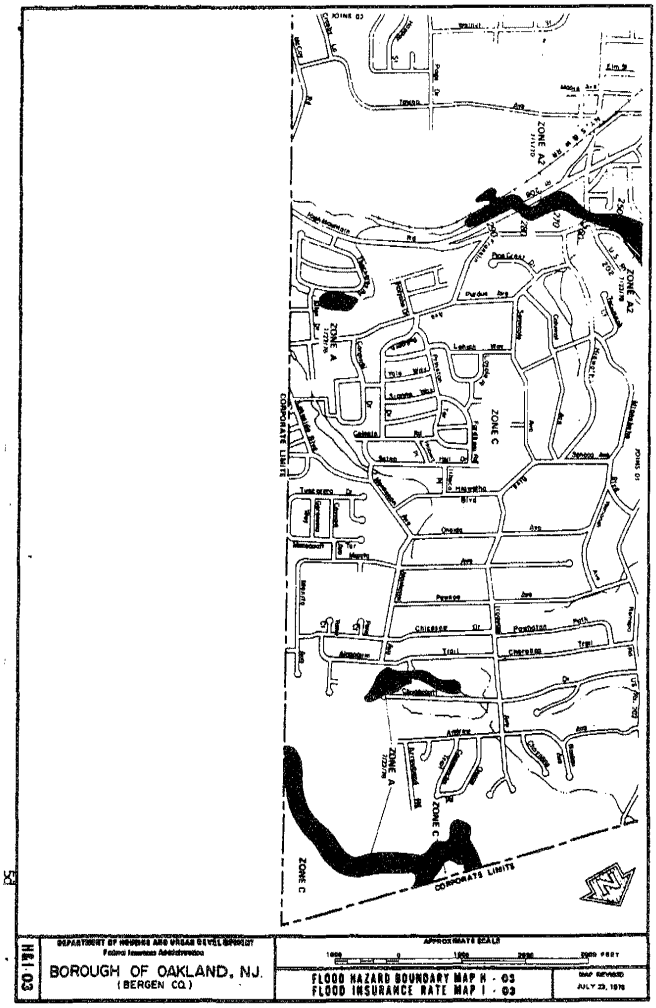

KEY TO SYMBOLS

| | |
|---|---|
| Base Flood Elevation Line with elevation in feet | 513 |
| Base Flood Elevation where uniform within zone | |
| Elevation Reference Mark | $RM7_x$ |
| River Mile | .M1.5 |

*Explanation of Zone Designations

A flood insurance map displays the zone designations for a community according to areas of designated flood hazards. The zone designations used by FIA are:

| Zone | Explanation |
|---|---|
| A | Areas of 100-year flood; base flood elevations and flood hazard factors not determined. |
| AO | Areas of 100-year shallow flooding; flood depth 1 to 3 feet; product of flood depth (feet) and velocity (feet per second) less than 15. |
| 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 | Area between limits of 100-year flood and 500-year flood; areas of 100-year shallow flooding where depths less than 1 foot. |
| C | Areas outside 500-year flood. |
| 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. |
| VO | Areas of 100-year shallow flooding with velocity; flood depth 1 to 3 feet; product of depth (feet) and velocity (feet per second) more than 15. |
| V1 – V30 | Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined. |




## ROAD LOG

**Cumulative Mileage**

0.0 Leave Rutgers Campus. Follow Rt. 21N to George St., Passaic. Trip parallels the Passaic River near the mouth in Newark Bay. Extending Northward to Dundee Dam in the Clifton-Garfield region the river is a salt-water estuary with about a four-foot tidal range. It is a navigable river with a 20 foot deep channel maintained in the lower estuary. Note the heavy industrialization and rotted piers and barges on either side.

10.0 Left onto George St.

10.1 Right onto Monroe St.

10.5 Over railroad trestle left onto River Rd. in Garfield. Note problem of debris build-up and desnagging needed.

13.9 Continue north on River Rd. to Rt. 46W. Dundee Dam is the area of demarcation between fresh water above and estuary below Garfield.

18.0 **STOP 1** Great Notch Rt. 46W Telephone Booth parking area. The roadway is located in an area that was formerly one of two spillways. The lithology is a basaltic flow of the First Watchung Mountain. This is the second water gap opened at the close of the Wisconsin glaciation.

20.9 Proceed West and turn right onto Rt. 23N. Continue North. Rt. 23N Rt. 46W and Rt. 80W mark the junction of Singac Brook and the Pompton River.

26.7 **STOP 2** Rear parking lot at Great Brake. Intersection of Rt. 23N and Pompton Plains Cross Road. Weir and flood marker are located at the junction of the Pequannock and Pompton Rivers. Note the bar deposits due to the curtailment of the stream energy by the bridge and pipeline. In this area the watershed traverses a setting of homes and ball fields. Return to bridge, proceed right on Pompton Plains Cross Road.

27.1 **STOP 3** Intersection of Pompton Plains Cross Road and Framingdale Ave. at John J. Baum Co. Old Feeder Dam above junction of the Pequannock and Pompton Rivers. Note changeable sign that keeps drowning record. This is a region of severe flooding after heavy rainfall despite the canal that can be followed from this region to Stop Two.

27.4 Follow Pompton Plains Crossroad and turn left onto Black Oak Ridge Rd. The ridge on the right is part of the First Watchung flow. Drainage on this side runs toward Pompton Lake, opposite is Wayne Township.

28.3 Continue to left turn onto Hamburg Turnpike.

29.1 Turn right onto Rt. 202N (Ramapo Valley Rd.) in Pompton Lakes and pumping station. Long term siltation and eutrophification has affected the retention ability of the lake. Dredging is to begin in mid-1980. Evidence of an abortive landfill can be seen in part of the lake shore along Rt. 202N.

31.3 **STOP 4** Turn left to Pleasureland Park at Doty Rd. and Rt. 202N, Oakland. This location is at the upper end of Terhune Park on Pompton Lake which receives the Ramapo River. It is named for Albert Payson Terhune, a dog breeder and author. It is also the site of boxer Joe Louis's training camp during the 1940's. Residential development lies on both sides of the river; note the undercutting of the retention wall. The area is connected by a small bridge to elevated Rt. 202N where residents park cars prior to flood events. Similiar bridges can be found east of this location. A major problem is that the flood plain is swamp woodland resulting in debris jams at many sites.

31.7 **STOP 5** Return to Rt. 202. Retrace route to Grand Union parking lot at left. Newark's Wanaque Reservoir pumping station has a persistant desnagging problem. The Ramapo Fault lies under the talus sloop (north) seen across the lake dam at the pumping station site.

Return to 202 and turn left onto Hamburg Turnpike.

32.1 Turn right over the Bridge at Dawes Highway. The Pompton River forms a meander near its junction with the Pequannock River. Two to four feet of water inundate four blocks of homes during severe flooding.

32.3 Follow Riveredge Drive to the left.

33.5 **STOP 6** Return to Dawes Highway and turn left at the

stop sign; turning right at Riverdale Blvd.

33.7 Turn left onto Riverdale Rd. at intersection of Riverdale Blvd.

34.3 Follow Riverdale Rd. over the bridge crossing the Pequannock River to Rt. 23S and bear left. Note the sand and gravel pits associated with the Wisconsin glacial moraine. Rt. 23 dips in several locations leading to major flooding following heavy rain, especially near the sites of the Racquetball Spa and MacDonald's Beach and Lake adjacent to the road.

37.3 Turn right onto Pequannock Ave. at the Hofbrau Restaurant bear left to Pequannock Ave.

37.4 Note the drainage ditch that now enhances flooding near the elevated cottages.

37.9 Turn left at Newark-Pompton Turnpike (old Rt. 23S).

38.1 **STOP 7** Bridge at Riverside Drive. The bridge and pipeline are part of the water supply for the city of Newark. The siltation and build up of debris occur in several locations in a limited area.

38.7 Proceed on the turnpike and turn right at Haul Avenue.

39.2 **STOP 8** Dorsa Ave. is the designated flood parking area for area residents. Pia Costa Co. property is a natural retention basin extending into Fairfield, now being developed near Rt. 46E at opposite side of the basin. The railroad trestle shows much evidence of heavy siltation.

40.2 Continue to Ryerson Ave. at stop sign. Turn right onto Ryerson Ave.

40.7 **STOP 9** Park at Soccer Field. Note Pompton River undercutting banks and homes with retaining walls opposite the fields. This is Lincoln Park, the site of repeated flood problems during heavy rainfall. The soccer fields have been flooded to a depth of 3-4 feet during flood stage of the river. Make a U-turn in parking lot and return to the Newark-Pompton Turnpike. This road follows part of the flood evacuation route to emergency parking.

41.4 Turn right onto the turnpike and follow it into Rt. 23S.

42.7 Turn right onto Fairfield Rd. at Jim's Gems. Fairfield Rd. follows the course of the Pompton River. Elevated homes are built on the island and opposite bank. Raised bridges create access to the sites of housing.

43.8 **STOP 10** Two Bridges - Cross the bridge and park in the lot on the right. This is the junction of the Passaic and Pompton Rivers, a site of frequent flooding after heavy rain. Color differences noting the river junction is often obvious at the bridge junction.

44.5 Proceed over Two Bridges to the left and cross onto Rt. 46E at sign.

45.2 Proceed to Riverside Drive. Homes built on the flood way of the Passaic River between it and a former retention site. Minor flooding occurred with frequency prior to the development of the retention site.

45.4 **STOP 11** Willowbrook Mall. A mall developed on the former retention area elevated the region. The homes near Riverside Drive now receive drainage from this parking lot and flood water from the river. Flooding is more frequent and severe. The roadway is township property and not mall property and is designated a flood parking area.

60.9 Return to Rt. 46E for one brief "mystery" stop. Proceeding to Rt. 3E and Rt. 21S to the Newark Rutgers University Campus.

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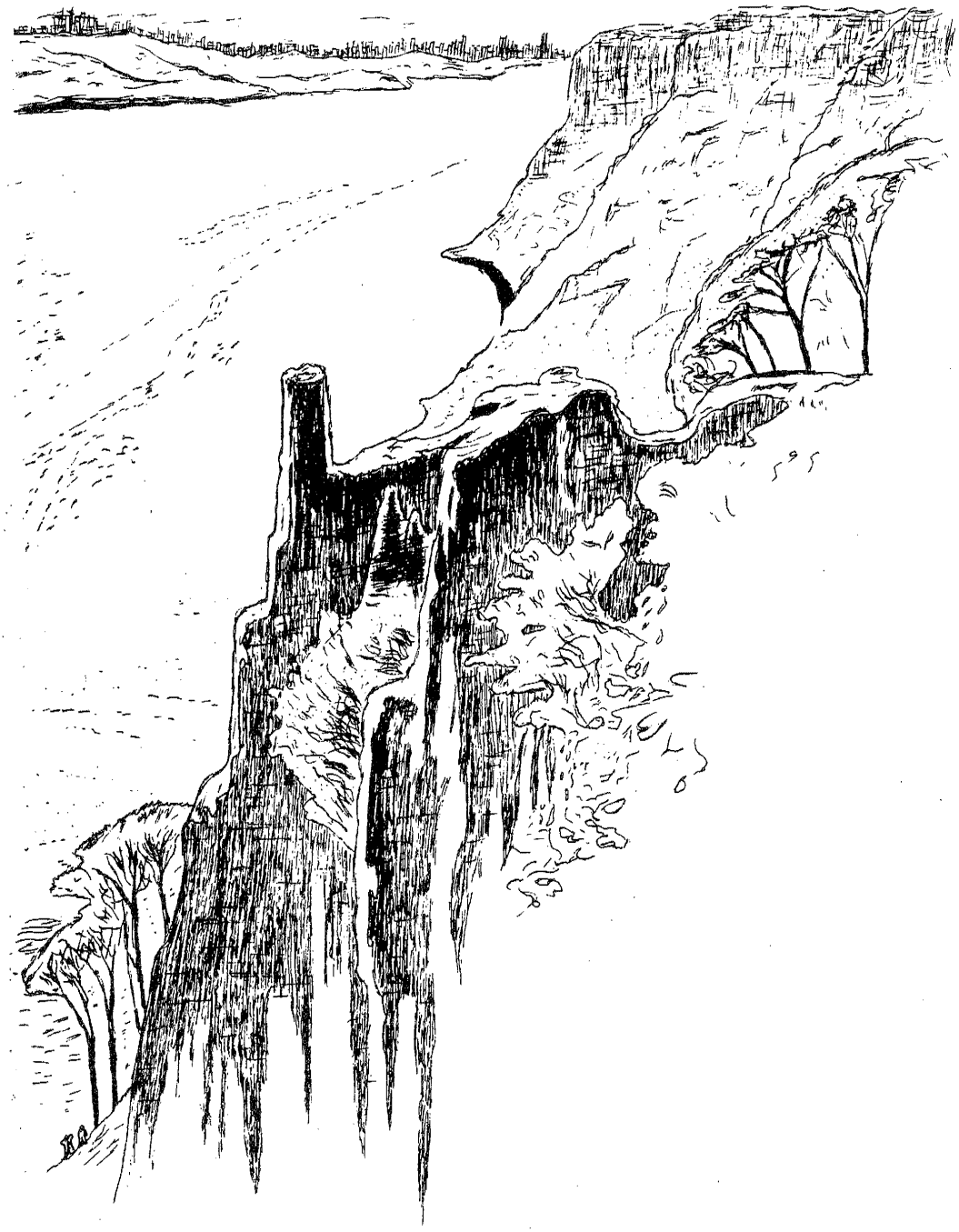

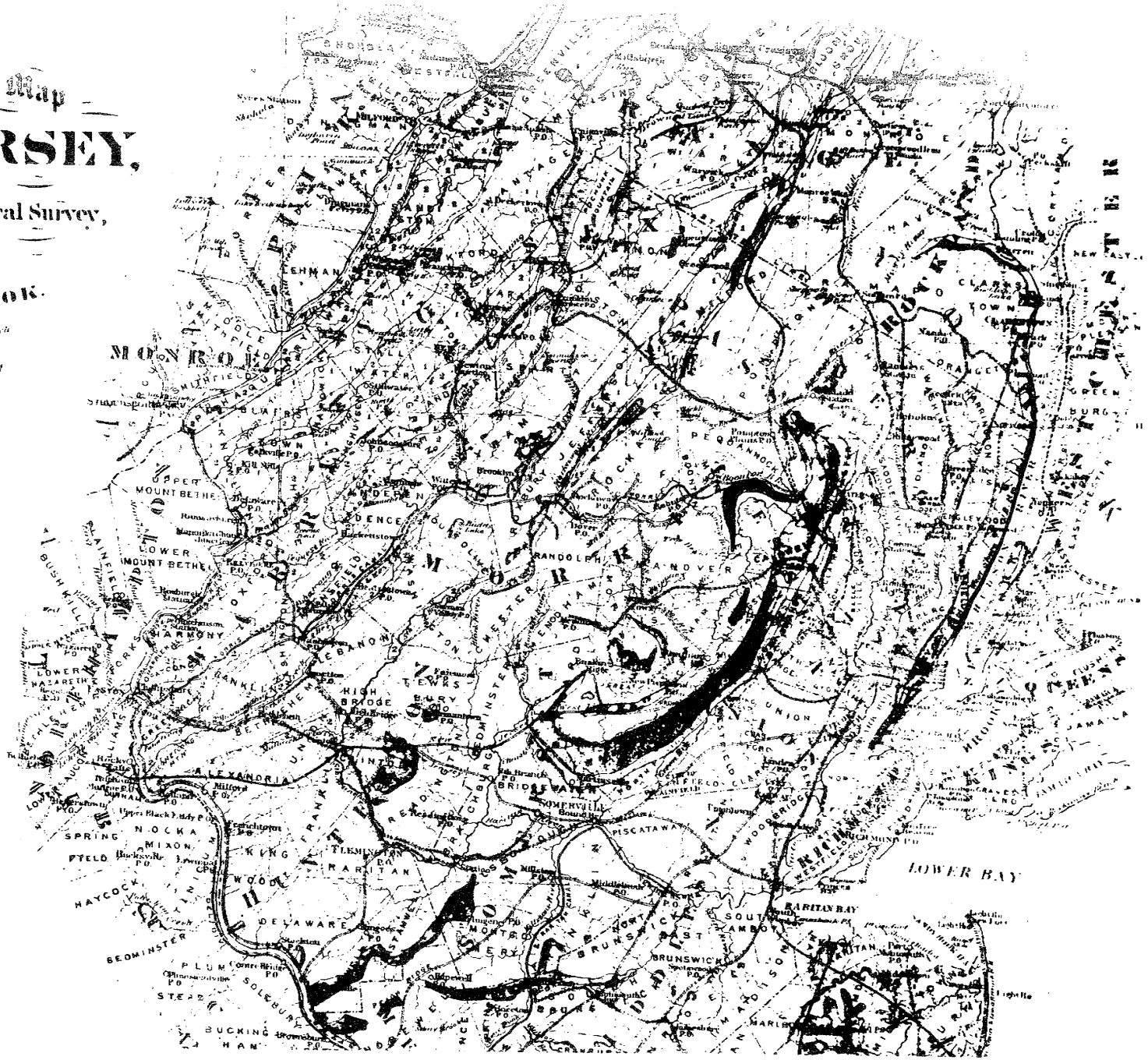


STATE ATLAS OF N.J.
1872
by G.H. Cook