SOME ENVIRONMENTAL PROBLEMS OF THE BINGHAMTON AREA

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THE SUSQUEHANNA RIVER BASIN

The Susquehanna River system is the largest drainage network in the northeastern United States draining to the Atlantic Ocean. Starting in central New York, the river flows southward through Pennsylvania and Maryland, draining 27,510 square miles (Fig. 1). We are concerned only with the eastern Susquehanna basin of New York in this report. The river here drains an area of 4,780 square miles in New York and Pennsylvania above and through the Binghamton area to Waverly, where it turns south into Pennsylvania and leaves New York. The major tributaries of the eastern Susquehanna River are the Otselic, Unadilla, Tioghnioga and and Chenango Rivers (Fig. 1). The Chenango joins the Susquehanna River at Binghamton. Indeed, this confluence determined the location of Binghamton.

The eastern Susquehanna River basin lies in the Appalachian geomorphic province. The bedrock is sedimentary sandstone, siltstone, and shale of Devonian age. The strata are essentially horizontal, but are slightly arched up into broad, gentle folds with axes oriented northeast-southwest. The folding generally has not markedly affected the basic dendritic drainage pattern of the section.

The region has been glaciated, resulting in a somewhat subdued topography. Hills have been smoothed and rounded and are commonly asymmetrical with steeper slopes on the north. Elevations range from 2500+ feet on the uplands to 750-850 feet along the river bottoms. The major valleys were broadened and deepened by glaciation and filled with thick deposits of glacio-fluvial sands, gravels, silts, and, in some cases, lake clays. Many of the small postglacial streams have cut steep, narrow gorges through bedrock. The combination of stream types and broad, open uplands gives a pleasing esthetic quality to the region.

Glaciation had a significant effect on drainage, not only in ways already mentioned, but also by disrupting and blocking pre-glacial drainageways. The extraordinary path of the Susquehanna as it loops down to Pennsylvania and back into New York east of Binghamton is a reflection of events during deglaciation. Many tributaries flow in "misfit" valleys which are too large for them. Drainage divides occur in "through valleys", i.e., a valley which is occupied by streams one of which flows north and the other south. Many obvious drainage diversions can be seen throughout the region.

Besides such changes, the glaciers exerted their influence on the Susquehanna drainage through the deposits they left. The uplands and valley side slopes of the watershed are covered with glacial till. This results in soils which are generally impermeable and poorly drained.

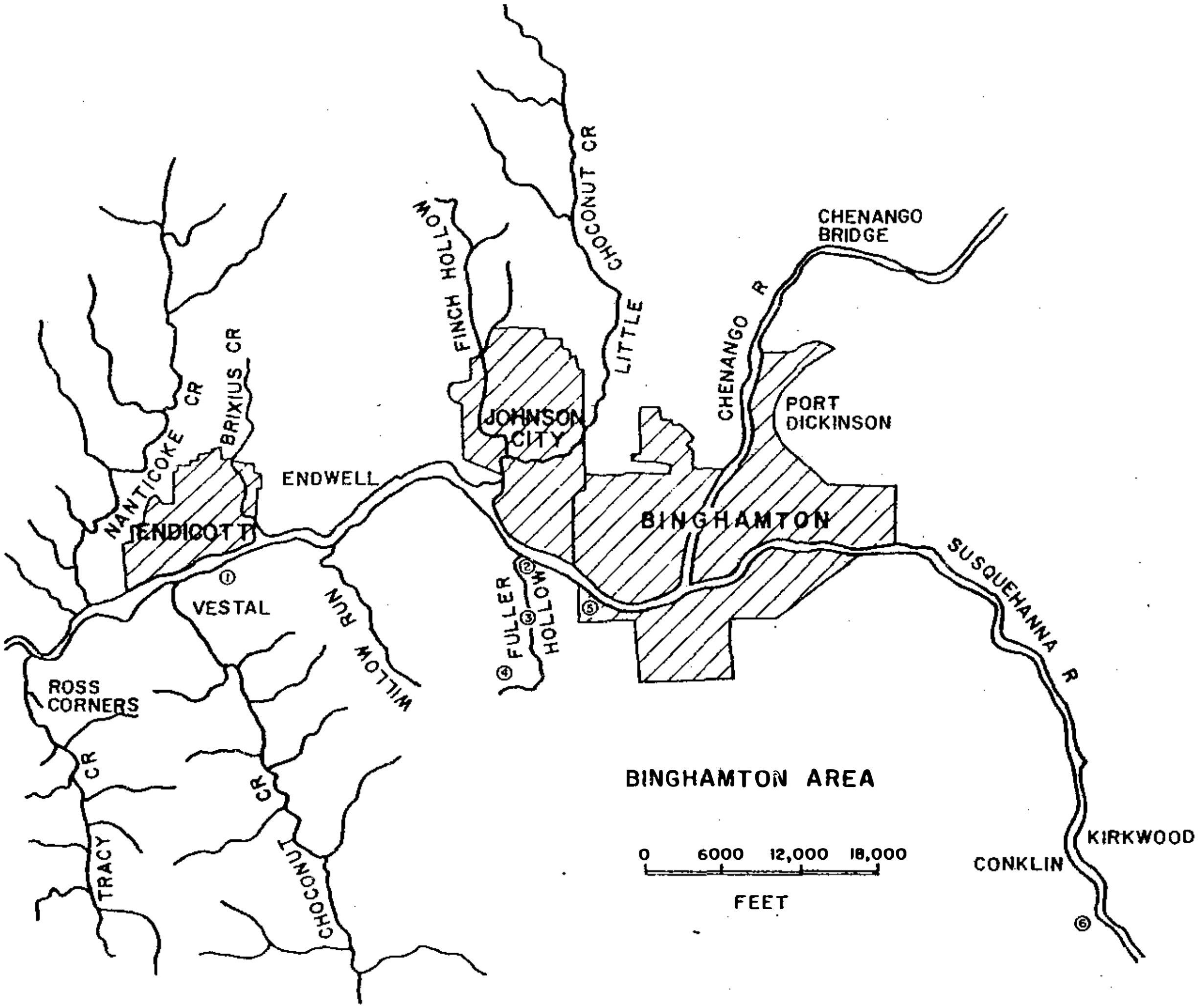

Figure 2. Map of the Binghamton area with stops indicated.

Hence, runoff is rapid and many tributaries are "flashy", i.e., have a quick rise and fall of discharge. The thick glacio-fluvial fills in the major valleys are good ground-water reservoirs which sustain flow of the larger streams throughout the dry summer months (Ku, Randall and MacNish, 1975).

The soils of Broome County were formed in glacial till, glacial outwash, glacial-lake deposits and more recent alluvial deposits. Soils in the low-lying areas, along the floodplains, are mostly of the Tioga-Chenango-Howard association. These are soils that are deep, well-drained, and gently sloping and are, therefore, very suitable for development. The main problem associated with these soils is that of occasional flooding.

The terraces bordering the floodplains are primarily Chenango, Howard, and Unadilla soils. Like those found in the floodplains, these soils are deep and well-drained (S.C.S., 1971).

In most of the county, particularly in the uplands, soils of the Volusia-Mardin association are formed on deep, gently sloping to very steep glacial till. These soils are not suitable for most types of development, because they exhibit a slowly permeable fragipan. A fragipan is a dense subsurface layer of soil; it is indurated, hard and slowly permeable. The Volusia fragipan is composed of grayish-brown silt-loam at a depth of 15-22 inches. This is not to say, however, that development has not occurred in areas with these soils; there has been little choice because these soils cover about 90 percent of the county.

The glacial modification of the topography has largely determined the human geography of the region. Population is mostly concentrated on the broad flood plains and terraces which are locally as much as two miles wide. Broome County has the higheset population density in the eastern basin, with development concentrated in the Triple Cities (Binghamton, Johnson City, Endicott) section along the Susquehanna (Fig. 2). The other counties in this watershed are primarily rural. Land use shows the effect of soil type. Upland and valley slopes in till are generally forested or in pasture. Much of the agricultural land is on the broad flood plain composed of glacio-fluvial deposits.

A conflict in use arises since the flood plains are also the places most easily and economically developed. The aquifers in the valley fill and the permeability of the sands and gravels for septic systems make the valleys more desirable for housing. During the post-World War II development boom, extensive urbanization occurred in the valleys, along the Susquehanna River itself and up larger tributaries. At present, 66 percent of the population resides in the strip of flood plain along the Susquehanna River. The steep slopes of the uplands tended to act as natural development barriers. It is only recently, with continued growth and some realization of the dangers of building on flood plains, that urbanization has spread to the flat upland summits and the valley side slopes. Urbanization of these seemingly innocuous areas also brings on drainage and river problems, as will be seen.

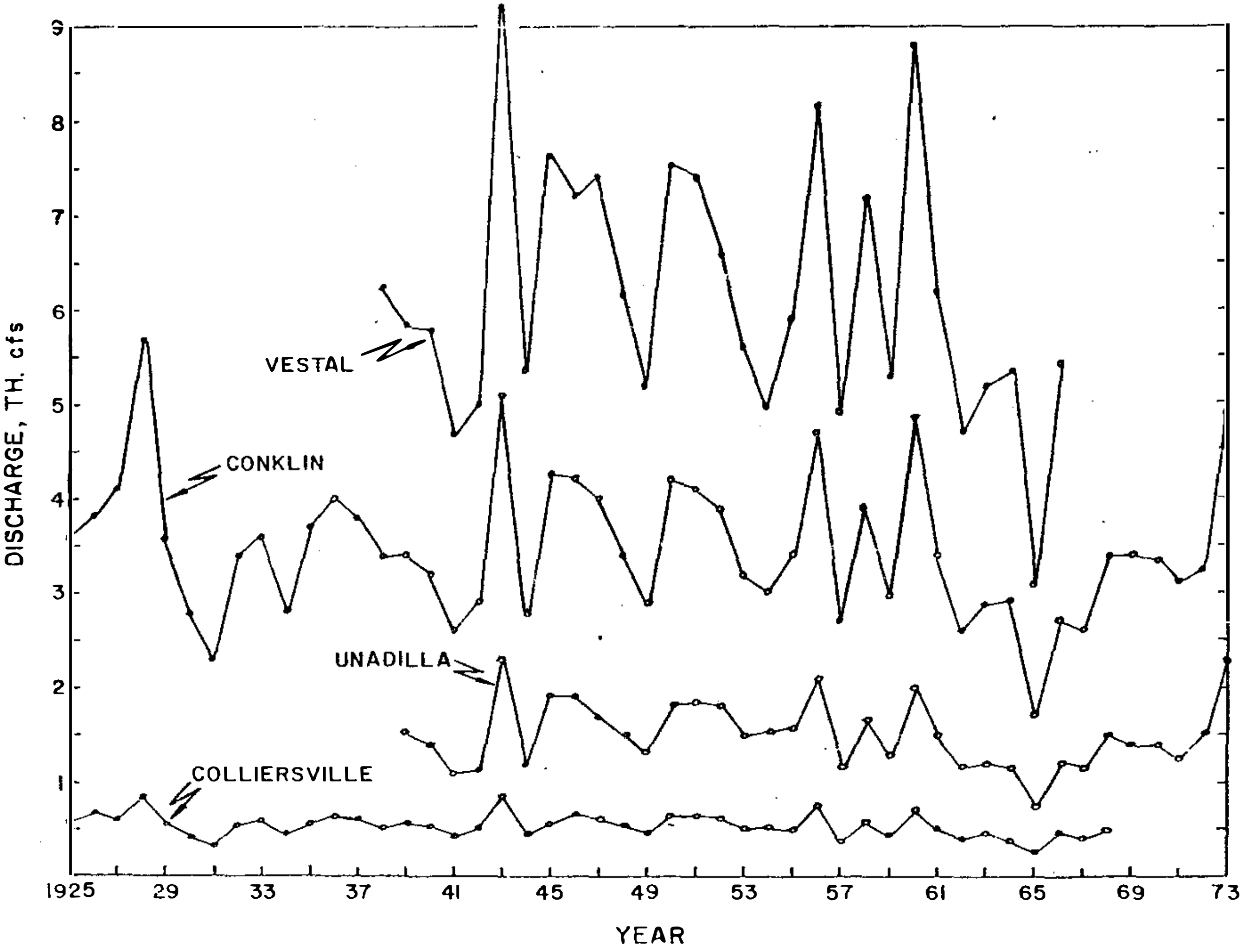

Figure 3. Annual discharge on stations at or upstream of the Binghamton area. From Morisawa and Vemuri (1975).

Hydrology of the Eastern Susquehanna Basin

The area has a humid, continental climate with an average precipitation of 36-40 inches per year. Precipitation is generally of the frontal type, where polar air masses meet the more humid warm air masses moving northeastward. The record flood of 1936 was produced by such frontal precipitation combined with a spring thaw (Susquehanna River Basin Study, 1970). Although the summer is dry, intense local thunderstorms may occur. The region also lies in the path of tropical hurricanes. These storms, originating in the Atlantic or Caribbean, sometimes swing inland bringing intense and excessive rainfall. Severe damage has been caused in the past by these tropical storms. More recently, Agnes (1972) and Eloise (1975) caused considerable damage on smaller tributaries, but did not cause damaging floods on the main stem.

Table 1

Highest Floods of Record, Binghamton Area

	Date	Stage ft.	Estimated Discharge, cfs
Susquehanna River			
Conklin	Mar. 1936	20.14	61,600
Vestal	Mar. 1936	30.5	107,000
Waverly	Dec. 1952	19.7	112,000
Chenango River			
Chenango Forks	July 1935	20.3	96,000
Broad Acres	July 1935	20.6	96,000

Data from Susquehanna River Basin Study, 1970.

The water budget reflects the difference between precipitation over the watershed and discharge flowing out of the basin. The runoff (20.8 inches) reflects 54 percent of the mean annual precipitation. Forty-six percent of the rainfall is lost by evapo-transpiration because the area is well forested and 87 percent of the watershed is agricultural or vacant.

There are four gaging stations on the eastern Susquehanna River main stem. Annual flow for the periods of record and flow-duration curves are shown in Figures 3 and 4. The four stations below Colliersville (Fig. 4) reflect the contribution of the thick valley fill which act as acquifers contributing to stable base flow. This is denoted by the levelling off of the curves at approximately 98.99 percent of the time with a good discharge. Note the difference between the tails of these curves and that of the Colliersville station.

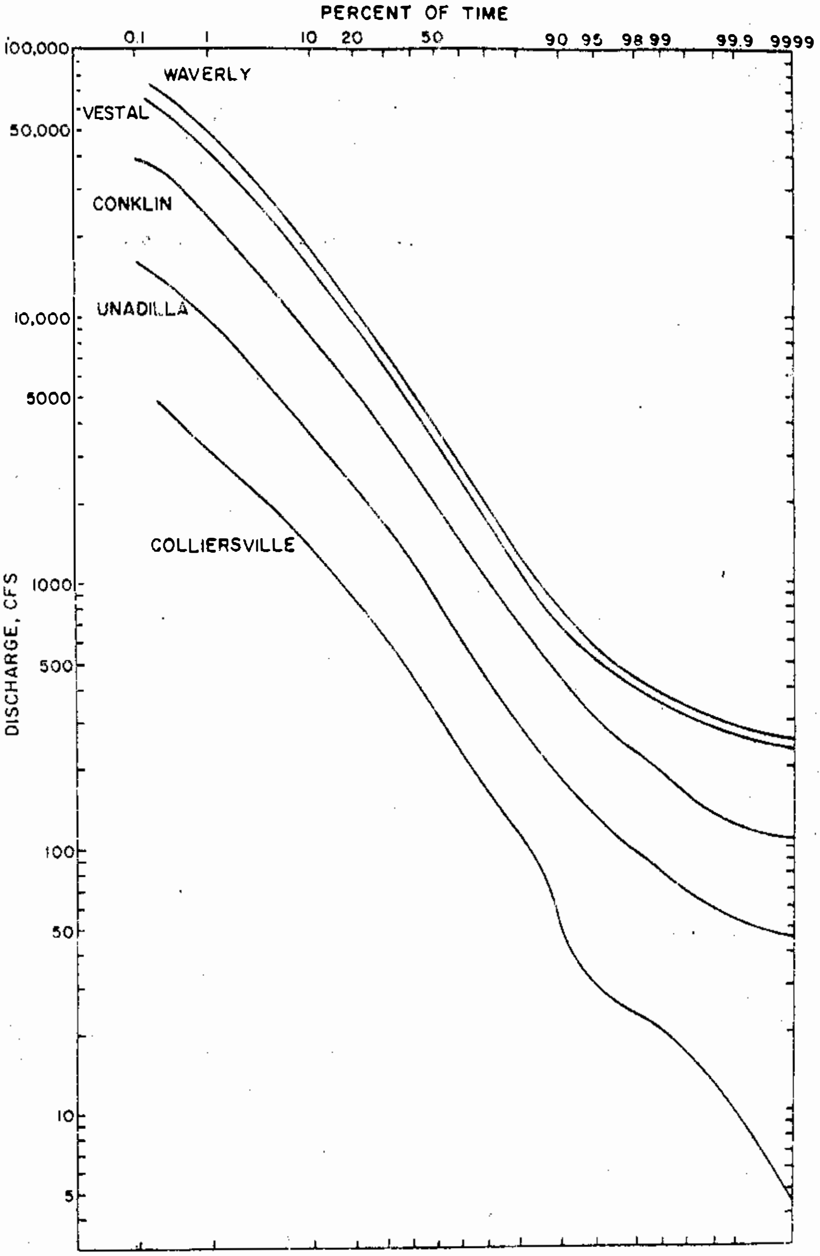

Figure 4. Flow-duration curves, Susquehanna River at Waverly and upstream. From Morisawa and Vemuri (1975).

The recurrence-interval curves (Fig. 5) indicate the average time interval at which a given discharge recurs. These can be used either to make predictions of peak flow or to determine the frequency of a given storm. For example, at Vestal a high discharge of 70,000 can be expected every 5 years. On the other hand, the peak flow of the storm Eloise in September of 1975, which was 61,500 cfs in Vestal could be expected about every 3 years or so, i.e. a 3-year recurrence interval.

The graph (Fig. 6) and the regressions which relate drainage area on the Susquehanna to mean annual discharge and to peak flow allow a prediction of these discharges, if one knows the area of basin above any point on the main stem. Cortland and Sherburne are on the Tioughnioga and Chenango Rivers, respectively, so their peak annual discharges lie somewhat off the regression line for the main stem Susquehanna River. Regressions of mean annual discharge ($\overline{Q}$) and mean annual peak flow (Qp) to watershed area (A) are:

$$\overline{Q} = 1.5\,A \qquad r = .99$$

$$Q_p = 25.7\,A^{0.93} \qquad r = .96$$

Note that the scales on the graph of Figure 6 are logarithmic. That is, the regression equations can be written:

$$\log \overline{Q} = \log 1.5 + \log A$$

$$\log Q_p = \log 25.7 + 0.93 \log A$$

Of particular importance in understanding the hydrology of the Binghamton area are the gages at Conklin above Binghamton and at Vestal below it. Table 2 gives the mean annual discharge per square mile of drainage area of the Conklin and Vestal stations. Since the area between these two gaging stations represents much of the urbanized stretch of the region, an attempt was made to evaluate the change in discharge which might be attributed to urban growth. In order to discount the amount of water carried into the Susquehanna by the upper Chenango, the Vestal flow minus the discharge at Chenango Forks was used (column 3). This was then recalculated to account for the increase in area of the Susquehanna Basin to Vestal over the area of the Chenango. To minimize precipitation variability, a ratio was calculated (column 5). This ratio represents the proportionate contribution of the basin over the Binghamton reach to the flow of the Susquehanna. Several points should be kept in mind. First, the Chenango River contributes a great deal of flow to the Susquehanna River. This is important at times of peak flow, because the city of Binghamton lies at their confluence and backwater effects at the junction can be disasterous. Also, at time of drought the low flow of the Susquehanna is augmented by discharge from the Chenango valley outwash deposits. Finally, the table shows that through 1956 there was a fairly constant ratio of discharge above Binghamton to that contributed by the urbanized stretch. However, a spurt of development in the late fifties resulted in a jump in this ratio after 1956.

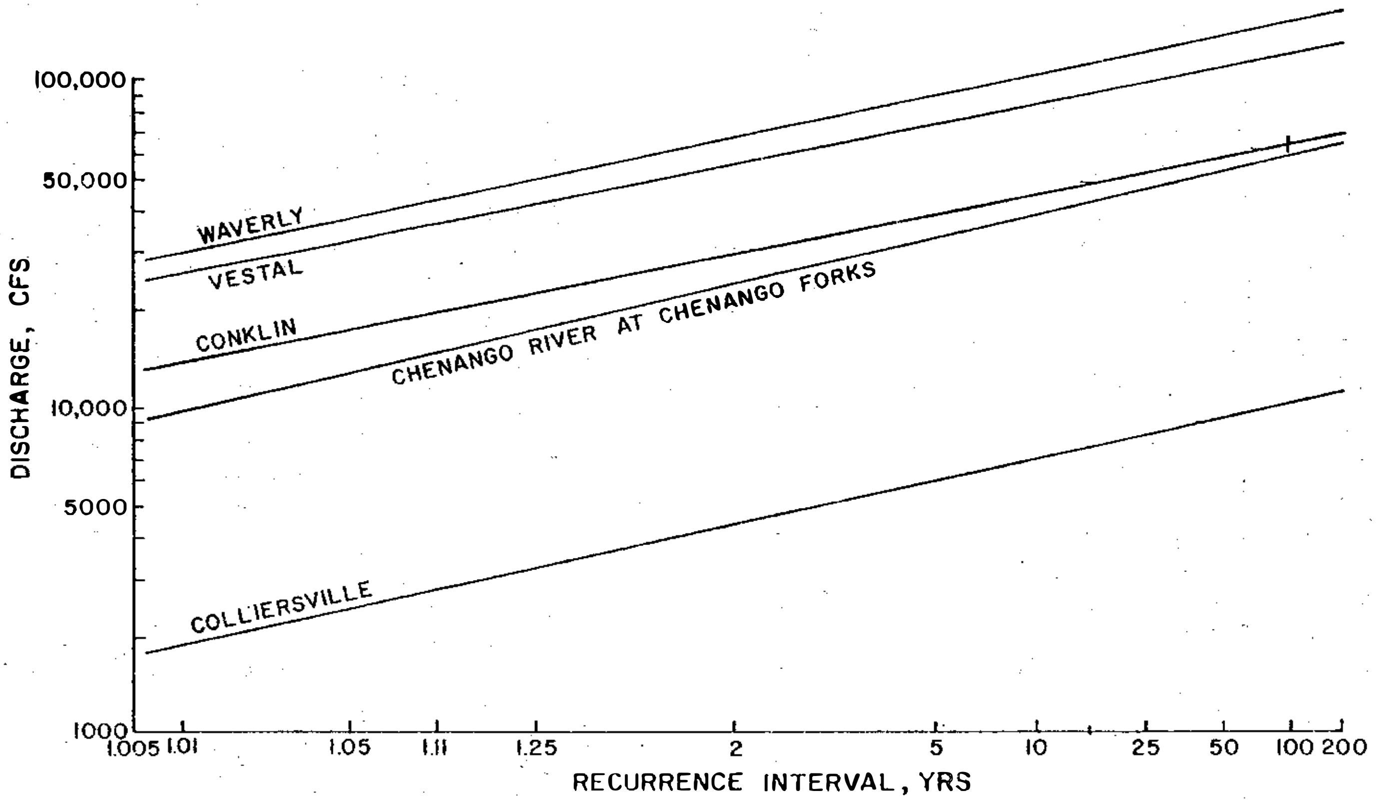

Figure 5. Flood-recurrence-interval curves, eastern Susquehanna Basin. From Morisawa and Vemuri (1975).

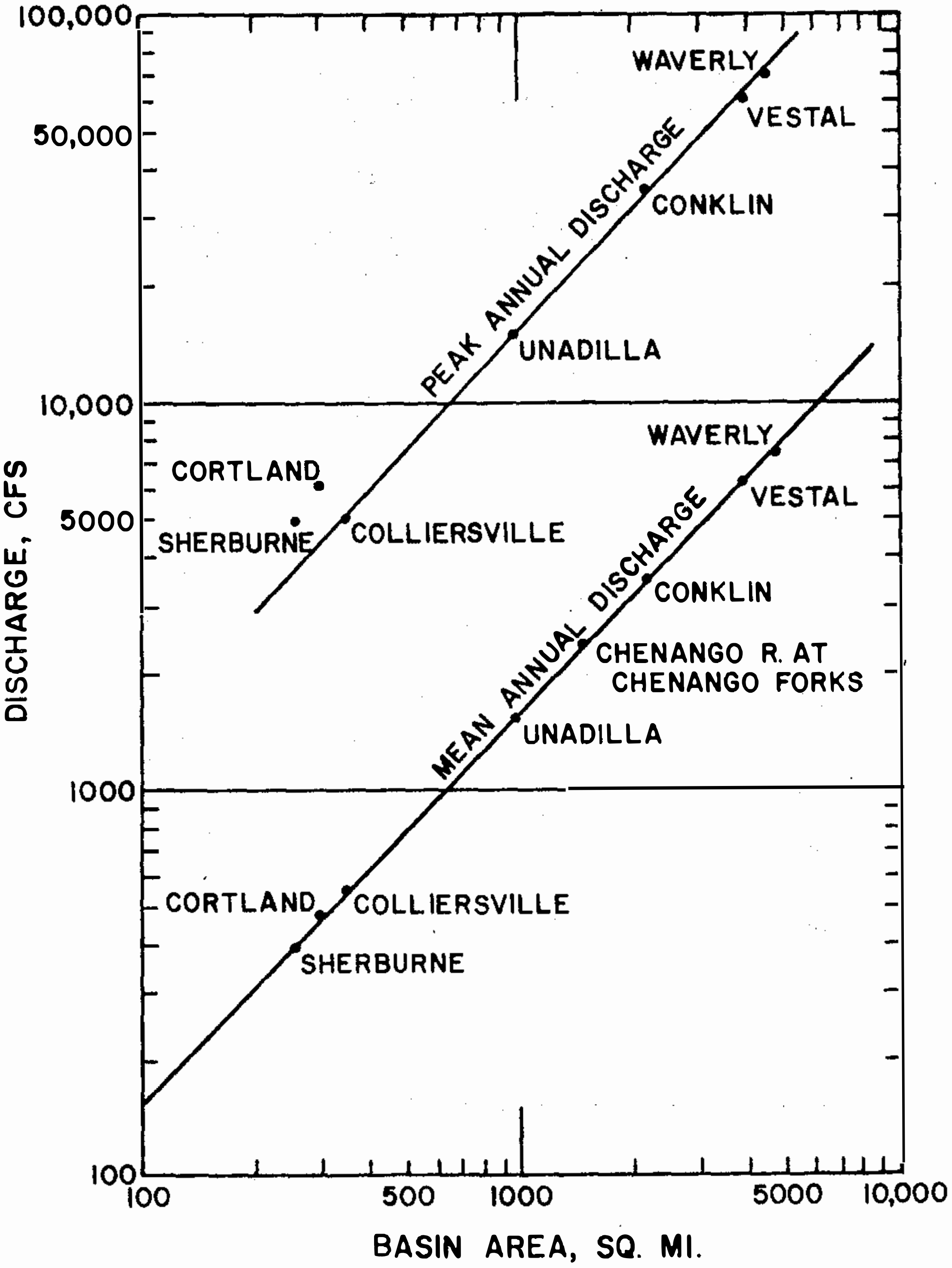

Figure 6. Relation of mean annual discharge and peak flow to basin area, eastern Susquehanna watershed. From Morisawa and Vemuri (1975).

Table 2

Ratios of Discharge per Square Mile, Susquehanna River at Binghamton

(1) Year	(2) Vestal cfs/mi^2	(3) Vestal minus Chenango Forks cfs/mi^2	(4) Conklin cfs/mi^2	(5)* V-CF/ C
1941	1.18	1.14	1.16	.98
	1.27	1.28	1.30	.98
	2.33	2.26	2.31	.98
	1.35	1.25	1.26	.98
1945	1.92	1.87	1.90	.98
	1.83	1.87	1.90	.98
	1.88	1.76	1.78	.99
	1.55	1.52	1.53	.99
	1.32	1.30	1.31	.99
1950	1.90	1.86	1.87	.99
	1.86	1.83	1.85	.99
	1.68	1.70	1.74	.98
	1.42	1.42	1.45	.98
	1.25	1.34	1.36	.98
1955	1.50	1.50	1.53	.98
	2.07	2.09	2.10	.99
	1.25	1.23	1.20	1.02
	1.81	1.82	1.76	1.03
	1.35	1.35	1.32	1.02
1960	2.22	2.27	2.17	1.05
	1.58	1.56	1.50	1.04
	1.19	1.16	1.16	1.00
	1.30	1.32	1.28	1.03
	1.34	1.30	1.30	1.00
1965	.78	.72	.75	.96

*Column 3/column 4

Flow data from U.S. Geol. Survey computer printouts.

Fig. 7 shows that 1945 was a year of high rainfall, yet the ratio (V-CF/C) remained the same as in 1952, a low-rainfall year. This probably reflects the effect of ground-water storage. Even though 1957 was a dry year, culminating a downward trend in precipitation, the ratio increased and remained high until the excessively dry 1965, after 5 years of drought. Unfortunately, the Vestal gaging station was discontinued after 1965 so data beyond that year is not available. It should also be noted that Binghamton gets its water from the Susquehanna River below the Conklin gaging station and this may account for some loss of water in the urbanized area. These ratios indicate that there has been an increase in the mean annual discharge per square mile in the urbanized Binghamton region, a result of growth and development.

EFFECTS OF URBANIZATION

One of the major problems in the metropolitan areas of the eastern Susquehanna River basin (as in many other watersheds) is urban growth and the settlement pattern. Early settlers established the city along the river in the broad flood plain at the junction of the Susquehanna and Chenango Rivers. Since this was the easiest, most economical, and most accessible place; the town grew by spreading along the river channel.

The settlers did not understand the fact that a river develops its network pattern and channel morphology in adjustment to the prevailing environmental conditions of the geology, topography, and hydrology of the watershed. The flood plain is an integral part of the river's drainage system, especially during times of peak flow. At such times the river overflows its normal channel and flows out over its extra-channel right-of-way, the flood plain. The flood plain is thus a normal escape valve for exceedingly high discharges and acts to increase flow capacity. It also serves to decrease velocity, acts as temporary storage, and promotes infiltration into the flood-plain sediments. Floods also serve to replenish the fertility of the flood-plain soil. Disruption of the natural way in which the stream discharges excessive flow is dangerous.

Urbanization disturbs the natural system of land drainage. Denudation of the surface and covering the land with buildings, streets, and parking lots changes the run-off and, thereby, the hydrologic balance. Rain water, no longer able to infiltrate the permeable sand and gravels of the flood-plain, runs off immediately into the rivers. In fact, development generally aids this run-off by supplying ditches, sewers, and storm drains to move rainfall quickly to the local streams. Such a practice increases peak flows and shortens the time lag to peak discharge. It also reduces ground-water recharge and thus reduces low-flow rates.

The filling of channels and flood plains to reclaim more land for development or for highways reduces channel capacity and, again, increases the potential for flooding. As urbanization spreads flood hazards grow, since runoff increases with a given rainfall. Also, as time goes by the probability of more extreme rainfall events increases.

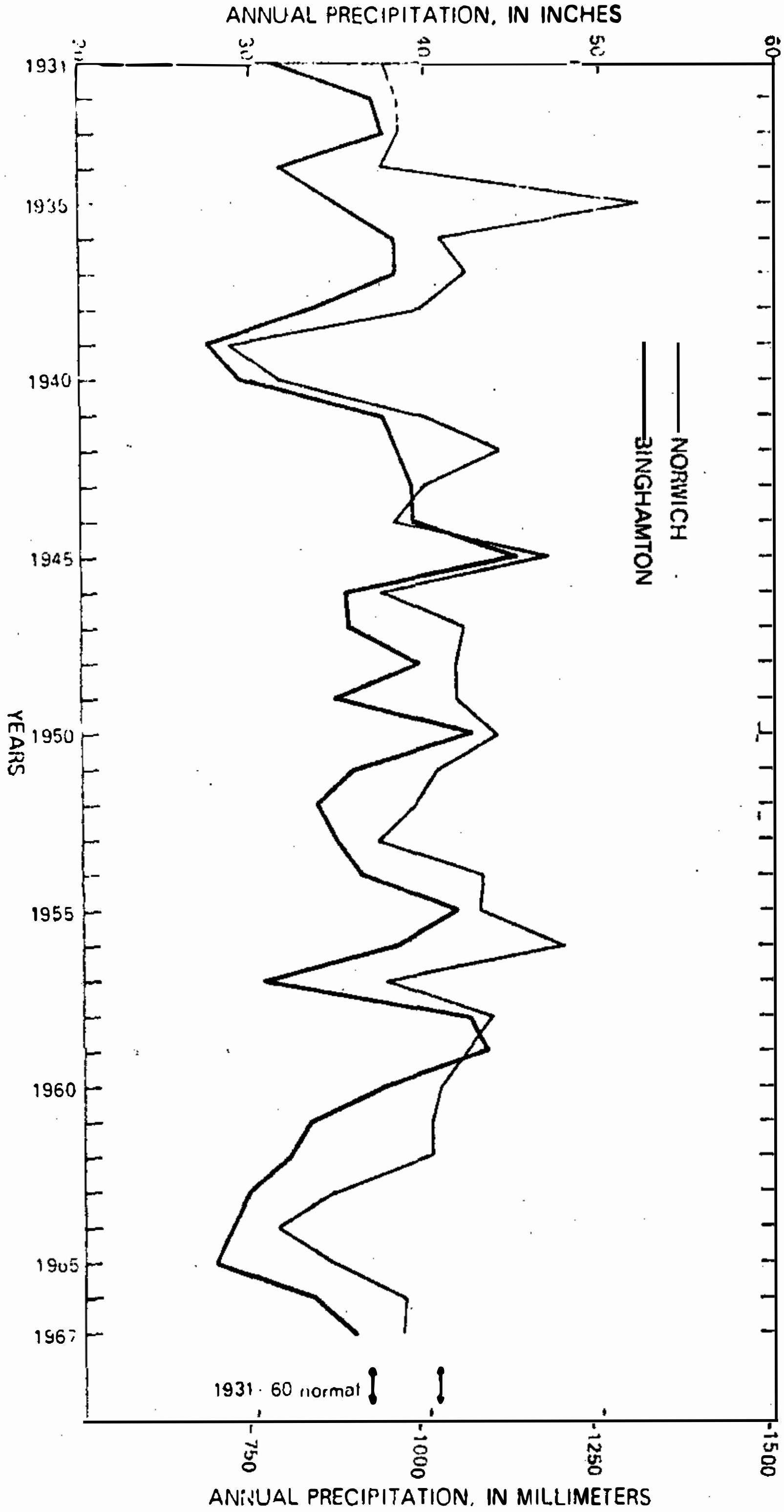

Figure 7. Annual precipitation at Binghamton and Norwich. (From Ku, Randall and MacNish, 1975).

Thus, by encroaching on the stream right-of-way, the flood plain, and by converting land to impervious surfaces, man has intensified the flood hazard. Floods occur and so man reacts, and his reactions have traditionally been in terms of structural measures to "control" the river. Instead of treating the illness, he treats the symptoms. He scratches the itch instead of controlling the allergy.

Flooding In The Binghamton Area

The flood history and its solution in the Binghamton area is similar to that of other watersheds. Following heavy flooding in 1935-36, the City of Binghamton promoted the sale of $200,000 in flood-control bonds. Money from this fund was used to construct flood walls on both sides of the Chenango River and along the north bank of the Susquehanna in Binghamton and Johnson City. This was complemented by the Corps of Engineers' construction of a major flood-control project in 1943, building levees, flood walls, and various channel improvements (especially near Conklin and Kirkwood) in the immediate area of Binghamton on the Susquehanna and Chenango Rivers. Work was later extended to Vestal, Westover, Endicott, and West Endicott. Total federal costs of these projects exceeded 13 million dollars (Table 3). The local costs amounted to over 1 million dollars.

Table 3

Costs of Flood Protection, Study Areas (from Tkach, 1975)

River	Structural Cost
Brixius Creek[a]	\$ $322{,}000^{+}_{*}$
Choconut Creek[b]	$194{,}000_{**}$
	$250{,}000_{*}$
Fuller Hollow[ab]	$60{,}000_{+}$
Little Choconut[a]	$678{,}730_{*}$
	$84{,}000_{*}$
Willow Run[b]	144,000
Susquehanna-Chenango[c]	11,381,228[c]

[a] plus unknown additional amount for channelization

[b] plus Corps of Engineers' diking near the mouth

[c] protection of Binghamton, Endicott, Johnson City by the Corps of Engineers. Includes flood walls, dikes, levees.

* cost of channelization

** diking

\+ dams and flood-retarding structures

Upstream controls by the Corps of Engineers consists of two major reservoirs; Whitney Point Dam on the Otselic River (upper Chenango basin) and East Sidney Dam on Ouleout Creek (upper Susquehanna watershed). The Whitney Point Dam, completed in 1942 at a cost of 5.5 million dollars, controls 255 mi^2 of drainage, and the East Sidney Dam, controlling 102 mi^2 and completed in 1950, cost over 6 million dollars (Susquehanna River Basin Study 1970). These dams reduce flood heights on the Chenango River and Susquehanna River through the Binghamton area.

Since these projects, urbanization has continued to increase in the Triple-Cities area causing or aggravating drainage problems in major and minor tributaries. After the floods of 1960 Broome County received government approval for the largest single flood-control project in the United States (PL 566). The project is a comprehensive plan for nine watersheds and includes dams, channelization, and other channel "improvements" at a federal cost of 6 million dollars and a local cost of over $750,000.

Table 4

Average Annual Flood Damages, Susquehanna River, Binghamton
($1000 at March, 1974, Price Level)

Locality	Normal Existing Conditions	Normal Growth Increment*	Economic Growth Increment**
Conklin-Kirkwood	136.80	10.79	85.12
Chenango River-above Binghamton	87.70	26.30	40.13
Binghamton-Vestal	287.73	6.69	115.50

Increases should be added to existing damage for totals.

*Damages which will occur if future flood-plain development is controlled.

**Damages associated with improvements and contents within the flood plain.

Data from Table III-5, Eastern Susquehanna River Basin Board, 1975.

The desperate need for an overall solution to the growing drainage problems of the Triple Cities region was shown by the effects of two recent storms, Agnes in 1972 and Eloise in 1975. Although the upper Susquehanna River basin was treated lightly by Agnes, damage in local watersheds amounted to 1.25 billion dollars. Damage by Eloise amounted to 1.5 million dollars (Vincent Vaccaro, personal communication). Therefore, despite the fact that a great deal of money has already been spent in protecting the Binghamton area from flood damages, the hazard grows (Table 4). Moreover, the likelihood exists that an extremely rare storm might overtop or break through the flood walls and levees in the Binghamton area, as happened at Wilkes Barre during Agnes. Damage and loss of life could be staggering, since the flood-protection structures have provided a false sense of security for increased flood-plain development. The normal growth increment is damage over and above existing damage which would occur under controlled development of the flood plain. Economic growth increment is the increased amount of damage with improvements and expansion of present flood-plain development.

FULLER HOLLOW CREEK

Fuller Hollow Creek is located on the south side of the Susquehanna River in the Town of Vestal, west of Binghamton (Fig. 2). The creek has its head on the north-facing slopes of Ingraham and Bunn Hills. Below Fuller Hollow Road the stream flows through a broad, wooded flat area with steep sides and into a city park where the channel is on bedrock. The flat above the park is an effective storage area for excessive runoff from above. However, the bedrock is not far below the surface as evidenced by the outcropping in the stream bed at the park. Once the water reaches the bedrock section where impermeable shale underlies the flood plain as well as the channel, water drains out and into the stream, increasing the discharge. Below the park the stream has been straightened, shortening its length by 200 feet. The creek has been channelized where it flows through the S.U.N.Y. campus athletic field and below to its mouth. Total drainage area is 3.8 square miles.

The State University lies within this watershed and is a cause of minor development of the nearby lower part of the basin, below the park. Urbanization has crept up the valley, and since 1970 the area at the head, above Fuller Hollow Road, began to be developed. Now almost the entire upper hillside, once densely forested, has been devegetated, bulldozed, and covered with a 300-home subdivision. The surface has been modified and tributaries and streets sewered to drain storm waters directly and quickly into Fuller Hollow Creek.

A typical hydrograph of stream flow below the subdivision is shown in Figure 8. Urbanization has not only increased storm runoff, but the augmented flow also rushes down the straightened section below the park with great vigor, eroding backyards and deepening the channel. The debris is carried off and deposited downstream. Two major sites of deposition of the debris eroded from upstream are a cemented channel below the Route 434 bridge and the mouth where Fuller Hollow Creek enters the Susquehanna River.

The delta deposited in the Susquehanna by Fuller Hollow Creek was mapped during the summer of 1975 when the flow was low. Much sediment had been carried down since Agnes, creating a sizeable mass of deposits. It is assumed that much of this debris was a result of housing construction in the subdivision and erosion of upstream bed and banks during high-runoff periods. Peak discharge during Agnes swept away the numerous deposits at the mouths of tributaries in the area. The delta was mapped again in October 1975, after Eloise. Peak discharge of Eloise on Fuller Hollow Creek,calculated from floodmarks after the storm and

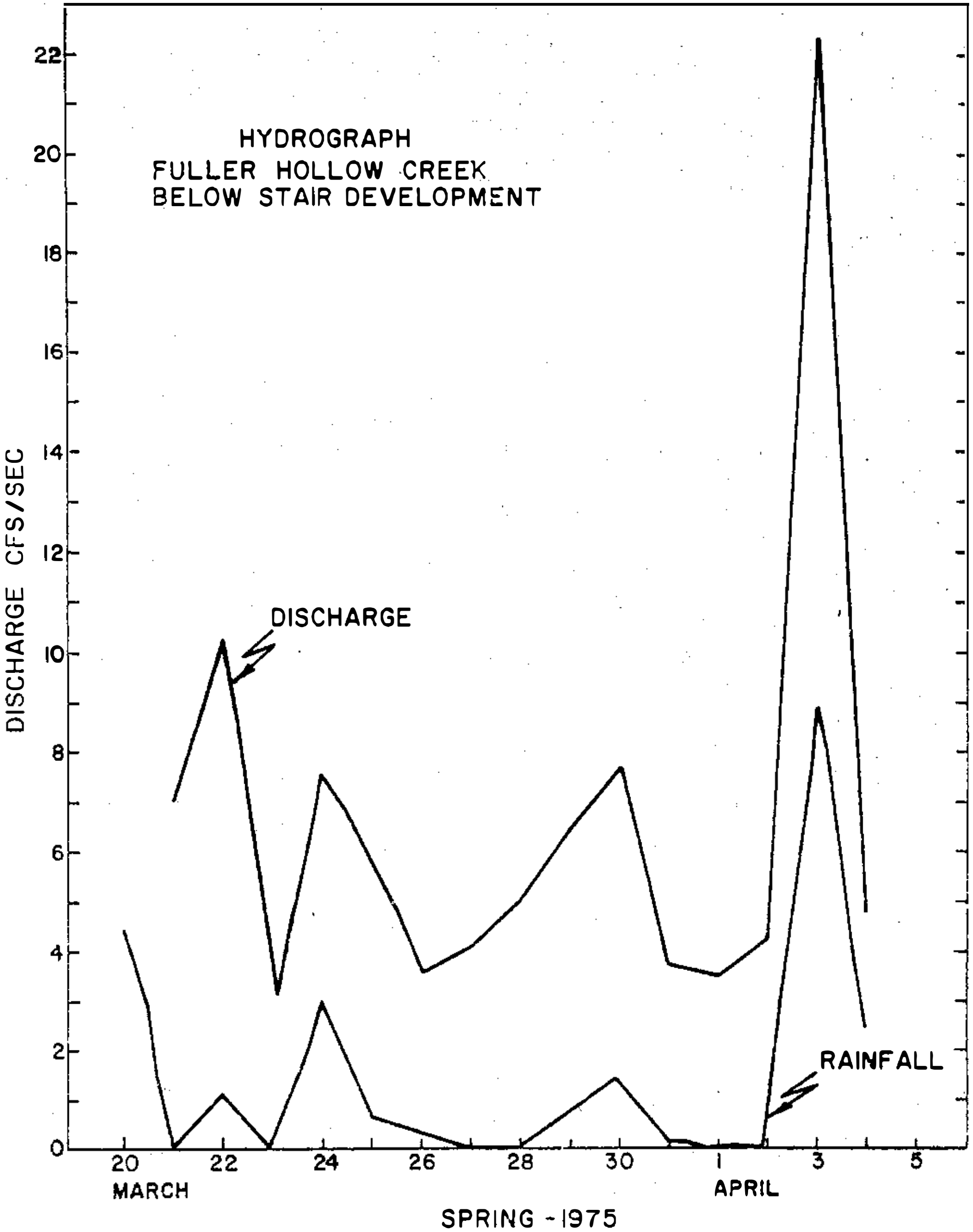

Figure 8. Hydrograph of discharge in Fuller Hollow Creek and rainfall for the same dates. From Morisawa and Vemuri (1975).

observations during it, was 550 cfs. Despite the high water on the Susquehanna during Eloise, the delta grew in size from 1570 sq. ft. before Eloise to 2051 sq. ft. after it. This is a large delta for such a small creek. The channel-bar deposits and the delta indicate that excessive erosion is taking place in Fuller Hollow Creek as a result of urbanization.

On such small creeks, developers should be required to provide storage for runoff during storms rather than sewer the rainfall excess directly into nearby stream channels. There is a large natural basin at the head of Fuller Hollow Creek in the valley south of Fuller Hollow Road where storm water could be detained. An alternative would be to drain the excess rainfall underground. Straightening the channel below the park to provide for development there was a mistake which should be avoided in the future. Such straightening increases the velocity of the water, adding to the energy which is used for erosion. Development should not be allowed on the west bank of the creek north of Fuller Hollow Road and should be barred from the flat between Fuller Hollow Road and Stair Park.

FLOODING IN CONKLIN, NEW YORK

The low-lying areas of Conklin, along the Susquehanna River (Fig. 2), have been flooded frequently, as a result of both spring rains combined with snowmelt and of winter ice jams on the river.

Table 5 shows the most severe floods that Conklin has experienced. Although the 1936 flood did not constitute a 100-year flood, it was

Table 5

Past Floods in Conklin

Date	Discharge, cfs	Flood Elevation, ft.
3/18/36	61,600	861.09
3/22/48	60,500	860.78
4/1/40	51,800	860.08
3/28/13	51,400	859.25
3/10/64	50,200	859.21
3/7/79		858.21

Gage Height = 840.95 ft.

100-year flood = 64,000 cfs.

Flood stage = 11 feet (elev. 851.95)

Sources: Dunn (1970), John May (pers. comm., Jan., 1980),
U.S. Army Corps of Engineers (1971).

devastating. Specifically, the flood level was reached in twenty-four hours, and the river was out of its banks for five days (U.S. Army Corps of Engineers, 1971).

This area is also characterized by more minor, localized flooding. As an indicator of this, the Susquehanna River overtopped its banks sixty-five times in Conklin during the 30-year period between 1935 and 1964. The most recent flood occurred on February 11, 1981, as a result of ice jams. This flood was 6 feet above flood stage.

Development in the floodplain in Conklin is relatively recent (mostly within the last 25 years), and therefore the history of flooding is well known to local residents. There are currently no structural measures in effect to protect Conklin, although a channel improvement project, consisting of seven miles on the Susquehanna River, was undertaken to provide relief in the event of smaller floods (U.S. Army Corps of Engineers, 1969). However, directly following the February, 1981, flood; attempts began (and still continue) to persuade the Corps of Engineers to construct a floodwall in Conklin. To date, the Corps has not agreed because of a low benefit-cost ratio, and because of probable adverse effects on downstream communities.

MASS MOVEMENTS

In a study of landslides in the Binghamton region, Ott (1979) identified 83 known slides and inferred an additional 55 using air photos and field checks (Table 6). From a frequency of occurrence, he rated soils as to susceptibility of sliding. Volusia, Mardin, Canaseraga, and Unadilla soils (S.C.S., 1971) were most susceptible to mass movements. He also found that north-facing slopes were more susceptible to failure. Soil characteristics contributing to slope instability were seasonally high water table coupled with slow permeability and a dense fragipan.

Two areas we will examine have failed primarily because they are slopes cut to a steep angle. Both are underlain by Canaseraga soils. Canaseraga soils are slowly permeable, have a seasonal high water table, often have local seeps, have a high available moisture capacity, and are susceptible to differential frost heave. Cut slopes are unstable and the soil surface is easily erodible.

The north face of Pierce Hill was cut into for road material and oversteepened during construction of Route 434 in the late 1960s. It has since been cut back even more for development. Since that time the slope has failed in a number of places. The Red Lobster and Howard's Florist have both gone to great expense in attempts at stabilization.

The slope on the east side of the Vestal Plaza was cut into to provide as eastern access to the Plaza. Failures occurred very shortly on the north-facing slope. Mass movements on the south-facing side have taken place over the last 3 years. The town of Vestal has to bulldoze the material from the road regularly, especially in the spring.

TABLE 6

Number of Landslides Per Quadrangle

Quadrangle	No. of Known Landslides	No. of Inferred or Questionable Landslides	Total No. of Landslides
Endicott	29	37	66
Binghamton West	33	10	43
Binghamton East	21	8	29
Totals	83	55	138

From Ott, 1975

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ROAD LOG FOR ENVIRONMENTAL PROBLEMS OF THE BINGHAMTON AREA

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
0.0		Bartle Drive Main Entrance to SUNY. Turn left (west) on Route 434.
3.5	3.5	Make a U-turn just past Red Lobster onto Route 434.
3.75	0.25	STOP 1 in parking lot of Gertrude Hawk Candies (Route 434).

STOP 1. PIERCE HILL CUT. This is a slope with active movement of material downslope. Originally a borrow pit, the slope has been cut back even more for the commercial development you see. Debris slides, slumps, rilling and rock fall are modes of downslope movement of the glacial materials. Both Howard's Florist and the Red Lobster have gone to considerable expense to stabilize the slope. One debris flow behind the Red Lobster reached the back door, covering several cars in the way. Subsequently, the wall and drainage pipes were installed.

7.4	3.65	Turn right (South) onto Murray Hill Rd. just east of SUNY campus.
7.5	0.1	STOP 2 along Murray Hill Rd. opposite East Gym.

STOP 2. LOWER FULLER HOLLOW CREEK. Here the creek has been riprapped to prevent erosion of the bed and further down the banks are riprapped. The riprap has progressively deteriorated, large blocks have removed and side-walls have slumped.

8.6	1.1	STOP 3 along Murray Hill Rd. at Stair Park.

STOP 3. MIDDLE FULLER HOLLOW CREEK. Evidence of destructive erosion can be seen here. The foot bridge was washed out in the spring of 1981. Note widening of the channel. Excessive runoff from storm drains have caused much erosion here. Along the downstream reach many landowners are losing their back yards.

8.9	0.3	Turn right (west) onto Fuller Hollow Rd.
10.4	1.5	Turn around in driveway on right. Proceed east on Fuller Hollow Rd.
10.8	0.4	STOP 4. Martin House on Fuller Hollow Road.

STOP 4. UPPER FULLER HOLLOW CREEK. From this viewpoint, one can see the 300 home Stair development. The whole hillside was wooded until approximately 1974-75. Tributaries and storm runoff are piped underground directly to the creek, greatly augmenting flow during storms. Directly below is a meadow through which the main creek flows. This would have been an ideal spot for a detention pond to which runoff could have been piped.

11.8	1.0	Turn left (north) onto Murray Hill Rd. to end.
13.35	1.55	Turn right (east) onto Route 434.
13.8	0.45	Turn right into Vestal Plaza and proceed to southeast corner behind the Grand Union.
14.2	0.4	STOP 4 in southeast corner of Vestal Plaza behind Grand Union.

STOP 5. VESTAL PLAZA SLOPE. This cut has failed in many places since it was made. The north-facing slope has moved much more and did so more quickly than the south-facing slope. The cut is in glacial material. Much of the fine sediment has been removed by mud flows which cover the road whenever it rains. Buildings and parking lots on the surface above the slopes have contributed to mass movement.

		Go out southeast entrance of Vestal Plaza and turn left at Club House Rd. (top of hill).
14.4	0.2	Turn right (east) onto Route 434.
16.5	2.1	Conklin Avenue east off Route 434. Turn left onto Tremont and then right onto Conklin Ave.
16.9	0.4	STOP 5 in Crowley's Parking Lot.

STOP 6. ROCKBOTTOM DAM. This dam is currently being rebuilt after years of deterioration on the older one. The dam is designed to retard the flow of water and to produce ponding so that the water intake for the City of Binghamton's water supply is below the surface even in dry years.

17.8	0.9	Cross Pierce Creek on Conklin Ave. Channelization is evident.
21.5	3.7	STOP 6. Tier gasoline station.

STOP 6. SUSQUEHANNA RIVER. The bend in the river at this point led to flooding of the area between the river and the gas station during the ice jams in February.

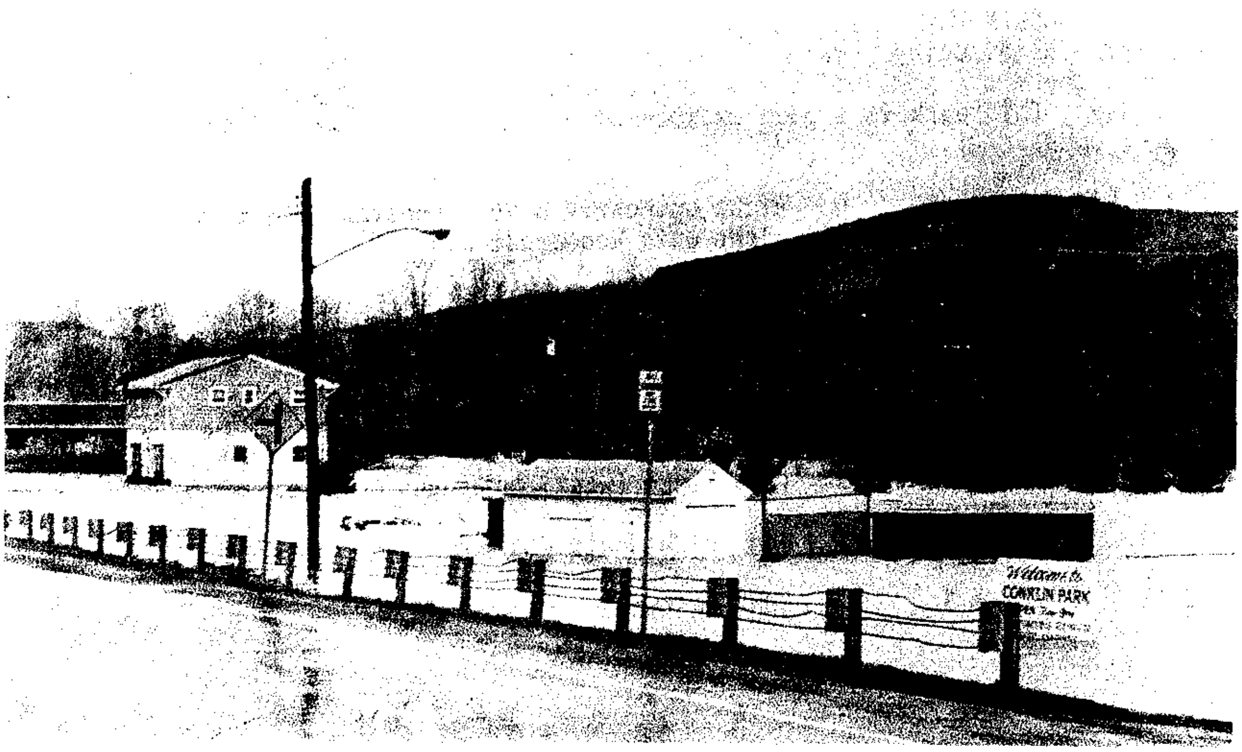
23.3	1.8	STOP 7 Conklin Park then return west on Conklin Avenue.

STOP 7. CONKLIN PARK. This park was flooded entirely during the February 1981 flooding. Water levels reached up to the park sign. Although there are some buildings in the park, they are for storage, primarily. This park is a good example of how flood plain areas should be developed.

24.7	1.4	Right on Morris Blvd. Continue and curve to right onto Wooderest Way.

Note the houses in this area (which was also flooded in February). Each has a nice view of the river and gets flooded almost annually. These are obvious examples of uneconomic floodplain development.

25.5	0.8	Turn right on Inamure.
25.7	0.2	Turn right (west) onto Conklin Ave.
31.7	6	Bear right onto 434 west.
34.7	3	SUNY entrance. Bartle Drive.



Flood at Conklin Park (Stop 7) caused by an ice jam, February, 1981.

Bridge at Stair Park (Stop 3) before it was washed away, Spring, 1981.