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DEPARTMENT OF THE INTERIOR
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FLOOD OF JULY 5, 1969, IN THE
VICINITY OF WOOSTER, OHIO

By

Earl E. Webber and Ronald I. Mayo
Hydraulic Engineers

Prepared in cooperation with the
Ohio Department of Highways

Open-file report

Columbus, Ohio

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Abstract

This report documents flood data for Killbuck Creek, Apple Creek, and Little Apple Creek at Wooster, Ohio, to show the high-water elevations and corresponding discharges produced by the July 5, 1969 flood. This flood resulted from a violent storm with officially recorded rainfall in excess of 10 inches and unofficial catches of over 14 inches in the vicinity of Wooster during the 18-hour storm period. A more detailed analysis of data for Killbuck Creek was made in order to define an estimated profile of the July 5 flood for an assumed condition with no obstructions present in the channel or on the flood plain. The 50-year frequency flood profiles on Killbuck Creek were also developed for existing conditions and for the assumed condition of no obstructions.

Introduction

This report provides flood elevations and discharges on Killbuck Creek, Apple Creek, and Little Apple Creek in the vicinity of Wooster, Ohio, and the effects of highway crossings on these elevations. The report was prepared as part of a continuing cooperative program with the Ohio Department of Highways to investigate floods. The flood resulted from an intense storm, reported by the U.S. Weather Bureau to have exceeded 10 inches of rainfall during the storm period. (See fig. 1.) There were unofficial reports of rainfall exceeding 14 inches in the vicinity of Wooster. One of the high intensity cells of the storm centered directly over the study area. This rate of rainfall is over twice the 24-hour rainfall of 5 inches to be expected on an average of once in 100 years as determined by Hershfield (1961) for this part of Ohio.

The hydraulics of floodflow on Killbuck Creek are complicated by the orientation of roads, bridges, and streams in the area. (See fig. 2.) U.S. Highway 30 crosses the Killbuck Creek flood plain on fill at a 45° angle about 1 mile upstream from the confluence of Killbuck and Apple Creeks. This highway then crosses a section of the combined Apple and Killbuck Creeks flood plain near the southern edge of the City of Wooster, and farther east crosses Apple Creek about 1 mile above its mouth. State Highway 3 crosses the Killbuck Creek flood plain on fill at a 20° angle, 3,000 feet downstream from U.S. Highway 30. State Highway 95 crosses both Killbuck Creek and Apple Creek with low-level bridges about 500 feet above the confluence. The lower reach of Apple Creek is crossed by two highway bridges, in addition to that of U.S. Highway 30, and two

railroad bridges. One of these, the Pennsylvania Railroad bridge, crosses Apple Creek on a high fill 1,500 feet downstream from U.S. Highway 30. The railroad enters the Killbuck Valley at a point where the flood plain is 3,000 feet wide and thence crosses the flood plain at a 20° angle on a low fill which gradually narrows the main channel floodway to 300 feet at a point about 2-1/2 miles downstream. Although there are relief openings through the railroad fill, washouts of the fill occurred in this 2-1/2 mile reach during the July flood.

The July 5 flood profile on Apple Creek was developed from the mouth upstream to the confluence with Little Apple Creek. A contracted-opening discharge measurement was made at the Pittsburgh Avenue bridge. The July 5 flood profile on Little Apple Creek was also developed from the mouth upstream to above Portage Road where a slope-area discharge measurement was obtained. All elevations presented in this report are related to mean sea level datum.

Data Available

Indirect measurements of peak discharge of the July 5, 1969 flood were made by the U.S. Geological Survey at four sites near this study area. (See table 1.) Gaging-station records (1931-69) for Killbuck Creek at Killbuck were available for flood-frequency studies. Low and medium water profiles and flood-frequency studies for Apple Creek and Little Apple Creek were available from an administrative report prepared by the U.S. Geological Survey for the Ohio Department of Highways (Webber and Mayo, written communication, 1964). Data in the Ohio Department of Natural Resources, Division

of Water Bulletin 43, "Floods in Ohio, Magnitude and Frequency," (Cross and Mayo, 1970) also were used. An isohyetal map (fig. 1) of the total storm rainfall was available from the July 1969 "Climatological Data," a publication of the U.S. Weather Bureau.

Field Work

Approximately 75 high-water marks from the July 1969 flood were identified and surveyed to mean sea level datum by the U.S. Geological Survey. These marks were located along Killbuck Creek between its confluence with Little Killbuck Creek and the Pennsylvania Railroad bridge, 5 miles downstream; along Apple Creek between the mouth and a point above Little Apple Creek; and along Little Apple Creek between the mouth and a point above Portage Road. Also surveyed were five cross sections of the Killbuck Creek flood plain as follows: No. 1 was 500 feet below the mouth of Apple Creek; No. 2 at State Highway 3; No. 2.5 at U.S. Highway 30; No. 3 at the Wooster water treatment plant; and No. 4 at County Road 4. Bridge openings and highway centerline profiles were surveyed on U.S. Highway 30 and State Highway 3. Stream channel and bridge-opening roughness coefficients were selected and 27 stereo pictures were taken of the flood reach. Low-water and bankfull profiles of Killbuck Creek from section 4 downstream to the Pennsylvania Railroad bridge were surveyed and a current-meter measurement of 827 cfs (cubic feet per second) was made at bankfull stage.

Computations

On July 5, 1969, the peak discharge on Killbuck Creek at Wooster was estimated to be 26,700 cfs above Apple Creek and 41,900 cfs below Apple Creek from a combination of indirect measurement methods and a study of relative discharges and drainage areas for the four discharge measurements listed in table 1. The indirect methods used the contracted-opening method at Highway 3 along with flow-over-embankment and flow-through-culvert methods, at Highways 3 and 30.

The 50-year frequency floods of 6,300 cfs on Apple Creek and 2,400 cfs on Little Apple Creek were estimated by regional methods described by Cross and Mayo (1970). The magnitude of the 50-year frequency floods for Killbuck Creek above and below Apple Creek (11,000 cfs and 16,000 cfs, respectively) were based on a drainage area adjustment of the 50-year frequency flood computed for the annual flood peaks at the gaging station on Killbuck Creek at Killbuck by the log-Pearson Type III method. The 50-year frequency flood stage at the initial section on Killbuck Creek (section 1) was obtained from a rating curve based on the observed water surface slopes and computed conveyance.

The roughness coefficients (n) for sections 1-4 were adjusted upwards from the field-selected values on the basis of a measurement of discharge and the observed water surface profile at bankfull stage, and on the estimated discharge and observed flood profile for the July 5 flood. Standard step-backwater methods were used to develop the 50-year flood profile of Killbuck Creek from section 1 to 4, with and without consideration of the bridges and fills on U.S. Highway 30 and State Highway 3.

The computed 50-year flood profile is comparable to the observed bankfull profile, indicating that the adjusted roughness coefficients are reasonable. (See fig. 3.) A comparison of the natural and modified 50-year flood profiles indicates that State Highway 3 would create 0.8 foot of backwater, and U.S. Highway 30, 0.7 foot of backwater, from a 50-year flood of 11,000 cfs.

The observed profile of the July 1969 flood (fig. 3) indicates a drop of 0.6 foot through the Killbuck Creek bridge on U.S. Highway 30 and 0.7 foot through the bridge on State Highway 3. To estimate the total effect of the bridges and fills on the July flood, the natural flood profile was developed from sections 2 to 4 using step-backwater methods and assuming no bridges or fills in place. As section 2 is downstream from both highways, the starting elevation (860.6 ft) was obtained directly from the observed flood profile (fig. 3). A comparison of the computed profile with the observed profile (fig. 3) indicates a backwater effect of approximately 2.0 feet above U.S. Highway 30, of which about two-thirds, or 1.3 feet is attributable to the bridges and fills of the two highways. The balance of the backwater is attributed to undefined factors including the warping of the water surface of Killbuck Creek as it makes two reverse curves, an increase in flood-plain friction losses due to the State Highway 95 bridges and the buildings of the municipal sewage treatment plant, and discharge from Apple Creek which flowed laterally along the north side of U.S. Highway 30 to the Killbuck Creek flood plain in the vicinity of the Highway 3 and Highway 30 interchange. Water surface profile data for Killbuck Creek between the Pennsylvania Railroad bridge and County Road 4 are presented in table 2.

On Apple Creek high-water marks left by the July 1969 flood were located and elevations surveyed from the mouth to the confluence with Little Apple Creek, and on Little Apple Creek from the mouth to a point above Portage Road. The observed flood profiles for these streams are presented on figures 4 and 5, respectively. The modified 50-year flood profile for Little Apple Creek as determined by Webber and Mayo (written communication, 1964) is also presented on figure 5. The surveyed flood marks indicate approximately 13 feet of backwater on Little Apple Creek upstream from the Pennsylvania Railroad's stone-arch culvert. Some of the floodwaters also passed through the opening in the Pennsylvania Railroad fill for the new State Highway 3 bypass which was under construction at that time.

Conclusions

The July 5, 1969 flood in the vicinity of Wooster was a very rare event. Recorded rainfall of 10 inches and unofficial catches of over 14 inches in 18 hours are over twice the 100-year recurrence interval value for 24 hours of 5 inches. The peak discharge on Apple Creek of 26,300 cfs is four times the 50-year flood of 6,300 cfs.

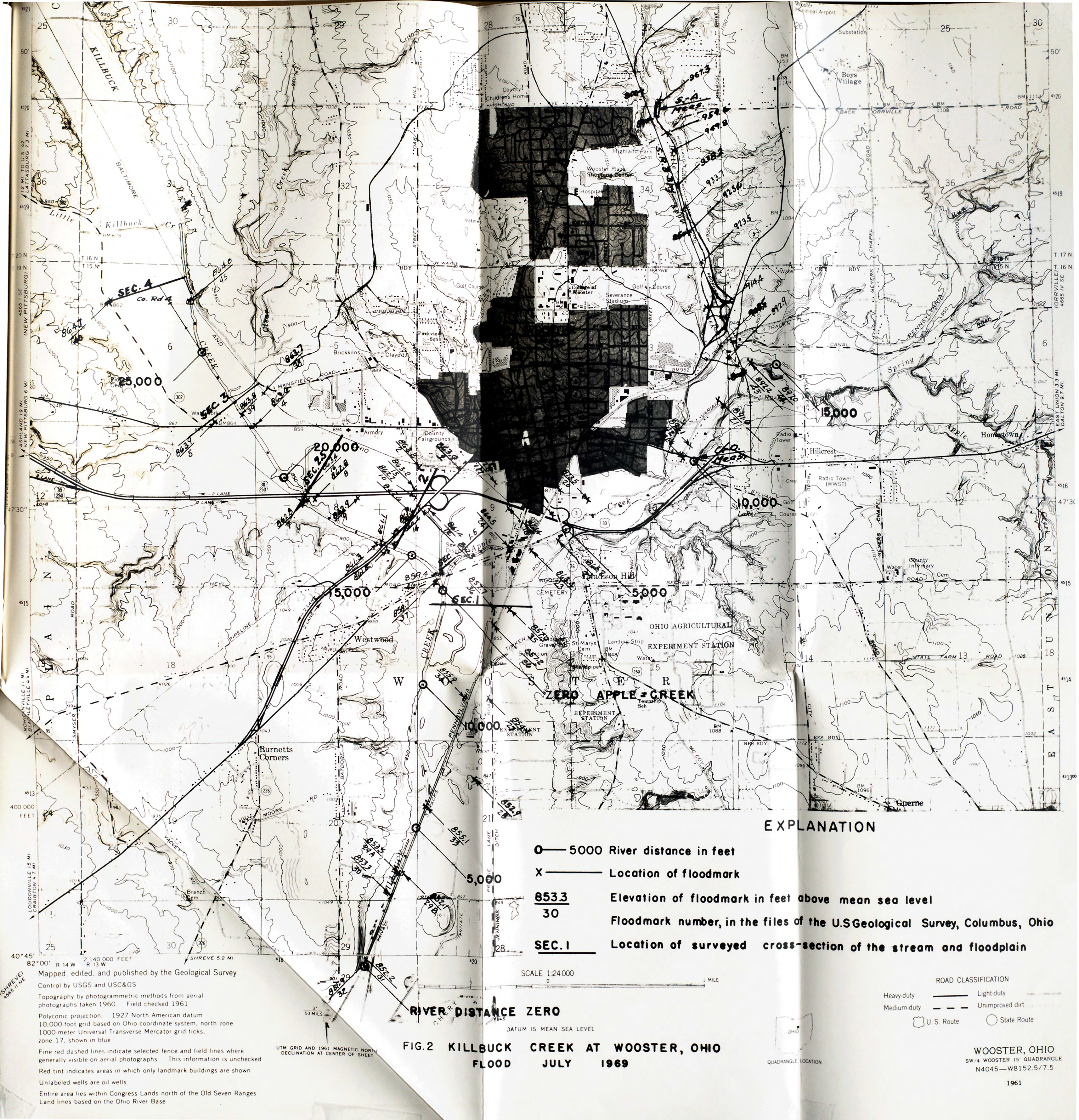
State Highway 3 and U.S. Highway 30 bridges and embankments caused a maximum of about 1-1/2 feet of backwater on Killbuck Creek during the July 1969 flood and they would cause about this same amount of backwater for a 50-year flood. This estimate of backwater for the flood of July 5, 1969, is based on comparison of a profile determined from observed flood

marks with a profile computed by the step-backwater method without bridges. The estimate of backwater for the 50-year flood is based on profiles computed by the step-backwater method with and without the bridges in place.

On Apple Creek from the mouth to Little Apple Creek and on Little Apple Creek from the mouth to Portage Road profiles were obtained from observed floodmarks. On Little Apple Creek approximately 13 feet of backwater occurred at the Pennsylvania Railroad's stone-arch bridge and some floodwater at this point passed through the new State Highway 3 bypass opening.

References

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- Hershfield, D. M., 1961, Rainfall frequency atlas of the United States: U.S. Weather Bureau Technical Paper no. 40, 115 p.
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OHIO
JULY 1969

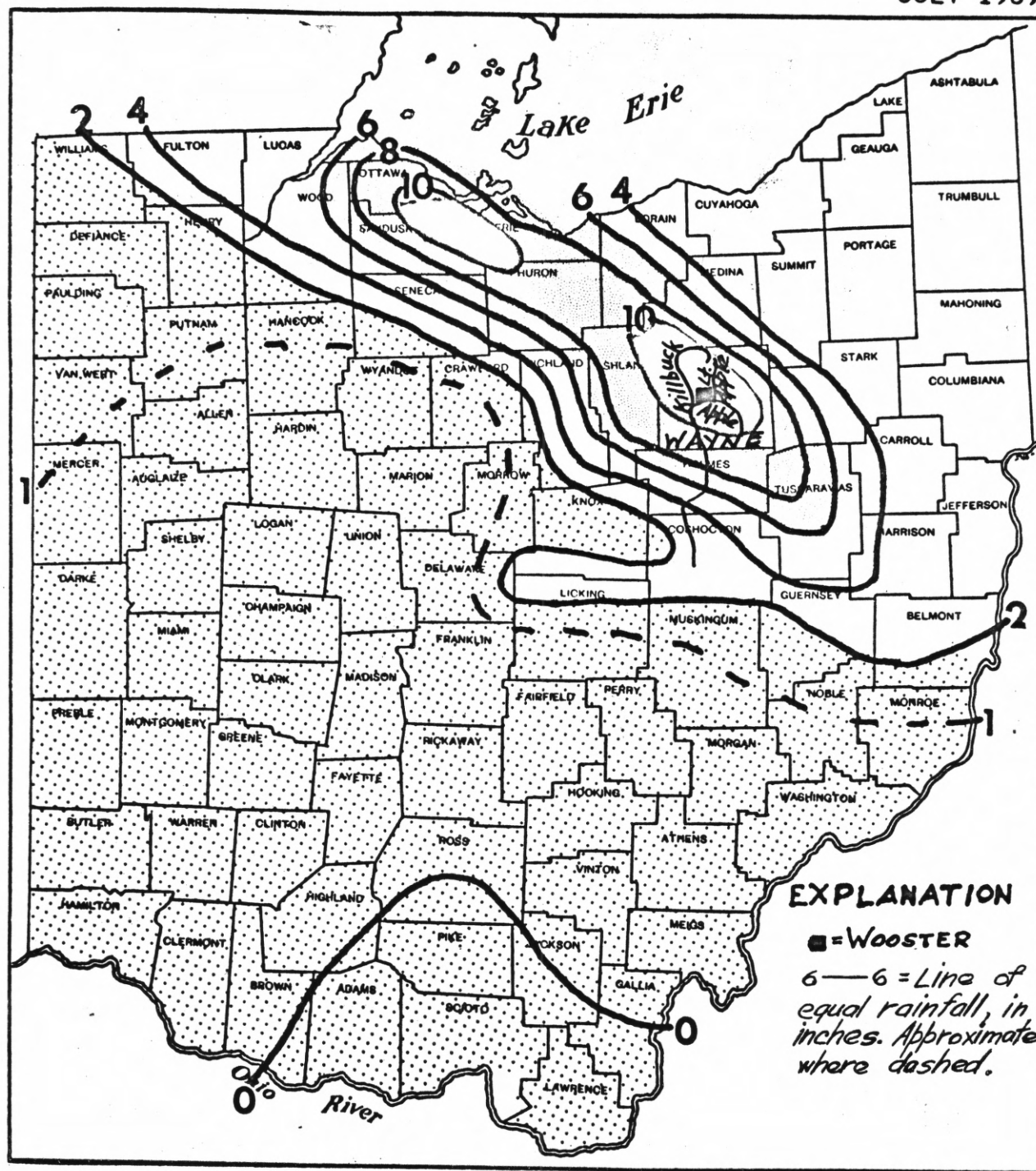
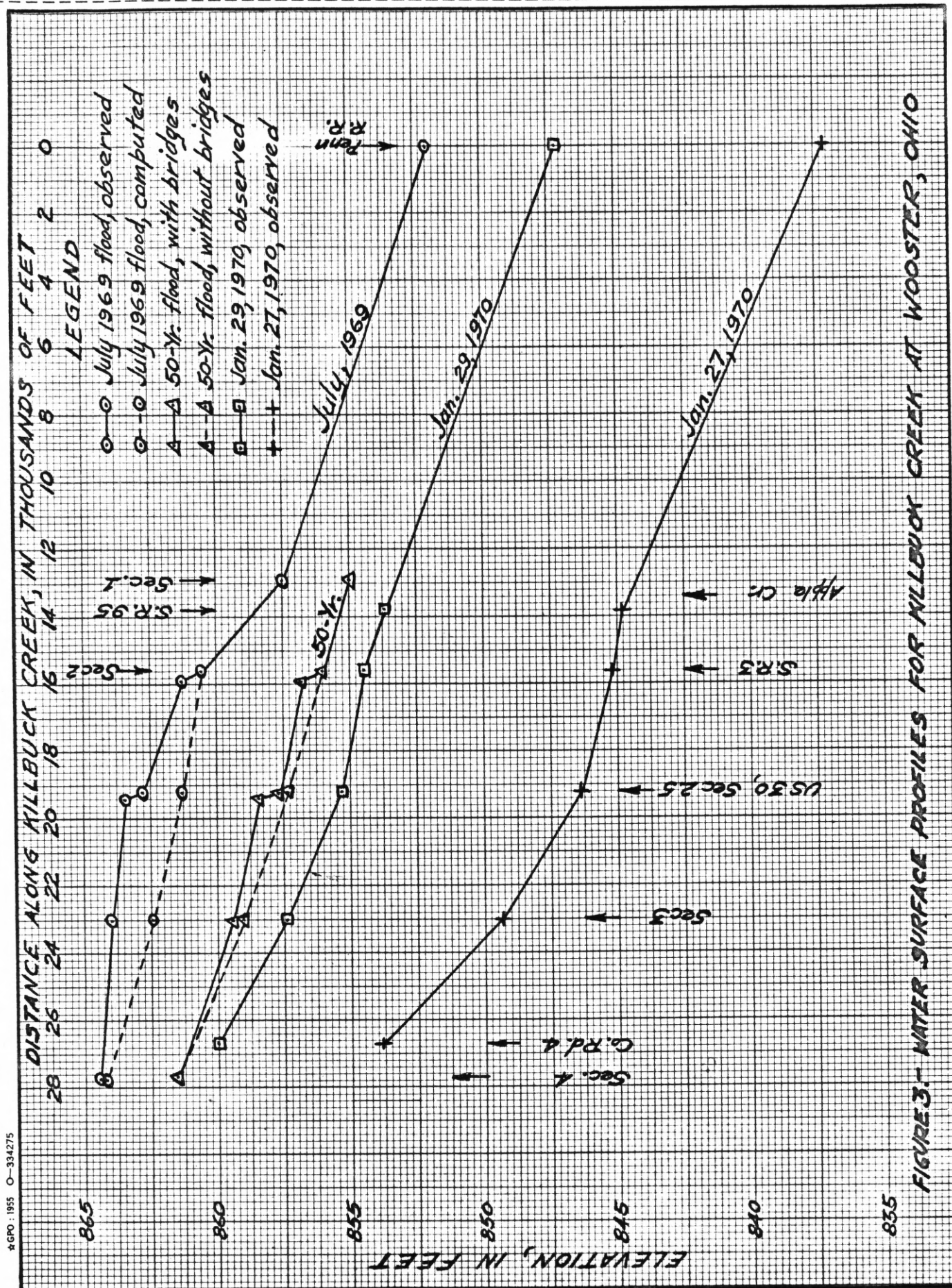
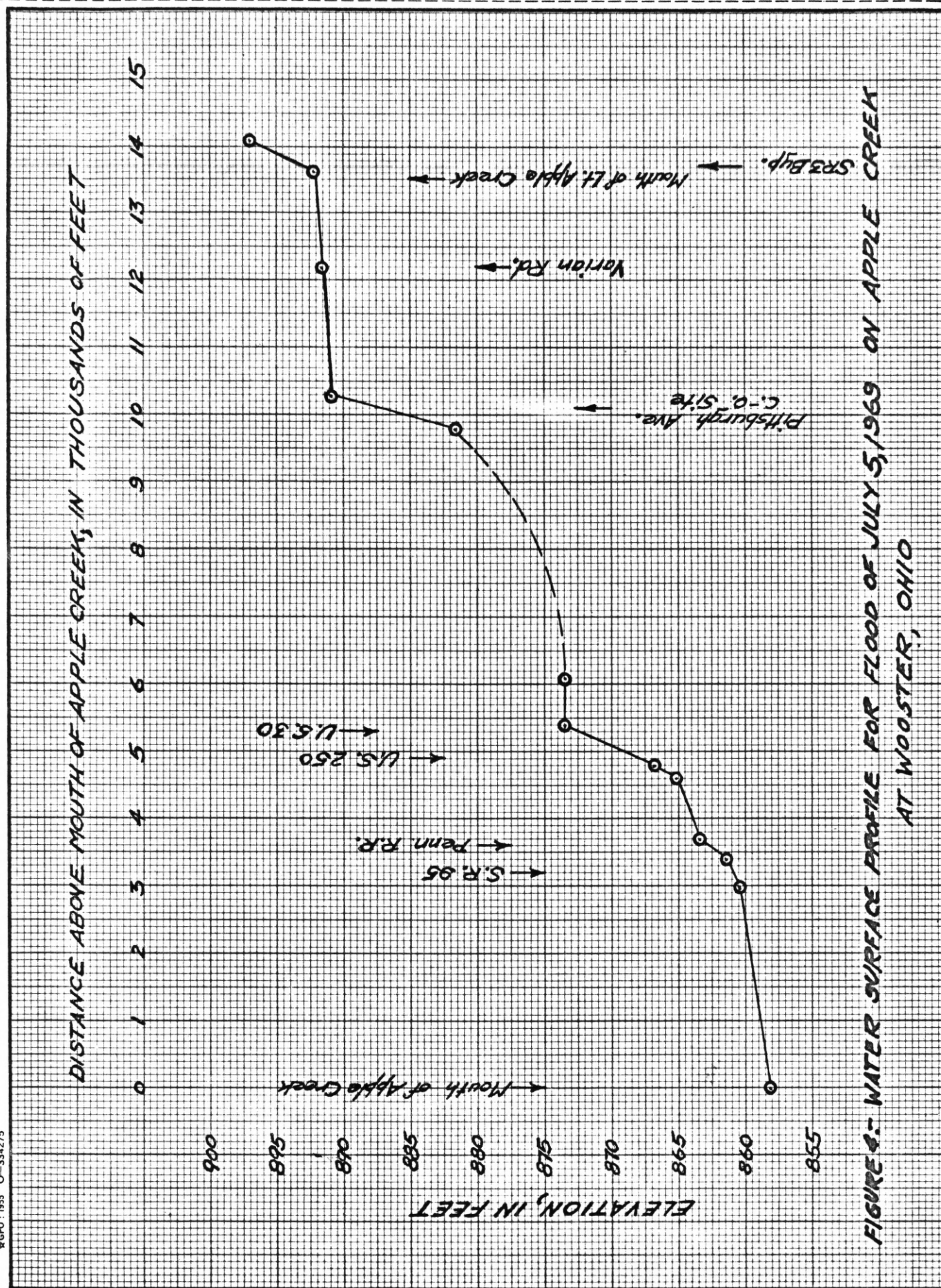


Figure 1.--Rainfall from storms of July 4-5, 1969. (All data from reports of U.S. Weather Bureau cooperative observers.)





*GPO : 1955 O-334275

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WATER RESOURCES DIVISION

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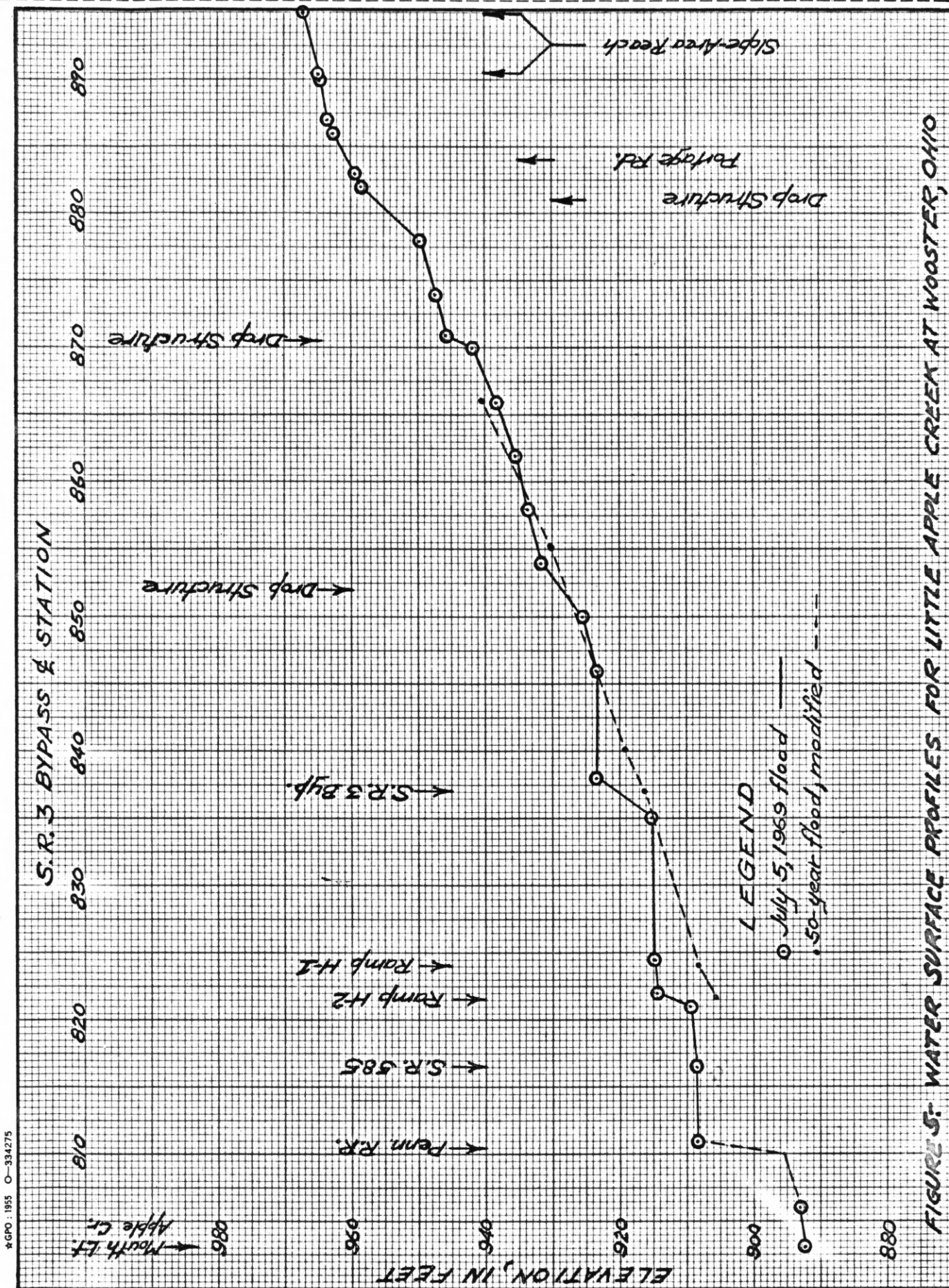


FIGURE 5- WATER SURFACE PROFILES FOR LITTLE APPLE CREEK AT WOOSTER, OHIO

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Table 1.--July 1969 peak discharge measurements, near Wooster, Ohio.

Stream and location	Drainage area (sq mi)	Peak discharge (cfs)	Unit runoff (cfs per sq mi)	Ratio to 50-year flood
Apple Creek at Wooster (at Pittsburgh Avenue) -----	48.3	26,300	545	4.2
Little Apple Creek at Wooster (above Portage Road) -----	10.9	6,260	574	2.6
Killbuck Creek at Burbank ----	42.4	6,810	161	2.0
Killbuck Creek at Killbuck ---	462	47,500	103	2.0

Table 2.--Water surface profile data for Killbuck Creek at Wooster, Ohio.

Location	River distance (feet)	July 1969 flood			50-year flood		
		Discharge (cfs)	Elevations		Discharge (cfs)	Elevations	
			Existing conditions (ft above msl)	Natural valley, no bridges (ft above msl)		Existing conditions (ft above msl)	Natural valley, no bridges (ft above msl)
Pennsylvania Railroad bridge --	-0-	-----	852.0	-----	-----	-----	-----
Section 1, below Apple Creek --	12,900	41,900	857.5	857.5	16,000	855.0	855.0
Section 2, State Highway 3,							
downstream -----	15,600	26,700	860.6	860.6	11,000	856.0	856.0
upstream -----	15,900	26,700	861.3	-----	11,000	856.8	-----
Section 2.5, U.S. Highway 30,							
downstream -----	19,200	26,700	862.8	861.3	11,000	857.7	857.4
upstream -----	19,400	26,700	863.4	-----	11,000	858.4	-----
Section 3, at water plant ----	23,000	26,700	863.9	862.4	10,900	859.4	859.0
Section 4, at County Road 4 --	27,700	26,700	864.4	864.2	10,900	861.6	861.6

