FLOODS ON BOONE AND WINKLER CREEKS AT BOONE, NORTH CAROLINA

This report was prepared by the U.S. Geological Survey to further the objectives of the Appalachian Regional Commission. Hydrologic data are presented that can be used to evaluate the extent, depth, and frequency of flooding that affect the economic development of flood plains in Boone, North Carolina. It will aid individuals, government agencies, and others seeking solutions to flood problems. More specifically, the information given herewith is useful to those responsible for formulating effective flood-plain regulations that would minimize the creation of flood problems. The report will be useful for preparing building and zoning regulations, locating waste disposal facilities, and developing recreational areas.

Boone is in Watauga County in the mountainous region of northwestern North Carolina. The reach of Boone and Winkler Creeks covered by this study begins on Boone Creek at U.S. Highway 421 and ends 3.1 miles downstream on Winkler Creek at Secondary Road 1521. The drainage area at the upper end of the reach is 0.59 square mile and at the lower end it is 10.7 square miles.

The approximate areas that will be inundated by floods of selected magnitudes along Boone and Winkler Creeks are delineated on the map.

Boone Creek heads on Rich Mountain and flows in a southeasterly direction along the southwestern edge of the city of Boone through the campus of Appalachian State University. It flows into Winkler Creek near the southeastern corner of the city. The bed slope of Boone Creek is rather steep with an average fall of about 80 feet per mile in the reach. This steep slope causes destructive velocities during large floods. The fall of Winkler Creek below its confluence with Boone Creek is only about 20 feet per mile.

The area along Boone Creek is partly developed and the greatest potential for future development is in the vicinity of Appalachian State University. The area along Winkler Creek is broad and flat. It is not highly developed at this time, but is a potential area for future economic development.

The general procedure followed in defining flood limits for Boone and Winkler Creeks was:

1. Determine the discharges of floods having recurrence intervals of 10, 25, and 50 years.
2. Compute profiles for these floods with an electronic computer and by hand utilizing the step-backwater method of computation.
3. Delineate the horizontal extent of flooding on the topographic map.

The determinations of flood discharges and profiles were based on the following assumptions:

1. Field conditions would remain as they existed at the time the field study was made in 1966.
2. Bridges and culverts would not be clogged with debris nor otherwise be inoperative during the floods.
3. The selected floods would be of equal recurrence intervals at all points in the reach.

Flood history.—The flood of August 14, 1940, is the highest known flood at Boone, exceeding those of both 1916 and 1877. In addition to causing major property damage, the flood of 1940 took the lives of at least 13 persons in Watauga County. Although some destruction resulted from inundation, the high velocity of the creeks was the major cause of property damage. The flood of 1940 was the result of a West Indian hurricane and covered a large part of the southeastern States. Flow data for this flood in the Boone area are not available but the recurrence interval has been estimated to exceed 100 years on the basis of areal studies. Eight inches of rain fell in Boone during this storm. The rain caused landslides that blocked many culverts and bridges. Since then road elevations have been raised and many culverts have been enlarged.

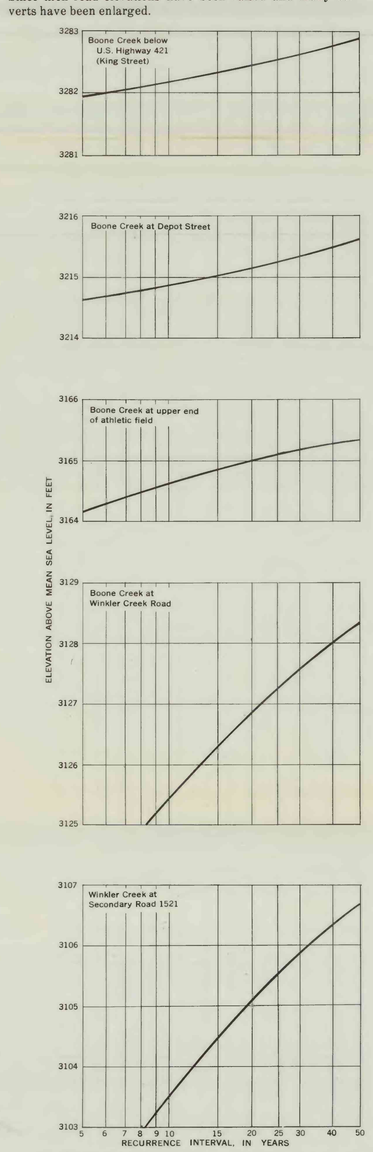


FIGURE 1.—*Frequency of flood stage on Boone and Winkler Creeks.*

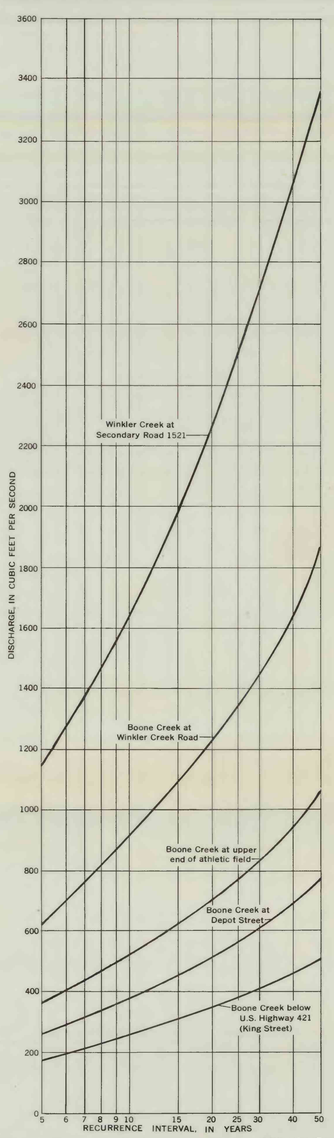


FIGURE 2.—*Frequency of flood discharge on Boone and Winkler Creeks.*

Determination of discharge.—Boone and Winkler Creeks are ungaged streams and no records of streamflow are available. Flood discharge values for this study were computed using methods described by Hinson (1963). Drainage areas and the magnitude and velocity of floods having selected recurrence intervals were determined at five selected sites along the channels. These data are listed in table 1.

Frequency and recurrence interval.—The terms "frequency" and "recurrence interval" are often used interchangeably when referring to extremes of floodflow. The greater the flood, the less frequently it occurs. As a consequence, we can refer to floods of selected magnitudes as having certain frequencies of occurrence. Recurrence interval is defined as the average time, in years, between floods of a given magnitude. It cannot be predicted when a flood of a given magnitude will occur, but the probable number of such floods during a long period of time may be estimated with reasonable accuracy. For example, about 50 floods of at least the magnitude of a 2-year flood may be expected to occur in a 100-year period, and about four floods of at least the magnitude of a 25-year flood may be expected to occur in a 100-year period. Similarly, a 50-year flood has 1 chance in 50, a 25-year flood has 1 chance in 25, and a 10-year flood has 1 chance in 10 of being equaled or exceeded in any one year.

The relationship between recurrence interval and flood elevation at the five selected sites is shown graphically in figure 1 and the relationship between recurrence interval and discharge for these same sites is shown graphically in figure 2. These two figures can be used to determine peak elevation and discharge values for floods having different recurrence intervals than those discussed in this report. For example, from figure 1 it can be determined that a flood having a recurrence interval of 20 years on Winkler Creek at Secondary Road 1521 would reach an elevation of 3105.8 feet at its peak and from figure 2 it can be determined that the instantaneous peak discharge for this 30-year flood would be about 2,700 cfs (cubic feet per second).

Confidence in the accuracy of flood-frequency relations declines as the recurrence interval becomes longer. Extrapolation of the frequency curves beyond the limits shown is not advisable.

TABLE 1.—*Drainage area, discharge, flood-plain and stream-channel velocities at five selected sites for 10-, 25- and 50-year floods along Boone and Winkler Creeks.*

Station name	Drainage area, in square miles	Discharge, in cubic feet per second, for floods at indicated recurrence intervals			Velocity, in feet per second, at indicated recurrence intervals								
					10-years			25-years			50-years		
		10-years	25-years	50-years	Left flain	Main channel	Right flain	Left flain	Main chantel	Right flain	Left flain	Main chantel	Right flain
Winkler Creek at Secondary Road 1521.	10.7	1700	2500	3400	1.6	3.0	0.69	0.98	1.5	0.87	0.92	1.4	0.73
Boone Creek at Winkler Creek Road.	4.24	900	1400	1800	No flood plain	10.5	No flood plain	No flood plain	10.5	1.5	No flood plain	9.3	3.1
Boone Creek at upper end of athletic field.	1.83	500	800	1050	1.2	7.3	2.9	2.6	14.3	4.0	3.5	22.9	5.0
Boone Creek at Depot Street.	1.10	380	570	770	1.2	8.2	1.7	2.6	8.9	2.4	3.3	9.6	3.4
Boone Creek below U.S. Highway 421 (King Street).	0.59	250	380	500	No flood plain	8.3	3.6	2.5	9.6	4.6	3.4	10.1	5.2

Flood profiles.—The elevations and discharges shown on figures 1 and 2 relate only to the selected sites. The flood profiles shown in figures 3 and 4 extend this information throughout the entire reach studied. Profiles of the floods shown were derived from the computed elevations.

Extent and depth of flooding.—Areas adjacent to streams become inundated when the flow of the stream exceeds the capacity of its channel to transmit water. The elevation of the flood depends upon the amount of floodwater and upon the capacity of the channel. Flood levels are increased by any constriction or obstruction to the flow. Roadfills, landfills, bridges, culverts, buildings, and other structures which obstruct the flow cause greater than normal flooding upstream. Flood computations were made assuming all bridge and culvert openings to be unobstructed. Should an opening become blocked during a flood, the water upstream would be higher than that shown on the map.

Depth of flooding at any point can be estimated for floods of each recurrence interval from the map, from profiles, or from the typical cross sections, figures 5–9. More accurate elevations can be obtained by leveling from any point in question to one of the reference marks described in table 2.

TABLE 2.—*Reference marks along Boone and Winkler Creeks, Boone, N. C. from Secondary Road 1521 to U.S. Highway 421 (King Street).*

Reference point	Elevation	Description
RM 1	3109.9	At bridge over Winkler Creek on Secondary Road 1521. A brass disk stamped, "U.S. Geological Survey, Reference Mark, 1967, 3109.9 MSL," and set in left upstream concrete wingwall.
RM 2	3117.4	At bridge over Winkler Creek on U.S. Highway 321 and 221. A brass disk stamped, "U.S. Geological Survey, Reference Mark, 1967, 3117.4 MSL," and set in right upstream concrete wingwall.
BM Z 46	3127.586	1.4 miles east along the abandoned East Tennessee and Western North Carolina Railroad from Boone, Watauga County, and 300 feet southwest of State Highway District shop, 8 feet northwest of the centerline of the old roadbed, and level with the old roadbed. A standard disk, stamped "3127.746 Z 46 1938" and set in the top of a concrete post projecting 8 inches above ground (953.290 meters or 3,127.586 feet.)
RM 3	3154.2	At culvert over Boone Creek on Clement Street. A brass disk stamped, "U.S. Geological Survey, Reference Mark, 1967, 3154.2 MSL," and set in center of downstream rock and concrete headwall.
RM 4	3191.9	At culvert over Boone Creek in front of Edwin Duncan Hall at Appalachian State Teachers College. A brass disk stamped, "U.S. Geological Survey, Reference Mark, 1967, 3191.9 MSL," and set in center of upstream concrete headwall.
RM 5	3215.7	At culvert over Boone Creek on Depot Street. A brass disk stamped, "U.S. Geological Survey, Reference Mark, 1967, 3215.7 MSL," and set in center of downstream concrete handrail.
RM 6	3288.0	At culvert over Boone Creek at U.S. Highway 421 (King Street). A brass disk stamped, "U.S. Geological Survey, Reference Mark, 1967, 3288.0 MSL," and set in left corner of downstream concrete headwall.

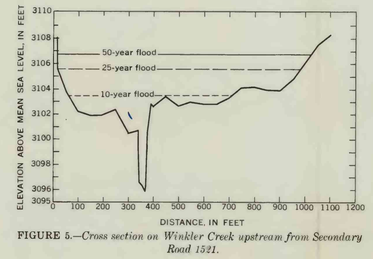


FIGURE 5.—*Cross section on Winkler Creek upstream from Secondary Road 1521.*

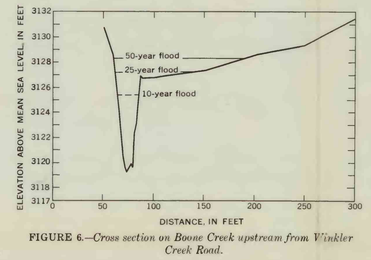


FIGURE 6.—*Cross section on Boone Creek upstream from Winkler Creek Road.*

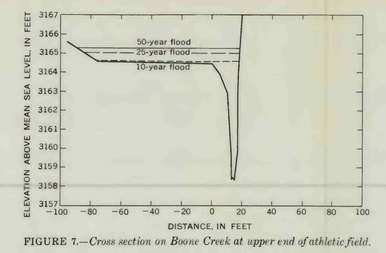


FIGURE 7.—*Cross section on Boone Creek at upper end of athletic field.*

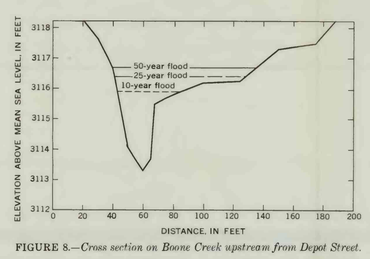


FIGURE 8.—*Cross section on Boone Creek upstream from Depot Street.*

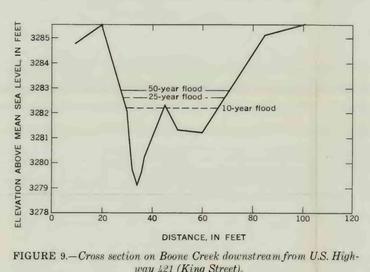


FIGURE 9.—*Cross section on Boone Creek downstream from U.S. Highway 421 (King Street).*

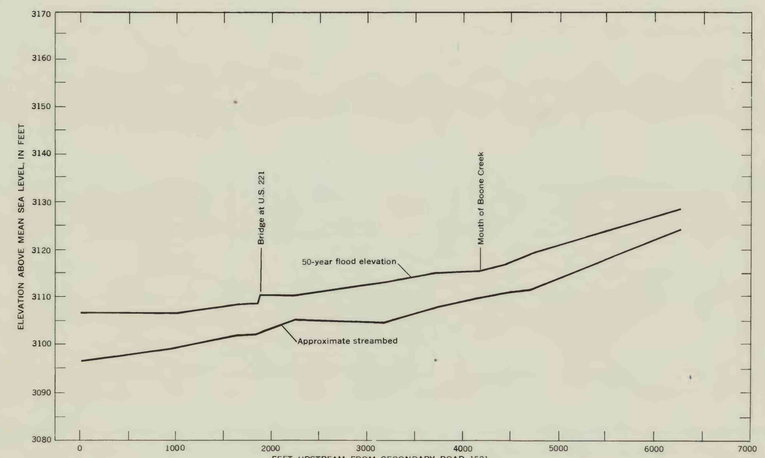


FIGURE 3.—*Profile of 50-year flood on Winkler Creek.*

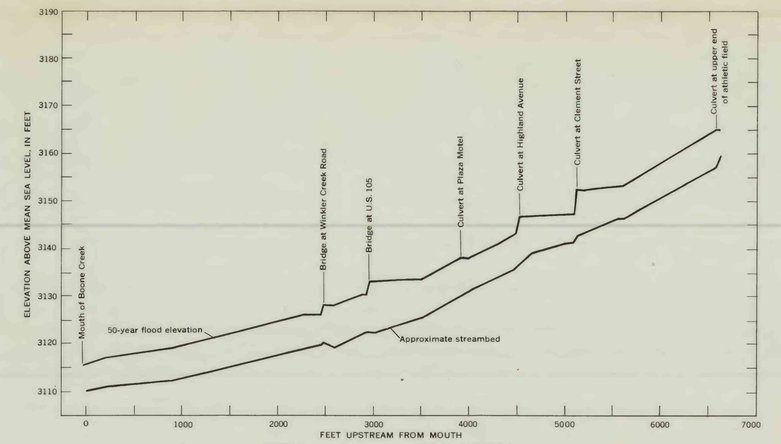


FIGURE 4.—*Profile of 50-year flood on Boone Creek.*

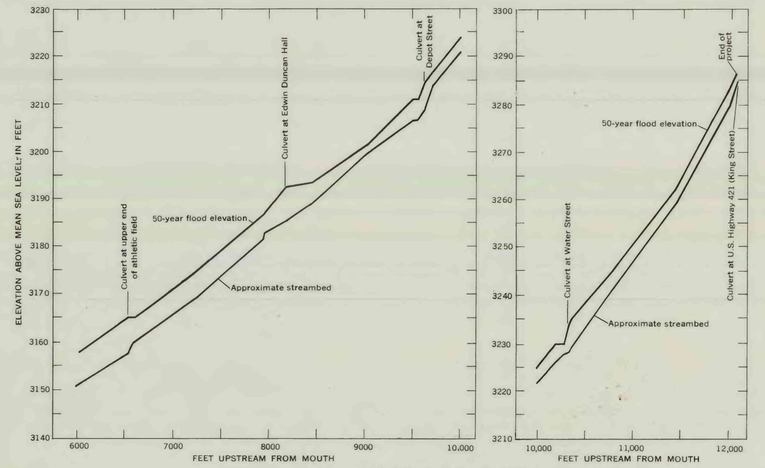


FIGURE 4 (continued).— *Profile of 50-year flood on Boone Creek.*

The flood limits reflect channel conditions that presently exist. No attempt has been made to appraise future channel conditions. The inundation pattern of future floods may be affected by new highways and bridges, by new buildings, or by relocation or excavation of stream channels.

Velocity.—Velocities of floodflow in both the main channel and on the flood plain vary considerably. Generally the velocities on the flood plain are less than those in the main channel. Listed in table 1 are flood velocities in right and left overflow channels and main channel at the five selected points on Boone and Winkler Creeks. These velocities are average figures for the indicated subsections. The high velocities shown in the table are the result of steep slopes and large volume of flow. It is evident that these high velocities which may damage or destroy buildings, embankments, and paving may create more of a flood hazard than will inundation in this particular study area.

Acknowledgments.—The selection of the site for this project was made in collaboration with the Appalachian Regional Commission. Coordination of planning with the district office of the Corps of Engineers was accomplished through the Office of Appalachian Studies, Corps of Engineers.

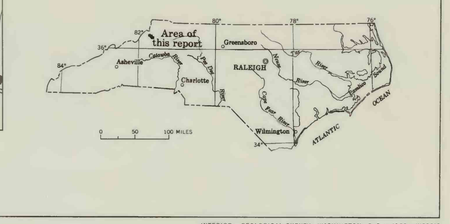
Additional information.—Supporting data and computations relative to this report are in the files of the U.S. Geological Survey, Raleigh, N. C.

Additional information pertaining to flooding in the general area may be found in the following publications:

Hinson, H. G., 1965, Floods on small streams in North Carolina, probable magnitude and frequency: U.S. Geol. Survey Circ. 517, 7 p.

Speer, P. R., and Gamble, C. R., 1965, Magnitude and frequency of floods in the United States, Part 3-A, Ohio River basin except Cumberland and Tennessee River basins: U.S. Geol. Survey Water-Supply Paper 1675, p. 270–273.

U.S. Geological Survey, Water Resources Division, 1949, Floods of August 1940 in the Southeastern States: U.S. Geol. Survey Water-Supply Paper 1066, p. 1–66; 219–229; 300 p.



EXPLANATION

- Area flooded by a hypothetical 10-year flood
- Area flooded by a hypothetical 25-year flood
- Area flooded by a hypothetical 50-year flood
- U.S.C. & G.S. bench mark ×
- U.S.G.S. reference mark △
- Boundary of 50-year flood
- Boundary of 25-year flood
- Boundary of 10-year flood

500 0 500 1000 1500 2000 FEET
100 0 100 200 300 400 500 METERS
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

81°40′ 36°15′30″

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1968

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—W63310

For sale by U.S. Geological Survey, price 75 cents