SUITABILITY OF GAGED WATERSHEDS IN COLORADO FOR RESEARCH IN SMALL WATERSHED FLOODS

by

E. F. Schulz and C. M. Hislope

Department of Civil Engineering

Colorado State University

Fort Collins, Colorado 80521

This report is published by the Colorado State University Experiment Station under project 114 supported (in part) by funds provided by the U. S. Department of Interior, Office of Water Resources Research as authorized by the Water Resources Research Act of 1964 and pursuant to Grant Agreement No. 14-31-0001-3565.

December 1972

CER72-73EFS9

SUITABILITY OF GAGED WATERSHEDS IN COLORADO FOR RESEARCH IN SMALL WATERSHED FLOODS

Introduction: - The estimation of runoff hydrographs from small, ungaged watersheds is becoming more important as urban and suburban development spreads from flood plain areas and valley areas into upstream regions and as cross-drainage problems of highways, canals and other structures multiply with time. Colorado is located in the headwaters region of the continental United States. With one or two minor exceptions, all streams rise within the state boundaries and flow outward. Virtually no runoff enters the state from outside. Since so many of the watersheds in Colorado are indeed small watersheds, it is natural that we should be interested in small watershed floods.

Small Watersheds: - A small watershed is a watershed in which the surface detention storage is the predominate storage feature. Small watersheds have very simple channel networks. Progressing downstream to larger watersheds, the channel networks become more complex, the surface slopes and physiographic features become more diverse, and the channel storage becomes the dominant storage feature in the runoff hydrograph.

Since the runoff hydrograph from the small watershed has a large component of surface detention storage, it is likely that the hydrograph is easily influenced by variations of surface roughness, shape of the watershed, watershed slope, drainage density and other physiographic variables. As the watershed size increases, the sensitivity of the catchment to small physiographic variations is damped or attenuated by the larger and more important channel storage component. A watershed smaller than 40 square miles in size has been defined as a small watershed in this report. It is admitted that this may very well be a somewhat arbitrary criterion.

Colorado State University Flood Data File: - In 1962 the Civil Engineering Department at Colorado State University initiated a program to collect, process and store in a form suitable for easy retrieval and ready analysis, a large volume of data on floods from small watersheds. The data file has been used in a number of research investigations for graduate students at Colorado State University. The basic philosophy of the data collection system was described by Laurenson et al (1963) and revised later by Yevjevich and Holland (1967). The data and information are now assembled on various sets of IBM cards and stored on magnetic tape. The computer can be used to efficiently sort and select flood events from the data file stored on the magnetic tape. Presently there are approximately 700 flood events measured on more than 200 watersheds smaller than 40 square miles in size stored in this data retrieval system. The watersheds are distributed over the United States with only a very few in Colorado. A list of the watersheds having data in the file is given in the Appendix B. The list is growing almost daily. A list of graduate theses produced from the data file is given in Appendix C.

DATA REQUIREMENTS

The data stored in the data retrieval system consists of the hydrograph of runoff, the mass curve of the causal rainfall areally averaged over the watershed, the antecedent rainfall data, and 24 different topographic and physiographic parameters of the watershed.

The flood events have been selected such that they were caused by reasonably simple rainfall and the relative completeness of the data in other respects.

Rainfall-caused floods were selected because initially the data were to be used for research work on the unit hydrograph theory and other similar methods of computing flood response of a small watershed. The majority of the floods occurring on small watersheds in Colorado are caused by melting snow. This is apparent when one looks at the date of the largest peak discharge in each year of record.

CAUSES OF FLOODS IN COLORADO

Floods on small watersheds in Colorado are caused by 1) melting snow, 2) a rain storm occurring after an extended period of minor rainfall and 3) summer thunderstorms.

The Snow Melt Flood: - Floods caused by melting snow are the predominant type in Colorado. This is true because so many of the small watersheds are at higher elevations where snow-fall can occur during almost every month of the year. When the precipitation occurs as snow, an additional storage time is introduced in the hydrological sequence between the precipitation (input) and the runoff (output) from the watershed.

While the snow fall may be rather uniformly distributed over the watershed, it undergoes a considerable redistribution because of wind. The snow is carried away in zones of high wind shear at ground level and redeposited in zones of diverging flow lines, protected areas and local low points in the topography.

at a particular elevation line but the snow line retreats more rapidly up the southward facing slopes because the snow surface is more nearly normal to the direction of the average daily solar radiation on these slopes and consequently receives effectively a higher radiation input per unit of area. After a time, the snow line elevation exists at a much lower elevation on the more shaded northern slopes than on the exposed southern slopes. In addition, the retreat of the snow line is delayed wherever the wind has produced snow drifts. At night the temperature falls and melting stops. Sometimes refreezing takes place, forming a night crust which must be remelted during the heating cycle of the next day. The snow melt hydrograph is therefore related to the amount of heat input and the area of snow pack which is actively yielding melt water. The hydrograph has typical daily rises and recessions which correspond to the daytime melt. A characteristic of a snow melt hydrograph is the cyclical oscillations about a generally high base flow. The snow melt hydrograph shown by Garstka et al (1958) demonstrates this.

Floods from Rainfall: - Floods caused by rainfall have caused many instances of great damage in Colorado. Considering small watersheds, there are two types of floods in this category. The first type usually occurs during the spring when the watershed soils are saturated from prior snow melt at the lower elevations or saturated by prior rainfall. Under these high antecedent moisture conditions, a relative minor rain storm can cause a large flood response from the watershed.

During this time of the year, the duration and intensity of the rainstorms are different than later in the season, the soil surface conditions and the extent and volume of the vegetative cover is more sparse. While high peak discharges can occur, the flood peaks last longer and the recession limb is more extended in time. The storms are often a convective cell (or cells) embedded in a slow moving cold-front. Some of the most severe floods in the foothills and eastern plains have been caused by this type of flood. The floods of June, 1965, on Plum Creek and Bijou Creek, were of this type (Matthai, 1969).

The second type storm is caused by a summer thunderstorm. The rainfall intensity is higher than for the previous type. The storm usually occurs on a dry (drier) watershed, consequently the infiltration capacity is much higher. The intensity of this type of storm is much higher than for the previously discussed spring rainstorm; the duration of the rainstorm is shorter (nearly always less than three hours); and the aerial extent is more limited than the spring rainstorm.

The hydrograph from the thunderstorm has a steeper rising climb, a steeper recession with smaller interflow/subsurface components and often only part of the watershed actually contributed surface runoff. The August 3, 1951 flood on Buckhorn Creek is a good example. This type of hydrograph is more difficult to analyze because of the limited aerial extent and high aerial variability of the rainfall. Often the major parts of the storm miss the existing rain gage network. The rainfall data are often largely limited to unofficial "bucket" measurements obtained during a field investigation conducted after the storm occurred.

CLASSIFICATION OF FLOOD PROBLEMS

The damage to installations in Colorado varies with the type of flood, the duration of the high flows and other related characteristics of the flood including sediment carried, debris, temperature, season of the year, etc.

Damage to Roads and Highways: -- Flood damage to roads and highways results from the high discharge which erodes the edges of highway embankments, bridge abutments and undermines the bridge supports or piling at points of local high velocity. Damage to bridges also results because of deposition of sediment, thereby reducing the waterway area under the bridge. The deposition of the sediment is sometimes caused by trapping floating debris on parts of the bridge or on other trees which in turn cause a deflection of part of the main flow to other parts of the channel and deposition in the slack parts of the channel. In steep mountain streams, bridges may suffer damage from large boulders carried as bed load.

Sometimes minor floods have a beneficial effect on the channel in that weeds and small trees are carried away, leaving a cleaner channel. In summary, the damage to roads, highways and bridges results from 1) erosion due to high flow velocities, 2) from sediment carried by the flood flows or 3) from deposition of debris carried by the flood flows. These damages occur during all three of the flood types previously described.

Damage to Communications and Power Distribution Systems: -- Flood damage to power and communication systems often occurs when these are most crucially needed in the mobilization of relief aid and other measures to mitigate the flood losses. Telephones are needed to call for help or obtain information when much of the road transportation is impaired. Electric power is needed to operate emergency pumps or fixed emergency equipment.

Switch boards, distribution centers, and transformers should always be located outside the floodway, preferrably on high ground or high within the building for installations in a building. Careful planning will keep important network centers out of hazardous flood areas and good network design will minimize the areas having disrupted service. Damage to communication and power distribution systems occurs during all three of the flood types described. With a growing economy, the communications and power networks are expected to expand rapidly. The new additions should be designed to satisfy the principles of flood proofing and thereby minimize the potential flood losses.

Damage to Farms and Ranches: -- Flood damages to farms and ranches can occur in many different ways. The buildings and capital investments in machinery and fixed facilities are subject to damage in much the same way that similar facilities are damaged in an urban area.

Livestock, particularly young animals and those animals confined to pastures in low lying areas, are drowned by flood water. Animals are sometimes killed by suffocation when they crowd together in snow storms or severe rain or hail storms. Injuries may result from hail stones. The animal losses are probably greater during winter snow storms than from other types of storms.

Crops in the fields may not suffer greatly from flooding unless the submergence is great and prolonged or if the flood damages a crop about ready for harvest or delays the timely planting or harvesting of the crop. In many instances, a moderate inundation may be regarded as a kind of unplanned irrigation.

The sediment, weeds and other debris carried by floods often pose a serious threat to farmlands. In ancient times, the fine sediments were regarded as a benefit, but the sediments carried during the 1965 flood in parts of Colorado covered some farmlands with undesirable sand, boulders, and debris which had to be physically removed (Matthai, 1969). Bank cutting also results in virtually complete destruction of farmland by reducing the land which was previously in the overbank zone to channel zone. There is some evidence that noxious weeds are spread by overflowing flood waters. Much of the spread of the salt cedar phreatophyte seems to be connected with floods which spread over the overbank area (Robinson, 1965).

The damage to farms and ranches results more from the rainstorms which occur on a saturated watershed. The June 1965 flood in the Bijou watershed (Matthai, 1969) or the May 1955 flood on the Purgatoire River are examples of these floods.

Damage to Urban Areas: -- Flood damages in urban areas have the highest total monetary value. Economic pressures, high land values and relatively flat topography sometimes results in occupation and urban construction on low lying lands subject to periodic inundation. There are numerous stream crossings by highway and railroad bridges, water mains, sewer lines, gas lines, etc. When the flood waters rise, there is a ready supply of buoyant objects such as storage tanks, house trailers, and lumber which are carried downstream and lodged in bridge openings. This causes further inundation upstream. The horizontal thrust from the debris dam may eventually carry the bridge away which might otherwise have survived the flood, had it not been for the floating debris.

The damage from floods in urban areas are proportional to the stage, length of inundation and to the rate of rise. A rapidly rising flood gives less warning and may carry more debris resulting in higher stages for a given discharge. Given adequate warning, the inhabitants can take some protective measures which will reduce the damages. The existence of urban areas in vulnerable locations makes a flood forecasting system a virtual necessity. The purpose of this report is to outline a systematic method for developing these forecasting procedures in the various geographical and physiographic regions in the state of Colorado.

STREAM GAGING STATIONS IN COLORADO

Stream flow measurement began with the permanent settlement in Colorado by the Anglo-Saxon settlers. Although permanent settlers of Spanish descent had settled in the San Luis valley in 1851 and developed a stable society based on irrigated agriculture, they apparently had no need for establishing records of stream flow (Hinderlider, 1952).

Gold was the early incentive for moving to Colorado. The early day miners required water for sluicing out the gold. A new legal concept for resolving the disputes over the use of water developed into the "Colorado Doctrine" or the Appropriation Doctrine (McHendrie, 1952). Stream flow measurements were required to manage the use of the water under the appropriation doctrine.

By the 1870's, there were many prosperous mining communities in the Colorado mountains. Colorado became a state of the Union in 1876 (Denver Post, 1959). Under the new constitution, the administration of the water rights adjudicated by the District Courts became the duty of the State Engineer. An Agricultural College was established at Fort Collins in 1871 (Steinel, 1926) (Watrous, 1911).

The early settlers had a first hand experiences with floods. The military encampment along the Cache la Poudre was destroyed in the early part of June 1864. Ansel Watrous (1911) gives a vivid account of the accumulation of an unusually heavy snow pack during previous fall and winter followed by heavy rains in June. He also describes the search for a new camp site high enough to be out of the reach of the flood waters.

The July 27, 1885 issue of the Rocky Mountain News in Denver gives an account of a warning by friendly Indians against settling in the low lying land between Cherry Creek and the South Platte River. (Follansbee and Sawyer, 1948). Five years after the settlers established Denver in 1859, a flood occurred on Cherry Creek. Denver has been menaced by floods ever since that time.

The first regular stream gaging stations in Colorado were planned on the St. Vrain, Big Thompson and the Cache la Poudre Rivers. The station was completed on the Cache la Poudre River at the mouth of the Canyon in 1881 and a continuous record of stream flow for this 1055 square-mile watershed has existed since 1873 (Nettleton, 1885). This is the longest record in the state of Colorado. The report of the State Engineer (Nettleton, 1885) cites the development of a new current meter for stream gaging work and the installation of a "self-registering apparatus in operation during the irrigating season" at the Cache la Poudre gaging station. He reports the construction of a measuring flume to rate the current meters. Professor Elwood Mead of the engineering faculty at Colorado Agricultural College was appointed as an Assistant State Engineer on July 1885 for the summertime to assist in operation of the station and processing the records.

Stream gaging stations were rapidly established on all streams where water rights were being adjudicated under the new Colorado doctrine of appropriation. Usually the gaging stations were established at those places where the streams emerged from the mountains and entered the flatter gradients on the plains. The fertile alluvial valleys developed downstream from these points. Transmountain diversions from better endowed watersheds to over-appropriated watersheds were promoted by the active entrepreneurship of the early day leaders. These active and proposed transmountain diversions required the installation of stream gaging stations in the higher mountains. The need for gaging stations was to document the size, seasonal and year-to-year variations of the runoff. These facts are needed to efficiently administer the water rights and in the engineering design of the facilities.

The runoff records will yield other features of the hydrology of the watershed. In 1961, a research project was initiated on the flood response from small watershed at the Colorado State University Experiment Station (Schulz, 1962).

SMALL WATERSHEDS IN COLORADO

A systematic review was made of the gaging stations in operation in the state of Colorado. The operation expenses of some of these stations are paid by the State Engineer, the Bureau of Reclamation and other agencies but the records are all published by the U. S. Geological Survey. As of 1970, there were 103 active stream gaging stations in the state of Colorado on watersheds smaller than 40 square miles in size. In addition there were 79 stations which are no longer active. Considering the elevation of the gaging station and the date of the annual flood peak, it was determined that only 32 of these watersheds had annual peak floods caused by rainfall. Melting snow causes the floods having the highest peak discharge in the remaining 71 watersheds.

If watersheds in the size range between 40 and 200 square miles are considered, it was found that in 1970, 101 gaging stations were in active operation while an additional 45 were in inactive status. The distribution of these watersheds by major river basis is given in Table 1. A complete list of the Colorado watersheds appears in the appendix together with elevation of the gaging station, period of record, annual yield and date and of peak flood of record.

USE OF FLOOD DATA FROM SMALL WATERSHEDS IN COLORADO

The previous discussion has provided a background for the classification of the use of the flood data to be found from the regularly established stream gaging stations in Colorado. The flood data from the small watersheds in Colorado have not been extensively used in the past. These data have potential value in the planning of the development in the state of Colorado. The selection of the Colorado

Table 1

SUMMARY OF GAGED SMALL WATERSHEDS IN COLORADO

Major Drainage	Watershed Area less than 40 sq. mi	40 sq. mi to 200 sq. mi
Colorado River	77 Active 64 Inactive	66 Active 31 Inactive
Platte and Kansas River	11 Active 7 Inactive	11 Active 10 Inactive
Arkansas River	4 Active 8 Inactive	11 Active 1 Inactive
Rio Grande River	11 Active	13 Active 3 Inactive
Total	103 Active	101 Active

Watersheds for inclusion in the CSU Flood Data File had been inhibited by several difficulties:

1. The significant floods are caused by snow melt.
2. There is a lack of concomitant rainfall data associated with those watersheds which have floods caused by rainstorms. There is a need for the record from a recording rain gage station in or near the watershed.
3. There is great areal variability of the rainfall over the watershed. When a large flood is caused by rainfall, the existing regular rain gage network is too sparse to give sufficient details of the causal rainstorm.
4. The floods which receive public attention are those which occur in an urban region. Urbanization is a very dynamic change in many of the hydrologic variables. The CSU Flood Data File had avoided acquiring data from urban watersheds because of their highly altered response characteristics.

For these reasons the data obtained from small watersheds have not been considered highly adaptable to the research efforts in the small watershed flood program at Colorado State University. On the other hand, many development projects in the state of Colorado would be enhanced by a research effort utilizing data from the Colorado Small Watersheds. The basic design of the data acquisition system is shown in Fig. 1. This diagram shows that the data storage system is "open-ended" in two ways. First, any number of additional flood events can be added to the information in memory by adding the 4000, 5000 and 6000 series resulting from the addition of a new flood to the already available data file. Secondly, any new type of information such as measured parameters of urbanization, snow water content, thermodynamic factors contributing to the melting of the snow can be added as additional series of data cards. The basic logic of the existing data storage system will not be perturbed by the addition of any new data or additional data to implement new concepts in the flood research program.

Accordingly several new thrusts in the flood research program are being implemented. These include:

1. Research in the development of floods from snow melt.
2. Research in the flood hydrology of urban regions.
3. Research in the development of a unit hydrograph in the absence of recording rainfall data.

The results of these research efforts would enrich the understanding of formation and occurrence of floods in Colorado.

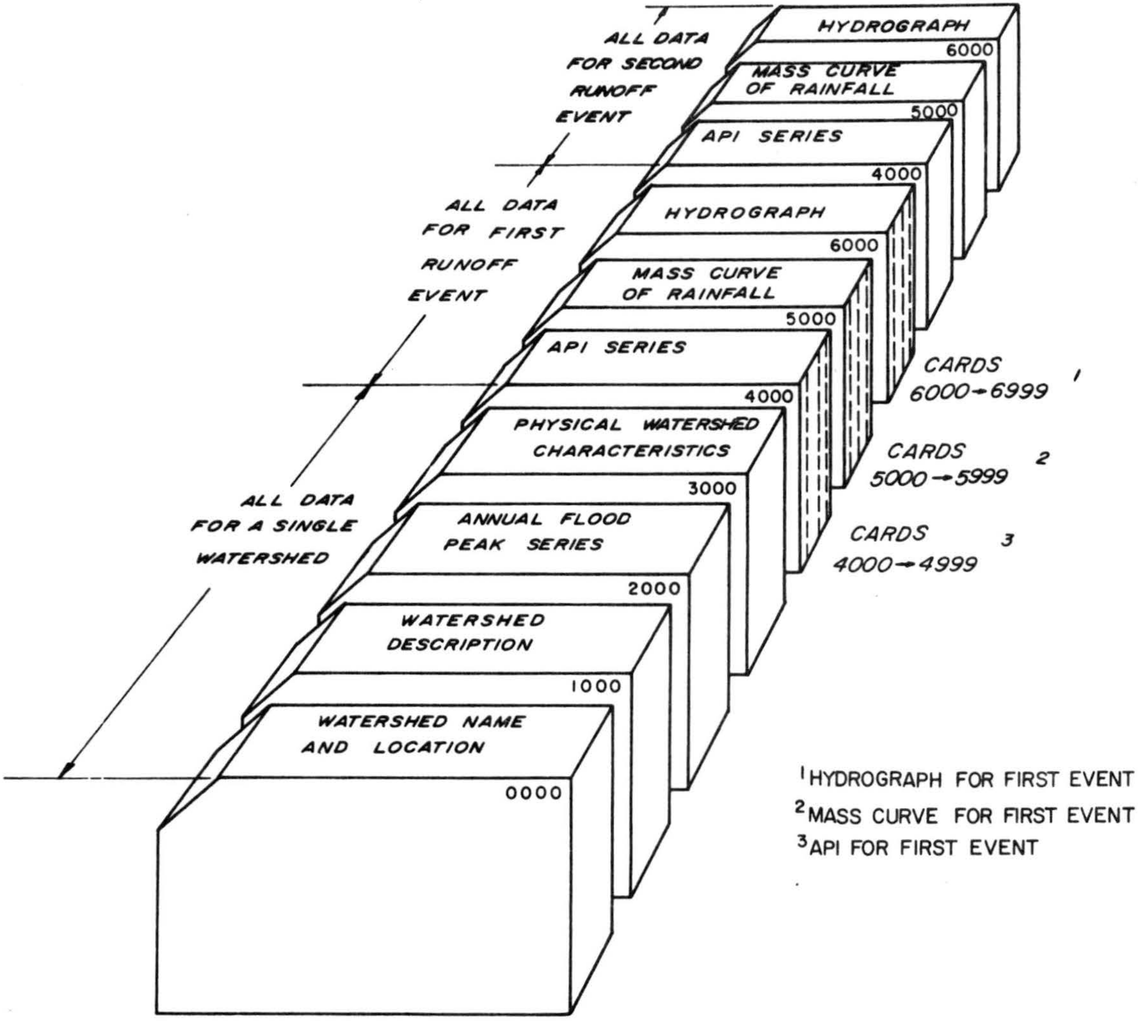

FIG 1 - Schematic representation of data arrangement for a single watershed with two runoff events

CONCLUSIONS

1. A systematic assembly of flood data has been established at Colorado State University (see Laurensen et al., 1963 and Yevjevich and Holland, 1967). These data are assembled in a standardized manner on IBM punch cards (see Fig. 1) and stored on magnetic tape.

2. Flood data have been assembled from several watersheds (less than 40 squares in size) from many locations in the United States (see list in Appendix A).

3. Small gaged watersheds in Colorado are primarily located where major floods occur as a result of snow melt. For this reason their flood data have not been thus far included in the data file.

4. Many of the gaged small watersheds in Colorado have inadequate recording rainfall stations. This is a second reason for utilizing so little of the flood data being recorded in Colorado.

5. There is a need to expand the Small Watershed Flood Data File to include snow melt initiated floods.

6. There is a need to document the floods and watershed characteristics of watersheds in rapidly evolving urban regions.

REFERENCES

Bertle, F. A. (1966), "Effect of snow compaction on runoff from rain on snow." Engr. Monograph No. 35, U. S. Bureau of Reclamation, June 1966, 45 p.

Chow, Ven te, editor, (1964), "Handbood of applied hydrology," Chapter 10, "Snow and Snow Survey" by W. U. Garstka, McGraw Hill Book Company, 1964. 1418 p.

Denver Post (1959), "This is Colorado - Special Centennial Supplement," June 1959, 384 p.

Follansbee, R. and P. V. Hodges (1925), "Some floods in the Rocky Mountain region," USGS WSP 520-G, 1925, pp. 105-125.

Follansbee, R. and L. R. Sawyer (1948), "Floods in Colorado," USGS WSP 997, 1948. 151 p.

Garstka, W. U., L. D. Love, B. C. Goodell and F. A. Bertle (1958), "Factors affecting snowmelt and streamflow," Rept. Coop. Snow Invest., USBR and USFS, March 1958, 189 p.

Hinderlider, M. C. (1952), "A century of the development of water administration in Colorado," a paper in "A hundred years of irrigation in Colorado 1852-1952," published by Colorado Water Conservation Board and Colorado A and M College, Fort Collins, 1952, 111 p.

Laurenson, E. M., E. F. Schulz and V. Yevjevich (1963), "Research data assembly for small watershed floods," Rept. CER63EMLEFSVMY37, September, 1963, Civil Engineering Department, Colorado State University, Fort Collins, Colorado, 36 p.

Matthai, H. F. (1969), "Floods of June 1965 in South Platte River basin, Colorado," USGS WSP 1850-B, 1969, 64 p.

McHendrie, A. W. (1952), "The early history of irrigation in Colorado and the doctrine of appropriation," a paper in "A hundred years of irrigation in Colorado 1952-1952," published by Colorado Water Conservation Board and Colorado A and M College, Fort Collins, 1952, 111 p.

Nettleton, E. W. (1885), "Second biennial report of the State Engineer for the years 1883-84," 1885, 132 p.

Robinson, T. W. (1965), "Introduction spread and areal extent of salt cedar in the western states," USGS Prof. Paper 491-A, 1965, 12 p.

Schulz, E. F. (1962), "Watershed Hydrology," 1961 Progress Report, Colorado State Experiment Station, February 1962.

Steinel, A. T. (1926), "History of agriculture in Colorado," Colorado State Board of Agriculture, Colorado Agricultural College, Fort Collins, 1926. 659 p.

Watrous, Ansel (1911), "History of Larimer County, Colorado," Conner Printing and Publishing Company, Fort Collins, 1911. 513 p. Reprinted 1972 by Cache la Poudre Chapter DAR, Fort Collins Colorado.

Yevjevich, R. and H. E. Holland (1967), "Research data assembly for small watershed floods - Part II.," Rept. CER67-68-13, September, 1967. Civil Engineering Department, Colorado State University, Fort Collins, Colorado. 86 p.

APPENDIX A

Stream Gaging Stations
on
Small Watersheds in Colorado

USGS NUMBER	STREAM	GAGING STATION	LATITUDE	LONGITUDE	ELEV. GNG. STA.	PERIOD RECORD	AVERAGE DISCHARGE	DRAINAGE AREA	MAX. PEAK DISCHARGE RECORD	DATE
6.6117	LITTLE GRIZZLY CREEK	COALMONT	40°33'05"	106°36'57"	8,625	67 --	--	10.1	342	5-27-70
6.6160	N. FORK MICHIGAN RIVER	GOULD	40°32'58"	106°01'14"	8,793	50 --	17.4	21.2	290	5-25-61
6.6575	LARAMIE RIVER	GLENDEVEY	40°48'02"	105°52'40"	8,230	04-05,10-	73.3	101	2,240	6- 9-23
6.7005	GOOSE CREEK (LOST PARK LAKE)	CHEESMAN LAKE	39°12'32"	105°18'11"	6,910	99-24 --	28.4	86.6	487	6- 9-57
6.7060	N. FORK S. PLATTE RIVER	GENEVA CREEK	39°27'26"	105°39'29"	8,560.81	08-13,42-	72.6	127	990	6-7,8-12
6.7105	BEAR CREEK	MORRISON	39°39'11"	105°11'43"	5,780.43	87-91,95-01, 02,19-	53.9	164	8,600	7-24-96
6.7120	CHERRY CREEK	FRANKTOWN	39°21'21"	104°45'46"	6,150	39 --	8.53	169	9,170	8- 5-45
6.7165	CLEAR CREEK	LAWSON	39°45'57"	105°37'32"	8,080	46 --	137	147	6,130	6- 4-56
6.7225	SOUTH ST. VRAIN CREEK	WARD	40°05'27"	105°30'50"	9,372	25-27,28-31, 54--	28	14.4	462	6-29-57
6.7255	MIDDLE BOULDER CREEK	NEDERLAND	39°57'42"	105°30'14"	8,186	07 --	54	36.2	811	6- 2-14
6.7270	BOULDER CREEK	ORODELL	40°00'23"	105°19'49"	5,826	87,88,06-14, 16 --	90.8	102	2,500	6- 6-21
6.7295	SOUTH BOULDER CREEK	ELDORADO SPRINGS	39°55'52"	105°17'43"	6,080	88-92,95-01 04 --	76.1	109	7,390	9- 2-38
6.7303	COAL CREEK	PLAINVIEW	39°52'40"	105°16'36"	6,540	59 --	4.30	15.1	2,060	5- 7-69
6.7318	BOULDER BROOK	ESTES PARK	40°18'57"	105°36'55"	8,850	68-70	--	3.83	68	6-21-69
6.7320	GLACIER CREEK	ESTES PARK	40°20'41"	105°35'00"	7,980	41-57,68-70	30.8	24.4	352	6-29-57
6.7323	BEAVER BROOK	ESTES PARK	40°22'28"	105°37'14"	8,590	68-70	--	1.49	14	6- 4-68
6.7330	BIG THOMPSON RIVER	ESTES PARK	40°22'42"	105°30'48"	7,492.5	46 --	126	137	1,660	6-18-49
6.7355	BIG THOMPSON RIVER	ESTES PARK	40°22'35"	105°29'06"	7,422.5	30 --	--	156	2,800	6-20-33
6.7482	FALL CREEK	RUSTIC	40°33'06"	105°37'35"	9,765	60 --	6.22	3.64	108	6-16-65
6.7485.1	LITTLE BEAVER CREEK	IDYLWILDE	40°38'19"	105°39'40"	10,000	60 --	1.07	.89	28	6-28-70
6.7485.3	LITTLE BEAVER CREEK	RUSTIC	40°37'23"	105°33'52"	8,350	60 --	7.36	12.3	187	6-17-65
6.7486	S. FORK CACHE LA POUDRE R.	RUSTIC	40°38'49"	105°35'35"	7,596.86	56 --	62.6	90.3	1,260	6-17-65
7.0812	ARKANSAS RIVER	LEADVILLE	39°15'26"	106°20'35"	9,730	67 --	--	97.2	719	5-23-70
7.0830	HALFMOON CREEK	MALTA	39°10'20"	106°23'19"	9,830	46 --	29.1	23.6	450	6-30-57
7.0845	LAKE CREEK	TWIN LAKES RESERVOIR	39°03'47"	106°24'26"	9,310	46-62,63-	170	75	3,150	6-10-52
7.0865	CLEAR CREEK	CLEAR CREEK RESERVOIR	39°01'05"	106°16'38"	8,885	46 --	71.0	67.1	1,300	6-29-57
7.0890	COTTONWOOD CREEK	HOT SPRINGS, BUENA VISTA	38°48'46"	106°13'18"	8,532	10-23,49-	58.5	65	1,180	7- 1-57
7.1037	FOUNTAIN CREEK	COLORADO SPRINGS	38°51'17"	104°52'39"	6,110	58 --	12	102	2,630	8- 4-64
7.1038	WEST MONUMENT CREEK	U.S. AIR FORCE ACADEMY	38°58'14"	104°54'08"	7,180	5- 9-70	--	14.9	47	5-20-70
7.1039	WEST MONUMENT CREEK	PIKEVIEW	38°58'17"	104°53'56"	7,080.78	57-70	.74	15.4	400	6-17-65
7.1045	TEMPLETON GAP FLOODWAY	COLORADO SPRINGS	38°53'17"	104°49'01"	6,200	51 --	.26	8.46	1,090	7-24-70
7.1110	HUERFANO RIVER	MANZANARES CROSSING, REDWING	37°43'40"	105°21'03"	8.270	23 --	32.2	73	10,200	8- 2-51
7.1140	CUCHARAS RIVER	BOYD RANCH, LA VETA	37°25'12"	105°03'08"	7,781	34 --	23.5	56	444	5-23-55
7.1176	CHICOSA CREEK	FOWLER	38°08'57"	104°04'47"	4,335	68 --	--	109	300	9-17-69
7.1224	CROOKED ARROYO	SWINK	37°58'56"	103°35'52"	4,100	68 --	--	108	865	7-14-70
7.1261	LUNING ARROYO	MODEL	37°18'16"	104°00'54"	5,150	66 --	--	86	9,400	8- 9-68
7.1262	VAN BREMER ARROYO	MODEL	37°20'45"	103°57'27"	4,960	66 --	--	168	6,240	5-26-57
8.2135	RIO GRANDE	CREEDE	37°43'29"	107°15'18"	9,300	09-23,25-	215	163	7,500	6-28-27
8.2145	N. CLEAR CREEK	CONTINENTAL RESERVOIR	37°53'18"	107°12'10"	10,200	29 --	30.8	51.7	362	5- 8-52
8.2165	WILLOW CREEK	CREEDE	37°51'20"	106°55'40"	8,880	51 --	22.1	35.3	430	6- 5-57
8.2185	GOOSE CREEK	WAGONWHEEL GAP	37°45'07"	106°49'46"	8,460	54 --	59.6	90	879	9-14-70
8.2205	PINOS CREEK	DEL NORTE	37°35'30"	106°26'28"	8,480	19-24,36-	24.6	53	720	8- 3-36
8.2235	ROCK CREEK	MONTE VISTA	37°29'25"	106°15'32"	8,230	35,36-55,66-70	11.3	32.9	190	8-19-52
8.2242	RASPBERRY CREEK	VILLA GROVE	38°20'25"	105°56'35"	8,960	67-70	--	1.78	3.8	5-26-69
8.2245	KERBER CREEK	VILLA GROVE	38°14'28"	106°06'57"	8,830	23-26,36-	12.5	38	407	5-14-41
8.2267	COTTON CREEK	MINERAL HOT SPRINGS	38°07'55"	105°47'17"	8,575	67-70	--	13.6	51	6-23-70
8.2275	NORTH CRESTONE CREEK	CRESTONE	38°00'49"	105°41'32"	8,360	36 --	11.0	10.7	735	8- 6-36
8.2295	COTTONWOOD CREEK	CRESTONE	37°56'00"	105°38'42"	8,340	36,67-70	--	6.77	540	6-26-68
8.2305	CARNERO CREEK	LA GARITA	37°51'35"	106°19'08"	8,150	19 --	11.5	117	1,600	7-21-45
8.2310	LA GARITA CREEK	LA GARITA	37°48'48"	106°19'04"	8,030	19 --	13.4	61	530	7- 9-57
8.2342	MOSCA CREEK	MOSCA	37°44'05"	105°30'27"	8,240	67-70	--	3.67	11	5-20-70
8.2360	ALAMOSA CREEK	TERRACE RESERVOIR	37°22'29"	106°20'03"	8,600	11-12,14, 15-27,34-	115	107	5,200	10- 5-11
8.2380	LA JARA CREEK	CAPULIN	37°12'32"	106°11'16"	8,130	16-17,19-23, 36-	16	98	653	4-22-19
8.2405	TRINCHERA CREEK	FORT GARLAND	37°22'29"	105°17'40"	8,520	23 --	23.3	45	689	5-27-42
8.2415	SANGRE DE CRISTO CREEK	FORT GARLAND	37°26'50"	105°25'30"	8,045	16,23-	20.6	187	630	5-15-41
8.2425	UTE CREEK	FORT GARLAND	37°26'50"	105°25'30"	8,045	16,23-	20.6	32	630	5-15-41
8.2445	PLATORA RESERVOIR	PLATORA	37°21'07"	106°32'38"	9,911.5	51 --	--	40	61,420	6-9,11-58
8.2450	CONEJOS RIVER	PLATORA RESERVOIR	37°21'18"	106°32'37"	9,866.6	52 --	89.4	40	1,160	11- 1-57
8.2475	SAN ANTONIO RIVER	ORTIZ	36°59'35"	106°02'17"	7,970	19-20,24-	25.7	110	1,750	4-15-37
8.2480	LOS PINOS RIVER	ORTIZ	36°58'56"	106°04'23"	8,040	15-20,24-	123	167	3,160	5-12-41
8.2494	CULEBRA CREEK	CHAMA	37°10'53"	105°19'14"	8,485.5	67-70	--	72.4	430	5-30-69
9.0101	LADY CREEK	GRAND LAKE	40°27'56"	105°50'46"	10,220	69 --	--	.08	2.0	5-27-69
9.0104	JIMMY CREEK	GRAND LAKE	40°22'32"	105°52'48"	10,320	69 --	--	.08	4.8	6-26-70
9.0105	COLORADO RIVER	GRAND LAKE	40°19'33"	105°51'22"	8,750	53 --	60.1	53.4	976	6-30-57
9.0110	COLORADO RIVER	GRAND LAKE	40°13'08"	105°51'25"	8,380	04-18,33-	93.5	102	1,840	6-15,16-18
9.0165	ARAPAHOE CREEK	MONARCH LAKE	40°06'45"	105°44'57"	8,310	44 --	82.3	46.9	1,300	6-11-52
9.0210	WILLOW CREEK	WILLOW CREEK RESERVOIR	40°08'45"	105°56'22"	8,023.64	53 --	25	134	867	6- 7-57
9.0220	FRASER RIVER	WINTER PARK	39°50'45"	105°45'05"	9,520	08,09,10,11, 68-	--	10.5	145	5-30-69
9.0240	FRASER RIVER	WINTER PARK	39°54'00"	105°46'34"	8,906.23	10 --	--	27.6	820	6-13-18

USGS NUMBER	STREAM	GAGING STATION	LATITUDE	LONGITUDE	ELEV. GNG. STA.	PERIOD RECORD	AVERAGE DISCHARGE	DRAINAGE AREA	MAX. PEAK DISCHARGE RECORD	DATE
9.0250	**VASQUEZ CREEK**	WINTER PARK	39°55'13"	105°47'05"	**8,768.48**	07,09,33-	--	27.8	470	6-10-52
9.0265	**ST. LOUIS CREEK**	FRASER	39°54'36"	105°52'40"	**8,980.17**	33 --	--	32.9	470	6-15-52
9.0320	**RANCH CREEK**	FRASER	39°57'00"	105°45'54"	**8,685**	34 --	--	19.9	402	6-28-57
9.0349	**BOBTAIL CREEK**	JONES PASS	39°46",	105°54',	10,430	65 --	9.88	5.49	187	6-20-68
9.0355	WILLIAMS FORK	STEELMAN CREEK	39°46'44"	105°55'40"	9,800	33-41,65-	25	16.3	441	6-21-38
9.0357	WILLIAMS FORK	LEAL	39°47'48"	106°01'31"	8,940	65 --	36.8	35.2	570	6-20-68
9.0358	DARLING CREEK	LEAL	39°48'17"	106°01'11"	9,090	65 --	9.12	8.18	224	6-20-68
9.0359	SOUTH FORK	LEAL	39°47'44"	106°01'49"	8,950	65 --	28.2	27.2	380	6-20-68
9.0360	WILLIAMS FORK	LEAL	39°49'53"	106°03'15"	8,790	33 --	101	89.3	1,720	6-10-52
9.0375	WILLIAMS FORK	PARSHALL	40°00'01"	106°10'45"	7,808.95	04-24,33-	140	184	2,620	6-14-18
9.0390	TROUBLESOME CREEK	PEARMONT	40°13'03"	106°18'45"	8,049	53 --	27.8	44.6	503	6- 7-57
9.0400	E. FORK TROUBLESOME CREEK	TROUBLESOME	40°09'27"	106°16'67"	7,670	37-43,53-	26.9	76	720	5- 9-62
9.0410	MUDDY CREEK	KREMMLING	40°17'37"	106°28'59"	7,856	37-43,55-	51.3	87.4	992	5- 9-57
9.0412	RED DIRT CREEK	KREMMLING	40°09'41"	106°33'32"	8,961	55 --	18.6	19	343	6-13-57
9.0413	PASS CREEK	KREMMLING	40°07'58"	106°29'23"	7,840	57-70	8.27	17.8	204	5-11-62
9.0466	BLUE RIVER	DILLON	39°32'58"	106°02'22"	9,120	57 --	96.2	119	1,250	6-17-65
9.0475	SNAKE RIVER	MONTEZUMA	39°36'20"	105°56'33"	9,320	42-46,51-	60.2	57.7	1,250	6-10-52
9.0477	KEYSTONE GULCH	DILLON	39°35'40"	105°58'19"	9,350	57 --	5.41	9.10	90	6- 5-68
9.0501	TENMILE CREEK	FRISCO	39°34'35"	106°03'30"	9,090	57 --	89.5	93.3	1,910	6-16-65
9.0520	ROCK CREEK	DILLON	39°43'23"	106°07'41"	8,502.52	42-56,66-	23	15.8	260	6-18-51
9.0524	BOULDER CREEK	DILLON	39°43'41"	106°10'22"	9,460	66 --	--	8.56	160	6-20-28
9.0528	SLATE CREEK	DILLON	39°45'47"	106°11'31"	9,040	66 --	--	14.2	252	5-25-67
9.0540	BLACK CREEK	DILLON	39°57'59"	106°16'04"	8,750	42-49,66-	32.3	15	384	7- 1-43
9.0553	CATARACT CREEK	KREMMLING	39°50'07"	106°18'57	8,605	66 --	--	12	321	6-21-67
9.0585	PINEY RIVER	MINTURN	39°42'26"	106°25'38"	9,145.25	47-54,63-	24.2	13	396	6-11-52
9.0586	DICKSON CREEK	MINTURN	39°42'15"	106°27'22"	9,250	64 --	3.21	3.41	41	6-13-65
9.0587	FREEMAN CREEK	MINTURN	39°41'50"	106°26'39"	9,360	64 --	1.12	2.94	29	6-13-65
9.0588	E. MEADOW CREEK	MINTURN	39°43'54"	106°25'36"	9,420	64 --	4.50	3.61	60	6- 5-68
9.0595	PINEY RIVER	STATE BRIDGE	39°48'00"	106°35'00"	7,272.35	44 --	73.4	86.2	1,110	6- 8-52
9.0605	ROCK CREEK	TOPONAS	40°02'28"	106°39'19"	8,544	52 --	31.3	47.6	482	5-12-62
9.0607	EGERIA CREEK	TOPONAS	40°02'50"	106°51'54"	--	65 --	9.87	29.4	250	5-22-68
9.0630	EAGLE RIVER	RED CLIFF	39°30'37"	106°22'00"	8,648.48	10-25,44-	50.9	70.0	1,010	6- 5-12
9.0632	WEARYMAN CREEK	RED CLIFF	39°31'14"	106°19'06"	9,250	64 --	7.98	8.78	140	6-18-65
9.0634	TURKEY CREEK	RED CLIFF	39°31'22"	106°20'15"	8,885	63 --	20.5	23.9	515	6-17-65
9.0645	HOMESTAKE CREEK	RED CLIFF	39°28'25"	106°22'00"	8,783	10-18,44-	86.6	58.3	1,300	6-24-18
9.0651	CROSS CREEK	MINTURN	39°34'05"	106°24'45"	7,990	56-63,67-	51.1	33.5	754	6-30-57
9.0655	GORE CREEK (UPPER STATION)	MINTURN	39°37'39"	106°16'28"	8,620	47-56,63-	27.8	14.3	588	6-10-52
9.0660	BLACK GORE CREEK	MINTURN	39°35'48"	106°15'54"	9,180	47-56,63-	16.2	11.8	365	6- 7-52
9.0661	BIGHORN CREEK	MINTURN	39°38'22"	106°17'34"	8,600	63 --	7.74	4.37	110	6-20-68
9.0661	PITKIN CREEK	MINTURN	39°38'36"	106°18'09"	8,600	66 --	--	5.39	123	6-20-68
9.0662	BOOTH CREEK	MINTURN	39°39'03"	106°19'16"	8,450	64 --	11	6.03	182	6-21-68
9.0663	MIDDLE CREEK	MINTURN	39°38'50"	106°22'48"	8,300	64 --	5.18	5.97	112	6-20-68
9.0664	RED SANDSTONE CREEK	MINTURN	39°40'55"	106°24'03"	9,150	63 --	8.04	7.27	139	6-17-65
9.0677	EAST BRUSH CREEK	YEOMAN PARK, EAGLE	39°30'15"	106°40'39"	9,050	65 --	14.7	9.84	282	6-20-68
9.0680	BRUSH CREEK	EAGLE	39°33'26"	106°45'45"	7,413	50 --	43.6	69.7	775	6- 7-52
9.0695	GYPSUM CREEK	GYPSUM	39°32'44"	106°56'03"	7,600	50-55,65-	31.4	63.4	395	6-11-52
9.0734	ROARING FORK RIVER	ASPEN	39°10'48"	106°48'05"	8,014.01	64 --	145	108	1,310	7- 1-65
9.0737	HUNTER CREEK	MIDWAY CREEK, ASPEN	39°12'50"	106°39'19"	10,500	64 --	15.7	6.18	492	7- 6-70
9.0740	HUNTER CREEK	ASPEN	39°12'21"	106°47'49"	8,610	50-56,69-	--	41.4	1,010	6-13-53
9.0748	CASTLE CREEK	ASPEN	39°05'15"	106°48'42"	9,100	69 --	--	32.2	398	6-23-70
9.0757	MAROON CREEK	ASPEN	39°07'25"	106°54'17"	8,720	69 --	--	35.4	382	6-26-70
9.0772	FRYINGPAN RIVER	IVANHOE LAKE	39°14'54"	106°31'53"	9,892.49	63 --	33.8	18.7	391	6-22-65
9.0776	IVANHOE CREEK	NORRIE	39°17'21"	106°33'09"	10,350	63 --	7.97	9.12	180	6-17-65
9.0778	SOUTH FORK FRYINGPAN RIVER	NORRIE (UPPER STATION)	39°14'30"	106°35'33"	9,960	63 --	21.3	11.5	278	6- 6-70
9.0779.5	CHAPMAN GULCH	NORRIE	39°16'01"	106°37'58"	9,920	66 --	--	6.38	132	6-20-68
9.0780	FRYING PAN RIVER	NORRIE	39°19'50"	106°39'30"	8,410	10-17,47-	123	90.6	1,780	6-30-57
9.0781	NORTH FORK FRYING PAN RIVER	CUNNINGHAM CREEK, NORRIE	39°21'27"	106°34'31"	9,410	63 --	20.2	12	313	6-17-65
9.0782	CUNNINGHAM CREEK	NORRIE	39°20'04"	106°34'28"	9,600	63 --	10.7	7.12	218	6-17-65
9.0785	NORTH FORK FRYINGPAN RIVER	NORRIE	39°20'40"	106°39'50"	8,400	10-17,47-	51.7	42	1,320	6- 6-58
9.0801	FRYINGPAN RIVER	MEREDITH	39°21'45"	106°43'58"	7,780	66 --	--	191	1,830	5-22-70
9.0803	ROCKY FORK CREEK	MEREDITH	39°21'42"	106°49'12"	7,494.50	59-67,68-	--	12.3	82.1	6- 7-62
9.0815.5	CRYSTAL RIVER	PLACITA	39°08'34"	107°15'26"	7,371.89	59 --	214	107	1,880	6-20-68
9.0816	CRYSTAL RIVER	AVALANCHE CREEK, REDSTONE	39°13'55"	107°13'35"	6,905	55 --	293	167	3,980	7- 1-57
9.0828	NORTH THOMPSON CREEK	CARBONDALE	39°19'47"	107°19'58"	8,120	63 --	17.4	28.6	365	5-22-70
9.0840	CATTLE CREEK	CARBONDALE	39°28'00"	107°03'06"	7,640	50-55,62-	15	31.1	280	6- 4-52
9.0852	CANYON CREEK	NEW CASTLE	39°36'19"	107°24'21"	6,180	69 --	--	23.8	486	5-27-69
9.0853	EAST CANYON CREEK	NEW CASTLE	39°36'33"	107°26'03"	6,280	69 --	--	15.1	320	5-30-70
9.0854	POSSUM CREEK	NEW CASTLE	39°35'52"	107°25'24"	6,410	69 --	--	6.41	59	5-26-70
9.0890	WEST DIVIDE CREEK	WILLOW CREEK, RAVEN	39°16'32"	107°31'10"	7,820	38-47,63-70	27.7	34.9	876	5-13-41
9.0895	WEST DIVIDE CREEK	RAVEN	39°19'52"	107°34'46"	7,050	55 --	29.8	64.6	790	5-12-62
9.0925	BEAVER CREEK	RIFLE	39°28'20"	107°49'55"	6,685	52 --	4.53	7.90	85	5-24-64
9.0930	PARACHUTE CREEK	GRAND VALLEY	39°34'15"	108°06'35"	5,770	48-54,64-70	19.0	141	738	5- 5-52

USGS NUMBER	STREAM	GAGING STATION	LATITUDE	LONGITUDE	ELEV. GNG. STA.	PERIOD RECORD	AVERAGE DISCHARGE	DRAINAGE AREA	MAX. PEAK DISCHARGE RECORD	DATE
9.0961	VEGA RESERVOIR	COLLBRAN	39°13'30"	107°48'40"	7,906	60 --	--	24.4	34,760	5-29 6-2-70
9.0965	PLATEAU CREEK	COLLBRAN	39°15'00"	107°50'25"	7,130	21 --	--	80.4	3,080	5-27-22
9.0968	BUZZARD CREEK	OWENS CREEK, HEIBERGER	39°14'10"	107°37'55"	8,206	55-70	25.2	49.7	652	5-17-70
9.0975	BUZZARD CREEK	COLLBRAN	39°16'20"	107°51'00"	6,955	21 --	46.5	139	1,630	5-14-41
9.1133	OHIO CREEK	BALDWIN	38°45'56"	107°03'28"	8,600	58-70	47.6	47.2	683	5-18-70
9.1135	OHIO CREEK	BALDWIN (NEAR)	38°42'08"	106°59'52"	8,230	40-50,58-	89.0	121	1,260	5-19-48
9.1155	TOMICHI CREEK	SARGENTS	38°23'45"	106°25'20"	8,416	16-22,37-	62.4	149	804	6- 6-57
9.1180	QUARTZ CREEK	OHIO	38°33'35"	106°38'09"	8,430	37-50,59-70	54.3	106	640	5-26-42
9.1250	CURECANTI	SAPINERO	38°29'15"	107°24'55"	7,867.43	45 --	32.7	35	480	6- 5-57
9.1260	CIMARRON	CIMARRON	38°15'30"	107°32'40"	8,650	54 --	88.6	66.6	1,790	6-28-57
9.1285	SMITH FORK	CRAWFORD	38°43'40"	107°30'22"	7,091	35 --	41.4	43.7	1,050	6- 6-57
9.1298	CLEAR FORK	RAGGED MOUNTAIN	39°08'37"	107°25'49"	7,450	65 --	35.3	38.5	792	5-18-70
9.1308	WEST MUDDY CREEK	BOWIE	39°06'56"	107°31'36"	8,240	68 --	--	26.5	659	5-11-70
9.1311	COW CREEK	PAONIA	39°06'15"	107°35'02"	9,060	68 --	--	12	100	5-12-69
9.1312	WEST MUDDY CREEK	SOMERSET	39°05'23"	107°30'17"	8,020	61 --	30.6	50.1	900	5-11-62
9.1329	WEST HUBBARD CREEK	PAONIA	39°01'56"	107°36'47"	9,640	60 --	3.56	2.36	93	7-30-69
9.1329.2	HUBBARD CREEK	BOWIE	39°02'41"	107°33'58"	8,440	68 --	--	20.6	853	6-24-69
9.1430	SURFACE CREEK	CEDAREDGE	38°59'05"	107°51'15"	8,261	39 --	41.5	26.7	578	5-12-41
9.1435	SURFACE CREEK	CEDAREDGE	38°54'06"	107°55'14"	6,220	16 --	21.7	39.5	1,190	5-13-41
9.1462	UNCOMPAHGRE RIVER	RIDGWAY	38°11'05"	107°44'40"	6,877.58	58 --	158	149	1,890	9- 6-70
9.1464	WEST FORK DALLAS CREEK	RIDGWAY	38°04'25"	107°51'02"	8,400	55-70	12.8	13.1	200	7-19-65
9.1465	EAST FORK DALLAS CREEK	RIDGWAY	38°05'37"	107°48'48"	7,980	47-53,60-70	25.2	16.8	297	6-18-49
9.1470	DALLAS CREEK	RIDGWAY	38°10'40"	107°45'28"	6,980	22-27,55-	37.4	96.2	1,120	8-15-23
9.1471	COW CREEK	RIDGWAY	38°08'58"	107°38'39"	7,620	55 --	62.1	45.4	1,360	6-28-57
9.1520	KANNAH CREEK	WHITEWATER	38°57'40"	108°13'50"	6,060	17-21,22-	38.8	61.9	1,640	6- 6-21
9.1650	DOLORES RIVER	RICO	37°38'20"	108°03'35"	8,422.23	51 --	131	105	2,120	6-10-52
9.1681	DISAPPOINTMENT CREEK	DOVE CREEK	37°52'35"	108°34'55"	6,420	57 --	15.5	145	4,360	7-13-65
9.1759	DRY CREEK	NATURITA	38°05'32"	108°37'17"	6,270	66 --	--	85.9	5,660	9- 5-70
9.2360	YAMPA RIVER	TOPONAS	40°03'00"	107°04'00"	9,700	52-65,66-	40.2	23	436	7- 2-57
9.2378	SERVICE CREEK	OAK CREEK	40°17'43"	106°48'03"	7,000	65 --	40.8	38.2	765	5-21-70
9.2385	WALTON CREEK	STEAMBOAT SPRINGS	40°24'33"	106°47'04"	7,100	20-22,65-	87.1	42.4	2,800	6-15-21
9.2389	FISH CREEK (UPPER STATION)	STEAMBOAT SPRINGS	40°28'30"	106°47'13"	7,100	66 --	--	25.8	1,110	6-20-68
9.2394	SPRING CREEK	STEAMBOAT SPRINGS	40°29'29"	106°48'19"	--	65 --	--	6.96	138	6- 5-68
9.2408	SOUTH FORK ELK RIVER	CLARK	40°44'43"	106°48'24"	7,980	66 --	--	33.7	892	6-26-70
9.2441	FISH CREEK	MILNER	40°20'10"	107°08'20"	6,930	55 --	12.3	34.5	342	5-18-70
9.2445	ELKHEAD CREEK	CLARK	40°44'00"	107°10'20"	7,800	42-43,43-44 58-	34.2	45.4	1,060	5-18-70
9.2450	ELKHEAD CREEK	ELKHEAD	40°40'15"	107°17'10"	6,830	10,20,53-	49.7	64.2	1,660	5-22-20
9.2455	NORTH FORK ELKHEAD CREEK	ELKHEAD	40°40'50"	107°17'10"	6,990	10,20,58-	16.7	21	1,100	5-21-70
9.2486	EAST FORK OF WILLIAMS FORK	WILLOW CREEK	40°15'40"	107°17'35"	7,100	56 --	107	108	1,570	5-19-70
9.2490	EAST FORK WILLIAMS FORK	PAGODA	40°18'45"	107°19'15"	6,830	53 --	111	150	1,620	6-26-57
9.2492	SOUTH FORK WILLIAMS FORK	PAGODA	40°12'44"	107°26'31"	7,235	65 --	40.6	46.7	878	5-20-70
9.2500	MILK CREEK	THORNBURGH	40°11'37"	107°43'57"	6,599.32	52 --	22.8	65	864	5-19-70
9.2550	SLATER FORK	SLATER	40°58'54"	107°22'58"	6,600	10,11,12,31-	71.6	161	1,700	5-19-12
9.3024	NORTH FORK WHITE RIVER	RIPPLE CREEK, TRAPPER'S LAKE	40°02'50"	107°18'32"	8,600	65 --	90.7	62.3	545	6-22-68
9.3024.5	LOST CREEK	BUFORD	40°03'00"	107°28'06"	7,560	64 --	21.1	21.6	818	5-18-70
9.3035	SOUTH FORK WHITE RIVER	BUFORD	39°55'19"	107°33'03"	7,460	03-06,10-15, 42-47,67-	263	157	3,230	6-17-06
9.3040	SOUTH FORK WHITE RIVER	BUFORD	39°58'28"	107°37'30"	6,970	19-20,51-	254	170	3,000	6-30-57
9.3399	EAST FORK SAN JUAN RIVER	SAND CREEK, PAGOSA SPRINGS	37°23'25"	106°50'25"	8,900	56 --	85.9	64.1	2,260	9-14-70
9.3400	EAST FORK SAN JUAN RIVER	PAGOSA SPRINGS	37°22'10"	106°53'30"	7,597.63	35 --	119	86.9	2,460	9-14-70
9.3412	WOLF CREEK	PAGOSA SPRINGS	37°26'47"	106°53'00"	7,900	68 --	--	14.0	585	9- 6-70
9.3430	RIO BLANCO	PAGOSA SPRINGS	37°12'46"	106°47'38"	7,950	35 --	84.9	58	2,500	9- 6-70
9.3440	NAVAJO RIVER	BANDED PEAK RANCH, CHROMO	37°05'07"	106°41'20"	7,940.6	36 --	103	69.8	1,350	9-14-70
9.3443	NAVAJO RIVER	CHROMO	37°01'55"	106°43'56"	7,700	56-70	116	96.4	1,400	9-14-70
9.3460	NAVAJO RIVER	EDITH	37°00'10"	106°54'25"	7,033	12 --	155	172	2,840	4-23-42
9.3470	MIDDLE FORK PIEDRA RIVER	PAGOSA SPRINGS	37°29'12"	107°09'46"	8,210	69-70	--	32.2	2,520	9- 5-70
9.3529	VALLECITO CREEK (HYDROLOGIC BENCH-MARK STATION)	BAYFIELD	37°28'39"	107°32'35"	7,906.08	62 --	143	72.1	7,050	9- 6-70
9.3550	SPRING CREEK	LA BOCA	37°00'46"	107°35'42"	6,160	50 --	28.7	58	1,980	9- 6-70
9.3575	ANIMAS RIVER	HOWARDSVILLE	37°50'00"	107°35'55"	9,616.98	35 --	104	55.9	1,980	6-18-49
9.3589	MINERAL CREEK	SILVERTON	37°51'04"	107°43'31"	9,980	68 --	--	11.0	750	9- 5-70
9.3610	HERMOSA CREEK	HERMOSA	37°25'20"	107°50'40"	6,705.88	11,12-14,19-28,39-	137	172	2,980	5-12-41
9.3630.5	FLORIDA RIVER	FLORIDA FARMER'S DITCH, DURANGO	37°17'42"	107°47'28"	7,065.35	67 --	--	108	598	5-18-70
9.3631	SALT CREEK	OXFORD	37°08'20"	107°45'10"	6,470	56-63,67-	12.4	16.7	713	8- 6-57
9.3655	LA PLATA RIVER	HESPERUS	37°17'23"	108°02'24"	8,104.71	04,05-06,10, 17-	45.1	37	1,880	9-22-41

Note: The gaging stations included in this listing are those stations on watersheds in Colorado leaving watersheds less than 200 square miles and those which were active in 1970. If the gaging record was of short length, the average discharge was not given. The largest flood peak recorded is given along with the data of the flood peak. If the data of the peak is in May or June and if the elevation of the gaging station is at 8,000 feet or above, the peak was probably a snow melt event.

APPENDIX B

List of Watersheds
in the
Colorado State University Small Watershed Data File

No.	Station No.	Name and Location	Area sq. mi.
1	1-03-06-001	Safford, W-I, Arizona	0.81
2	1-03-06-002	Safford, W-II, Arizona	1.07
3	1-03-06-003	Tombstone, W-3, Arizona	3.47
4	1-03-06-004	Tombstone, W-4, Arizona	0.88
5	1-03-06-005	Tombstone, W-5, Arizona	8.61
6	1-03-06-006	Safford, W-5, Arizona	1.13
7	1-03-06-015	Bear Creek near Tucson, Arizona	16.30
8	1-03-06-017	Sabino Creek near Tucson, Arizona	35.50
9	1-03-06-018	Safford, W-4, Arizona	1.19
10	1-03-06-019	Tombstone, W-2, Walnut Creek, Ariz.	43.19
11	1-05-01-001	Lopez Creek near Smith River, Calif.	0.93
12	1-05-02-001	Sebastopol, W-1, California	0.13
13	1-05-02-002	Green Valley Creek near Corralitos, California	7.05
14	1-05-02-003	East Fork Russian River Tributary nr. Potter Valley, Calif.	0.15
15	1-05-02-004	Honda Barranca nr. Somis, California	2.57
16	1-05-02-005	Ti Creek near Somesbar, Calif.	9.46
17	1-05-02-006	Dunn Creek nr. Rockport, Calif.	1.88
18	1-05-02-007	Cow Creek near San Ardo, California	4.80
19	1-05-02-008	Rat Creek near Lucia, California	0.82
20	1-05-02-009	North Fork Matilija Creek at Matilija Hot Springs, Calif.	15.67
21	1-05-02-011	Coyote Creek near Oak View, Calif.	13.20
22	1-05-02-014	Cachuma Creek near Santa Ynez, Calif.	23.80
23	1-05-02-015	Canada Honoa Creek near Lompoc, Calif.	3.09
24	1-05-02-016	Jacoby Creek near Freshwater, Calif.	6.07
25	1-05-02-018	Purisima Creek near Half Moon Bay, California	4.83
26	1-05-02-019	Miller Creek near Live Oak Springs, California	0.97
27	1-05-02-022	Short Creek near Covelo, California	15.20
28	1-05-02-023	West Branch Soquel Creek near Soquel, California	12.10
29	1-05-02-024	Zayante Creek at Zayante, California	11.10
30	1-05-02-055	Wolfskill, W-01, at San Dimas Exp. Forest, California	2.39
31	1-05-02-056	Fern, W-02, at San Dimas Exp. Forest, California	2.14
32	1-05-02-057	Upper East Fork, W-03, at San Dimas Exp. Forest, Calif.	2.14
33	1-05-02-058	East Fork, W-04 at San Dimas Exp. Forest, California	5.48
34	1-05-02-059	North Fork, W-05 at San Dimas Exp. Forest, California	4.23

No.	Station No.	Name and Location	Area sq. mi.
35	1-05-02-062	Bell, W-08, at San Dimas Exp. Forest. California	1.36
36	1-05-02-063	Volfe, W-09, at San Dimas Exp. Forest. California	1.16
37	1-05-02-064	Monroe, W-10, at San Dimas Exp. Forest, California	1.37
38	1-05-02-067	Cholame Creek Tributary nr. Cholame. California	9.26
39	1-05-03-001	Highland Creek nr. Highland Creek Dam, California	11.90
40	1-05-03-005	Capell Creek Tributary nr. Wooden Valley, California	0.87
41	1-05-03-007	Shingle Creek nr. Shingletown, Calif.	3.25
42	1-05-03-008	Little Panoche Creek Tributary No. 1 nr. Panoche, California	0.33
43	1-05-03-009	Cascade Creek nr. Pinecrest, California	4.97
44	1-05-03-010	Bear Creek Tributary nr. Wilber Springs, California	4.50
45	1-05-03-016	Packsaddle Canyon Creek nr. Fairview, California	4.05
46	1-05-03-018	Redwood Creek at Redwood City, Calif.	9.81
47	1-05-05-001	Beacon Creek at Helendale. Calif.	0.72
48	1-05-05-002	Buckhorn Creek nr. Valyermo, California	0.48
49	1-05-05-006	Alder Creek near Truckee. California	7.36
50	1-05-05-027	Wildrose Creek nr. Wildrose Station. California	23.70
51	1-05-05-028	China Spring Creek nr. Mountain Pass, California	0.94
52	1-05-06-007	Cottonwood Wash nr. Cottonwood Spring, California	0.71
53	1-06-06-002	Meadow Creek near Tabernash, Colorado	7.73
54	1-06-06-104	Lower Fool Creek at Fraser Exp. Forest, Colorado	1.12
55	1-06-06-105	East St. Louis Creek at Fraser Ex. Forest Colorado	3.10
56	1-06-06-135	Badger Wash 2-A nr. Mack Mesa County, Colorado	0.17
57	1-06-06-136	Badger Wash 2-B nr. Mack Mesa Co., Colorado	0.16
58	1-06-08-004	Lower Missouri Gulch Manitou Exp. Forest. Colorado	7.19
59	1-09-16-001	Vero Beach W-3. (Taylor Creek nr. Basinger), Florida	15.60
60	1-12-04-001	Emmett, W-2, Idaho	0.11
61	1-12-04-003	Moscow. W-1. Idaho	0.23
62	1-12-04-004	Moscow. W-2. Idaho	0.28
63	1-12-04-016	Clear Creek near Naf, Idaho	20.20
64	1-12-04-021	Robie Creek near Arrowrock, Idaho	15.80
65	1-12-04-024	Macks Creek near Boise. Idaho	12.49

No.	Station No.	Name and Location	Area sq.mi.
66	1-12-04-025	Salmon Creek near Boise, Idaho	13.62
67	1-13-11-003	Monticello, IA, Illinois	0.13
68	1-13-14-001	Lake Glendale Inlet nr. Dixon Springs, Ill.	1.04
69	1-15-11-001	Ralston Creek at Iowa City. Iowa	3.01
70	1-18-08-001	Little Sandy Creek at Kisatchie, La.	21.46
71	1-20-18-001	Northwest Branch Anacostia River nr. Colesville, Maryland	21.14
72	1-24-12-001	Oxford, W-4, Mississippi	3.13
73	1-24-12-002	Oxford, W-5, Mississippi	1.77
74	1-24-12-003	Oxford, W-10, Mississippi	8.64
75	1-24-12-004	Oxford, W-12, Mississippi	35.63
76	1-24-12-005	Oxford, W-19, Mississippi	0.38
77	1-24-12-006	Oxford, W-24, Mississippi	0.80
78	1-24-12-007	Oxford, W-28, Mississippi	1.69
79	1-24-12-009	Oxford, W-32, Mississippi	31.26
80	1-24-12-010	Oxford, W-35, Mississippi	11.57
81	1-24-12-019	Oxford. W-35A, Mississippi	1.70
82	1-24-12-020	Oxford. W-17A, Mississippi	5.21
83	1-24-12-021	Oxford. W-17, Mississippi	54.36
84	1-27-07-001	Hastings. W-3, Nebraska	0.74
85	1-27-07-002	Hastings. W-5, Nebraska	0.64
86	1-27-07-003	Hastings. W-8. Nebraska	3.26
87	1-27-07-004	Hastings. W-11, Nebraska	5.45
88	1-31-06-001	Mexican Springs. W-2. New Mexico	0.95
89	1-31-06-002	Mexican Springs. W-6. New Mexico	8.76
90	1-31-06-003	Mexican Springs. W-8. New Mexico	33.00
91	1-31-09-001	Albuquerque. W-1. New Mexico	0.15
92	1-31-09-002	Albuquerque. W-3 (1939-56), New Mexico	0.29
93	1-31-09-003	Albuquerque, W-3 (after 1956). New Mexico	0.26
94	1-31-09-004	Santa Fe, W-1, New Mexico	0.22
95	1-31-09-005	Three Rivers nr. Three Rivers. New Mexico	6.81
96	1-31-09-006	Indian Creek near Three Rivers. New Mexico	6.76
97	1-31-09-033	Santa Fe River nr. Santa Fe. New Mex.	18.20
98	1-31-09-041	Cornfield Wash No. 6A nr. Cuba. New Mexico	2.18
99	1-31-09-042	Cornfield Wash No. 7A nr. Cuba. New Mexico	0.51
100	1-31-09-043	Cornfield Wash No. 3 nr. Cuba. New Mexico	0.25
101	1-31-09-044	Cornfield Wash No. 4 nr. Cuba. New Mex.	1.18

No.	Station No.	Name and Location	Area sq.mi.
102	1-31-09-045	Cornfield Wash No. 5 nr. Cuba, New Mexico	1.04
103	1-31-09-046	Cornfield Wash No. 6 nr. Cuba, New Mexico	2.77
104	1-31-09-047	Cornfield Wash No. 7 nr. Cuba, New Mexico	1.07
105	1-31-09-048	Cornfield Wash No. 10 nr. Cuba, New Mexico	3.05
106	1-31-09-051	Cornfield Wash No. 30 nr. Cuba, New Mexico	0.33
107	1-31-09-052	Cornfield Wash No. 15 nr. Cuba, New Mexico	1.04
108	1-31-09-053	Cornfield Wash No. 16 nr. Cuba, New Mexico	0.56
109	1-31-09-054	Cornfield Wash No. 17 nr. Cuba, New Mexico	0.59
110	1-31-09-055	Cornfield Wash No. 10A nr. Cuba, New Mexico	2.01
111	1-33-15-001	Parker Branch, TVA, nr. Leicester, North Carolina	1.50
112	1-33-15-010	Coweeta Exp. Forest, W-8, North Carolina	2.94
113	1-33-15-011	Coweeta Exp. Forest, W-14, North Carolina	0.24
114	1-33-15-012	Coweeta Exp. Forest, W-28, North Carolina	0.55
115	1-33-15-013	Coweeta, W-36, North Carolina	0.18
116	1-35-14-001	Hamilton, W-1, Ohio	0.17
117	1-35-14-002	Coshocton, 5. Ohio	0.55
118	1-35-14-003	Coshocton, 10, Ohio	0.19
119	1-35-14-004	Coshocton. 92. Ohio	1.44
120	1-35-14-005	Coshocton. 94, Ohio	2.38
121	1-35-14-006	Coshocton. 95. Ohio	4.30
122	1-35-14-007	Coshocton. 97, Ohio	7.16
123	1-35-14-008	Coshocton, 183. Ohio	0.12
124	1-35-14-009	Coshocton. 196. Ohio	0.47
125	1-35-14-010	Coshocton, 994, Ohio	2.73
126	1-35-14-032	Coshocton, 177, Ohio	0.12
127	1-36-08-001	Stillwater. W-3. Oklahoma	0.14
128	1-36-08-002	Stillwater. W-4. Oklahoma	0.32
129	1-36-08-003	Guthrie, W-6. Oklahoma	0.15
130	1-36-08-008	Sandstone Creek above structure No. 16A nr. Cheyenne. Okla.	8.78
131	1-36-08-009	Sandstone Creek above Structure No. 16. near Cheyenne. Okla.	10.52
132	1-36-08-010	Sandstone Creek above Structure No. 14 near Cheyenne, Okla.	1.02
133	1-36-08-011	Sandstone Creek above Structure No. 17 near Cheyenne. Okla.	11.13
134	1-36-08-012	Sandstone Creek above Structure No. 10A near Elk City. Okla.	2.87
135	1-36-08-013	Sandstone Creek above Structure No. 6 near Elk City. Oklahoma	6.46

No.	Station No.	Name and Location	Area sq. mi.
136	1-36-08-014	Sandstone Creek above Structure No. 5 near Elk City, Oklahoma	3.89
137	1-36-08-015	Sandstone Creek above Structure No. 3 near Elk City, Oklahoma	0.62
138	1-36-08-016	Sandstone Creek above Structure No. 9 near Elk City, Oklahoma	3.50
139	1-36-08-017	Sandstone Creek above Structure No. 22 near Cheyenne, Okla.	2.25
140	1-36-08-018	Sandstone Creek above Structure No. 1 near Cheyenne, Okla.	5.33
141	1-38-18-001	Evitts Creek near Centerville, Pa.	30.63
142	1-38-18-017	Shaver Creek at University Park, Pennsylvania	3.75
143	1-41-07-009	Newell, W-12, South Dakota	0.14
144	1-42-15-001	White Hollow, TVA, near Sharps Chapel, Tennessee	2.76
145	1-42-15-002	Chestuee Creek, TVA, at Zion Hill, Tenn.	37.80
146	1-42-15-003	Chestuee Creek, TVA, above Englewood, Tennessee	14.84
147	1-42-15-004	Little Chestuee Creek, TVA, below Wilson Sta., Tenn.	8.19
148	1-42-15-005	Cane Creek, TVA, near Shady Hill, Tennessee	16.70

No.	Station No.	Name and Location	Area sq. mi.
149	1-42-15-006	Harmon Creek, TVA near Lexington. Tennessee	6.87
150	1-42-15-012	Turtletown Creek at Turtletown, Tenn.	26.90
151	1-42-15-017	North Fork Citico Creek nr. Tellico Plains, Tennessee	7.07
152	1-43-08-001	Vega, W-2, Texas	0.15
153	1-43-09-001	Riesel, C, (Waco), Texas	0.90
154	1-43-09-002	Riesel. D, (Waco), Texas	1.74
155	1-43-09-003	Riesel, G, (Waco), Texas	6.84
156	1-43-09-004	Riesel, J, (Waco), Texas	9.16
157	1-43-09-005	Riesel, W-1, (Waco), Texas	0.28
158	1-43-09-006	Riesel. W-2, (Waco), Texas	0.20
159	1-43-09-007	Riesel. Y, (Waco), Texas	0.48
160	1-43-09-008	Riesel. Y-2, (Waco), Texas	0.21
161	1-43-09-009	Riesel. Y-4. (Waco), Texas	0.12
162	1-43-09-010	Deep Creek Sub-watershed No. 8 nr. Mercury, Texas	4.32
163	1-43-09-023	Calaveras Crk Sub-watershed No. L nr. Elmendorf, Texas	7.01
164	1-43-09-024	Escondido Crk Sub-watershed No. 1 nr. Kenedy, Texas	3.39
165	1-43-09-025	Escondido Crk Sub-watershed No. 11 (Dry Escondido Crk) nr. Kenedy. Texas	8.43

No.	Station No.	Name and Location	Area sq. mi.
166	1-43-09-027	Honey Creek Subwatershed No. 11 nr. McKinney, Tex.	2.14
167	1-43-09-028	Honey Creek Subwatershed No. 12 nr. McKinney, Tex.	1.26
168	1-43-09-030	Mukewater Subwatershed No. 9 nr. Trickham, Tex.	4.02
169	1-43-09-031	Dry Prong Deep Crk nr. Mercury, Texas	8.31
170	1-44-05-002	Dove Creek near Park Valley, Utah	35.00
171	1-44-05-010	Holmes Creek near Kaysville, Utah	2.49
172	1-44-05-011	Ricks Creek above Diversions near Centerville, Utah	2.35
173	1-44-05-023	Vernon Creek nr. Vernon, Utah	25.00
174	1-44-05-044	Stone Creek near Bountiful, Utah	4.48
175	1-44-05-045	Mill Creek at Muller Park near Bountiful, Utah	8.79
176	1-44-06-023	Kanarra Creek at Kanarraville, Utah	10.00
177	1-45-17-001	North Danville, W-1, Vermont	16.58
178	1-45-17-002	North Danville, W-2, Vermont	0.23
179	1-46-18-001	Bell Creek, W-1, Staunton (at Saint Pauls Chapel), Virginia	0.61
180	1-46-18-002	Chub Run, W-1, Blacksburg, Virginia	3.16
181	1-46-18-003	Chestnut Branch, W-1, Blacksburg, Virginia	1.65
182	1-46-18-004	Brush Creek, W-1, Blacksburg, Virginia	1.40
183	1-46-18-005	Crab Creek, W-1, Blacksburg, Virginia	1.23
184	1-46-18-006	Fosters Creek, W-1, Blacksburg, Virginia	0.61
185	1-46-18-007	Little Winns Creek, W-1, Blacksburg, Virginia	2.30
186	1-46-18-008	Pony Mountain Branch, W-1, Blacksburg, Virginia	0.30
187	1-46-18-009	Powells Creek, W-1, Blacksburg, Virginia	0.28
188	1-46-18-010	Rocky Run Branch, W-1, Blacksburg, Va.	0.87
189	1-46-18-011	Thorne Creek, W-1, Blacksburg, Virginia	4.77
190	1-47-04-001	Pullman, G.S.I., Washington	0.11
191	1-49-11-001	Fennimore, W-1, Wisconsin	0.52
192	1-49-11-002	Fennimore, W-4, Wisconsin	0.27
193	1-49-11-003	Colby, W-1, Wisconsin	0.54
194	1-50-06-021	New Fork River nr. Cora, Wyoming	36.20
195	1-50-07-001	Douglas Creek above Keystone, Wyoming	22.10

APPENDIX C

List of Graduate Theses Utilizing Small Watershed Flood Data File

APPENDIX C

List of Graduate Theses Produced Utilizing Small Watershed Flood Data File

Downer, R. N., The effect of the time distribution of rainfall intensities on small watershed floods, Ph.D. Dissertation, August 1967.

Hiemstra, L. A. S., Frequencies of runoff for small basins, Ph.D. Dissertation, March 1968.

Ho, Y. B., Evaluation of runoff characteristics from hydrograph recessions, M.S. Thesis, June 1967.

Kavvas, M. L., Derivation of stable non-oscillating unit hydrographs, M.S. Thesis, Colorado State University, July 1972.

Om Kar, S., Hydrograph rise times, M.S. Thesis, June 1967.

Reich, B. M., Design hydrographs for very small watersheds from rainfall, Ph.D. Dissertation, July 1962.

Sangvaree, Wiroj, Land-use effects on flood peaks, Ph.D. Dissertation, August 1969.

Ulugur, M. E., Fluvial physiography as a factor in basin response, Ph.D. Dissertation, June 1969.

Voytik, A., Runoff predictions from arid regions, M.S. Thesis, June 1967.

Wilson, Wallace, Unit hydrograph response times, M.S. Thesis, Colorado State University, June 1972.