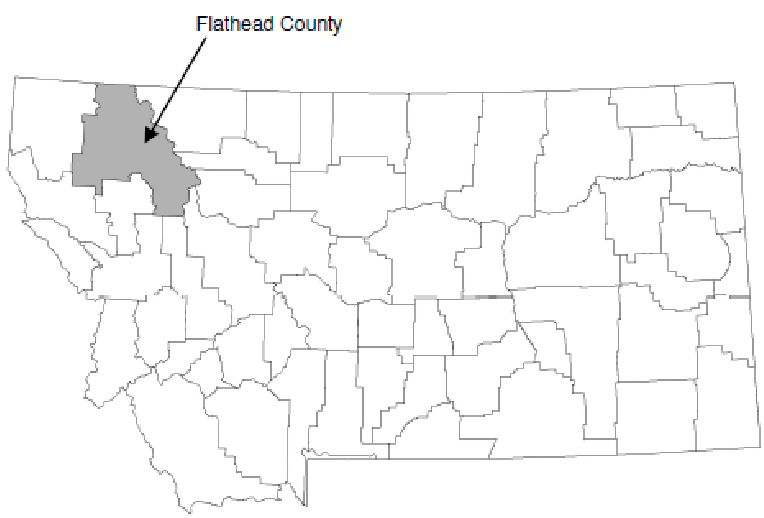
FLOOD INSURANCE STUDY

FLATHEAD COUNTY, MONTANA

AND INCORPORATED AREAS

VOLUME 1 OF 2



COMMUNITY NAME	COMMUNITY NUMBER
COLUMBIA FALLS, CITY OF	300024
FLATHEAD COUNTY (UNINCORPORATED AREAS)	300023
KALISPELL, CITY OF	300025
WHITEFISH, CITY OF	300026

REVISED:
June 18, 2013

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
30029CV001B

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the Community Map Repository. Please contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross-sections). In addition, former flood hazard designations have been changed as follows:

Old Zones	New Zone
A1 through A5, A7, A8, A12 and A13	AE
A0	AO
B	X
C	X

Initial Countywide FIS Report Effective Date: September 28, 2007

Revised Countywide FIS Report Effective Date: June 18, 2013

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1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs)/Flood Boundary and Floodway Maps in the geographic area of Flathead County, Montana, including the Cities of Columbia Falls, Kalispell, and Whitefish, and unincorporated areas of Flathead County (hereinafter referred to collectively as Flathead County) (References 1, 2, and 3) and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Flathead County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the previous studies for Flathead County and the Cities of Kalispell and Whitefish were performed by HKM Associates, the study contractor, for the Federal Emergency Management Agency (FEMA), under Contract No. H-4026. Those studies were completed in 1978.

Revised hydrologic and hydraulic analyses for the Flathead River from Flathead Lake to approximately Foy's Bend, along with new hydrologic and hydraulic analyses of the Swan River from the Steel Bridge to the Lake County line, were performed by Simons, Li, & Associates, Inc., for FEMA under Contract No. EMW-84-C-1635.

A revision was performed along Ashley Creek to revise the floodway and floodplain because of updated topographic information, channel improvements, and the addition and replacement of stream hydraulic structures. The hydraulic analyses for the revision were performed independently by Pacific International Engineering and were completed in June 2006.

For this initial countywide study a hydraulic and hydrologic analysis was developed to support a new approximate Zone A boundary for the North Fork Flathead River. This analysis was performed by PBS&J, Inc. for the Montana Department of Natural Resources & Conservation (MTDNRC) under contract WO-PBSJ-040. This work was completed in April 2006.

The DOQQ (Digital Orthophoto Quarter Quadrangle) base map for Flathead County was provided by Natural Resources Conservation Service (NRCS) Data Gateway (http://datagateway.nrcs.usda.gov/GatewayHome.html). The black and white DOQQ mosaic for the County was acquired from the NRCS Data Gateway website. Though the photo mosaic does not cover the entire county, it does cover the mapped floodplains. The U.S. Department of Agriculture produced this orthophoto mosaic at 1:12,000 scale. It has one meter ground resolution and the DOQQs used to produce the mosaic were photographed between 1990 and 1995. The DOQQs have a 1-meter ground resolution, quarter-quadrangle image cast on UTM coordinates of the North American Datum of 1983. Though the photos are more than seven years old, they are the most recent DOQQs available for the County. Therefore, they will be used for the base map.

There was no previously printed Flood Insurance Study for the City of Columbia Falls.

1.3 Coordination

For the countywide FIS, the initial Consultation Coordination Officer (CCO) meeting was held on October 7, 2005 and was attended by representatives of FEMA, Montana Department of Natural Resources and Conservation, Flathead County, the City of Kalispell, and the study contractor.

The results of the study were reviewed at the final CCO meeting held on September 7, 2006, and attended by representatives of FEMA, Montana Department of Natural Resources and Conservation, Flathead County, the City of Kalispell, and the study contractor. All problems raised at the meeting have been addressed.

Flathead County (Unincorporated Areas)

Streams requiring detailed study were identified at an initial CCO meeting attended by representatives of the study contractor, FEMA, Montana Department of Natural Resources and Flathead County, in the City of Kalispell on April 15, 1976.

Telephone and personal contacts were made by the study contractor throughout the duration of the Flood Insurance Study in an effort to coordinate activities and accumulate pertinent information. In addition to those mentioned previously, agencies and offices contacted were: the U.S. Geological Survey (USGS); local newspapers; the Flathead County Library; the Montana Department of Highways; local photographers who have taken flood photographs; the U.S. Army Corps of Engineers (USACE), Seattle District; The U.S. Soil Conservation Service (SCS); the local weather bureau; the local unit of the U.S. Forest Service of Flathead National Forest; local private engineering firms; the Burlington Northern Railroad, Bridge Section; the local unit of the Montana Fish and Game Department; local planning units; and others.

On November 17, 1982, the results of the original study were reviewed at the final meeting attended by representatives of Flathead County, FEMA, and the study contractor. The study was acceptable to the county.
Additional streams requiring detailed and approximate analyses for the revised report were identified at a meeting attended by representatives of Flathead County, FEMA, the study contractor, and the Montana Department of Natural Resources and Conservation (MTDNRC) in April 1984.

Telephone and personal contacts were made by the study contractor throughout the duration of the Flood Insurance Study in an effort to coordinate activities and accumulate pertinent information. In addition to those previously mentioned, the following agencies and offices were contacted: the USGS; local newspapers; Flathead County Library; the USACE, Seattle District; SCS; the local unit of the U.S. Forest Service of Flathead National Forest; local private engineering firms; the local unit of the Montana Fish and Game Department; and others.

On January 7, 1987, the results of this study were reviewed at the final meeting attended by representatives of Flathead County, FEMA, and the study contractor.

City of Kalispell
The initial CCO meeting was held on April 15, 1976, and attended by representatives of Flathead County, the City of Kalispell, FEMA, the Montana Department of Natural Resources (Floodway Management Bureau), and the study contractor. This meeting was held to identify streams which required approximate and detailed study.

Telephone and personal contacts were made by the study contractor throughout the duration of the study in an effort to coordinate activities and accumulate pertinent information. In addition to those mentioned previously, agencies and offices contacted were: the USGS; local newspapers; the Flathead County Library; the Montana Department of Highways; the USACE, Seattle District; the SCS; the local weather bureau; the local unit of the U.S. Forest Service of Flathead National Forest; local private engineering firms; the Burlington Northern Railroad, Bridge Section; and the local unit of the Montana Fish and Game Department.

The results of the study were reviewed at the final CCO meeting held on February 27, 1979, and attended by representatives of FEMA, the study contractor, and the City of Kalispell. All problems raised at that meeting were addressed in the study.

City of Whitefish
On April 15, 1976, streams requiring approximate and detailed study were identified at the initial CCO meeting held in Kalispell, Montana. The meeting was attended by representatives of FEMA; Montana Department of Natural Resources, Floodway Management Bureau; study contractor; Flathead County; and the City of Whitefish.

Telephone and personal contacts were made by the study contractor throughout the duration of the study in an effort to coordinate activities and accumulate pertinent information. In addition to those mentioned previously, agencies and offices contacted were: the USGS;

Whitefish Pilot; the Flathead County Library; the Montana Department of Highways; Whitefish Municipal Library; the USACE, Seattle District; the SCS; the local weather bureau; the local unit of the U.S. Forest Service of Flathead National Forest; local private engineering firms; the Burlington Northern Railroad, Bridge Section; and the local unit of the Montana Fish and Game Department.

The results of the study were reviewed at a final CCO meeting held on June 14, 1978. Attending this meeting were representatives of FEMA, the study contractor, the Montana Department of Natural Resources, and the City of Whitefish. The study incorporated all appropriate comments, and all problems were resolved.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Flathead County, Montana including the Cities of Columbia Falls, Kalispell, and Whitefish, and unincorporated areas of Flathead County. The Kalispell Air Force Base was excluded from this study.

The streams studied by detailed methods are presented in Table 1.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through 2007.

Areas studied by approximate methods include segments of Ashley Creek, Bear Creek, Big Lost Creek, Brush Creek, Cow Creek, Cedar Creek, Flathead Lake, Flathead River, Garnier Creek, Haskill Creek, Lazy Creek, Logan Creek, Mud Creek, Mount Creek, North Fork Flathead River, Patrick Creek, Spring Creek, Stillwater River, Swift Creek, Truman Creek, Trumbull Creek, Walker Creek, West Spring Creek, Whitefish Lake, Whitefish River, and several small lakes within the county. Therefore, these areas were designated as zones of minimal flooding.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by FEMA and Flathead County.

Table 1 – Streams Studied by Detailed Methods

Ashley Creek	Stillwater River near Olney
Bear Creek	Swan River
Flathead River	Swift Creek
Flathead Lake	West Spring Creek
Lazy Creek	Whitefish River at Whitefish
Middle Fork Flathead River at Nyack	Whitefish River near Kalispell
Middle Fork Flathead River at West Glacier	Whitefish Lake
Stillwater River near Kalispell	

2.2 Community Description

Flathead County, in the northwestern corner of Montana, is one of the largest counties in the state. It is bounded on the north by the Canadian Provinces of Alberta and British Columbia; on the west by Lincoln County; on the south by Sanders, Lake, Missoula, and Powell Counties; and on the east by Glacier, Pondera, Teton, and Lewis and Clark Counties.

The topography of the county ranges from extremely mountainous in the eastern and northern sections to only moderately mountainous in the west-southwestern section. Mountains within the county include the Whitefish, Salish, Livingstone, Flathead, and Swan Ranges. Many large lakes dot the countryside, and several deep river valleys cut through the mountains forming a very complex drainage system. Elevations in the county range from more than 10,000 feet in Glacier National Park to approximately 2,900 feet along the shore of Flathead Lake.

As in other mountainous areas, the previously described geographical features contribute to the wide variation in climate. The variation is most evident between the actual slopes of the Continental Divide and the broad valleys north of Flathead Lake including the Whitefish-Columbia Falls area. The county climate is classified as a modified Pacific maritime-type. It varies from a moist, maritime type climate in the upper Flathead River Valley to a drier, continental-type climate farther south. Although the entire valley is affected by weather from the Pacific and Arctic Oceans, the dominant weather patterns vary from north to south. Pacific Ocean air is more dominant in the winter, resulting in a milder climate than would be characteristic of areas influenced by continental air masses (Reference 4).

Average temperatures within the Flathead River basin are generally a little cooler than in other parts of Montana, which are east of the Continental Divide. However, temperatures during the winter are less severe, mainly due to the sheltering effect of the divide. Although polar air masses develop enough vertical depth to spill westward over the Continental Divide, such cold waves occur one-half as often as in eastern Montana. The annual average temperature for Kalispell is 44 degrees Fahrenheit (°F), and monthly averages are 20°F and 66°F for January and July, respectively. These temperatures are generally warmer than those at the unincorporated community of Summit, which is on the Continental Divide. There the average annual temperature is 36°F and January and July monthly averages are 15°F and 57°F, respectively (Reference 5).

Precipitation averages are generally higher in Flathead County than in other areas of Montana. Records indicate that Kalispell, which averages 15 inches per year, may be the driest point in the county. The average annual precipitation for Summit is 37 inches (Reference 5).

The pronounced early summer rainfall maximum common to most of Montana is not characteristic of this area. The variation from month to month is relatively small. In the Flathead River Valley, 40 to 60 percent of the annual precipitation occurs during the growing season. The midwinter precipitation is substantial, particularly in the mountains where winter and early spring snowfall is usually heavy. The mountains sometimes receive several hundred inches of snow annually. Severe snowstorms (a yearly occurrence in the mountain climate complex) are common in Flathead County. Thunderstorms usually are less severe in this area than east of the Continental Divide.

Low flows in the basin occur naturally during the winter months, and floods normally occur in the spring during periods of rapid snowmelt. Rain also may be an important factor during these floods periods. Winter floods in this area rarely reach substantial proportions.

Most of Flathead County has been influenced by alpine glaciation. The glaciated areas are covered with material that was picked up, mixed, and redeposited either by ice or glacial melt water.

Soils in the relatively flat portion of the Flathead River Valley north of Flathead Lake are generally of two types. One type is rocky and poorly drained, and is underlain by unsorted glacial till. This soil is only used marginally for agriculture but is more extensively managed for timber production. The other soil type, underlain by deposits that have been reworked or sorted by running water, is the most productive in the area and is managed extensively for cultivated crops. These valley soils are generally deep, well structured, and well drained.

Because of the high quality environment, (i.e., clean air and pristine environment), and the outdoor recreational opportunities, Flathead County has more than doubled in population since 1970. The current growth rate for the county is nearly 1,700 people per year. The April 1970 census indicated a county population of 39,460 (Reference 6), the estimated 1980 population was 51,966 (Reference 7), and the estimated 1990 population was 59,218 (Reference 7). The 2000 population estimate was 74,471 (Reference 7) and by July 1, 2004 that number had risen to 81,217 (Reference 7). Of this total, the three incorporated communities of Kalispell, Whitefish, and Columbia Falls are estimated to contain 31 percent of the population (Reference 7). Since 1960, suburbanization has been the predominant trend in the county.

As indicated previously, the abundance and diversity of natural resources have contributed to the growth of the area. These natural resources not only attract commercial and residential development, but provide areas well suited to agricultural and timber production. Mountains dominate the landscape; approximately 80 percent of the total land is classified as mountainous with slopes generally exceeding 40 percent. Foothills and valley-bottom land (in approximately equal proportions) make up the remaining 20 percent of the landscape. The geologic, hydrologic, and soil characteristics such as earthquake hazards, high groundwater table, floodplain, steep slopes, and erosion hazard are natural development constraints.

Ashley Creek originates in the Salish Range of the Flathead National Forest and flows easterly for approximately 50 miles before joining Flathead River. The total vertical drop in that distance is approximately 2,100 feet. The drainage area is approximately 280 square miles above the detailed study segments and 323 square miles above the mouth.

Development within the Ashley Creek detailed study floodplain is residential and commercial (including part of the Kalispell Municipal Airport and a sewage disposal plant).

The Ashley Creek watershed is generally characterized by alluvial soils along the stream and gray wooded soils in the mountain regions. The alluvial soils usually occur in small areas along the stream bottom and in areas that may be flooded periodically. These incipient soils consist of a thick dark organic horizon underlain by parent material (i.e., alluvial sediments). Gray wooded soils occur in conifer forests and are more developed compared to alluvial soils. A dark surface layer of less than four inches may be present just under the forest litter. In the absence of the dark layer, a light gray to white zone 4 to 12 inches thick lies just beneath the litter. The subsoil (a mixture of surface soil and the substratum) may extend to depths of 3 to 4 feet. A clay accumulation zone lies below this zone of mixing and may extend to depths of 6 feet.

Bear Creek begins at the Continental Divide in the east-central portion of Flathead County, and flows generally southwesterly for approximately 19 miles before joining Middle Fork Flathead River. Bear Creek channel slopes average 440 feet per mile upstream of the first approximate study reach, 215 feet per mile near the gaging site (which is within the detailed study segment), and 87 feet per mile for the total stream length. Maximum and minimum elevations within the Bear Creek watershed range from approximately 8,610 to 3,880 feet, respectively. The drainage area upstream of the gaging site, within the detailed study stream segment, is 20.7 square miles, and at the mouth the drainage area is 56.2 square miles. The average annual precipitation values for the watershed range from a high of 54 inches in the upper areas to 49 inches at the mouth, resulting in an overall weighted average 51 inches. There are only a few private structures in the Bear Creek detailed study floodplain.

Flathead River is the major watercourse through Flathead County and is an upper tributary to the Columbia River. The Flathead River drainage is the most northeastern basin of the basins within the Columbia River system. Flathead River has its headwaters in the mountainous areas in western Montana on the western side of the Continental Divide and north of the international boundary. The river flows southerly for approximately 95 miles from Columbia Falls, Montana, to the unincorporated community of Dixon, Montana. Columbia Falls is significant because it is below the confluences of all three tributaries to Flathead River (North, South, and Middle Forks of Flathead River). Also, its geographic location is such that it can be described as the gateway to the broad Kalispell Valley along Flathead River. Dixon is significant because it is here that the Flathead River joins Clark Fork.

The middle one-third of the 95 mile stream distance is occupied by Flathead Lake, one of the largest bodies of freshwater in the western United States. Upstream of the lake, the river is referred to as Upper Flathead River, and the section downstream from the lake is referred to as Lower Flathead River. Only the section of Flathead River upstream of Flathead Lake is considered in this study.

The Flathead River drainage area is approximately 7,096 square miles at the outlet of Flathead Lake and 5,280 square miles at the inlet. The drainage basin of the river upstream from Kalispell is 5,212 square miles, and upstream of the stream gage at Columbia Falls, it is 4,464 square miles. The drainage area upstream of the international boundary between Flathead County and British Columbia is approximately 430 square miles.

The Flathead River basin above Flathead Lake consists of a series of northwest-southeast trending mountain ranges drained by tributaries of Flathead River. Mountain elevations average slightly more than 7,000 feet, but extend to 10,000 feet. The topography of the Kalispell Valley reflects both the most recent glacial recession and the meanderings of

Flathead River. Above Kalispell, the river typically has a slope gradient of approximately 6 feet per mile; below Kalispell, it decreases to approximately 1 foot per mile during minimum impoundment of Flathead Lake.

Glacial outwash (glacial deposits reworked and resorted by glacial melt water) underlies most of the area in the Flathead River Valley and forms floodplains and terraces adjacent of Flathead River and its tributaries.

Soils in the Upper Flathead Basin tend to be immature or incompletely developed due to their relatively recent disturbances by glacial ice. A major exception is evidenced in the relatively productive alluvial soils developed from outwash deposits on the floodplain and terraces on the Flathead River.

Soils on mountain slopes and narrow valleys tend to be rocky, thin, and nutrient-poor; they are often unstable on steeper slopes if vegetation is removed. These soils support a luxuriant coniferous forest, where drainage and depth are suitable. Soils in the relatively flat portion of the valley north of Flathead Lake are generally of two types; one type is underlain by unsorted glacial till and is generally rocky and poorly drained; and the other valley soils are underlain by deposits that have been reworked or sorted by running water. The latter group is generally deep, well-structured and well-drained. These soils are the most productive in the area and are managed extensively for cultivated crops.

The Upper Flathead River Basin includes a wide variety of vegetation types, reflecting the variability of physiography, climate, and substrates found within the basin. While most of the Flathead River Valley south of Columbia Falls has been cultivated, some natural grasslands remain, particularly on south-facing foothills and lower slopes of mountains. At lower elevations, these are usually dominated by bunchgrasses such as bluebunch wheatgrass. The Flathead River floodplain supports extensive forests dominated by cottonwoods and often including spruce and juniper. Streambanks and valleys in the higher mountains often support a dense shrubland dominated by willow, alder, and aspen and bordered by birches or conifers. Ponderosa pine dominates the lowest forest zone in the Flathead River Basin, often occurring on drier sites as scattered trees or groves of trees interspersed with grassland. Annual precipitation averages approximately 15 to 20 inches through the Flathead Valley, but is much higher on adjacent mountain slopes and in the upper reaches of the watershed. Snowfall of several hundred inches a year is common in the high-mountain ranges.

The source of Lazy Creek is in the foothills of the Whitefish Range in the Stillwater State Forest. The stream travels approximately 12 miles before entering Whitefish Lake. The drainage area upstream of the detailed study stream segment near the lake is approximately 11.5 square miles. Lazy Creek has an average streambed slope of 55 feet per mile through the middle sections, 150 feet per mile for the steeper slopes in the uppermost reaches, and 15 feet per mile near the lake inlet. The weighted average annual precipitation for the watershed is 25 inches.

Vegetative land cover near the stream mouth consists of bunchgrasses and scattered groupings of thick brush or tress. Timber stands are relatively dense in the upper reaches of the watershed.

There are several farm structures within the detailed study area floodplain along Lazy Creek.

Middle Fork Flathead River originates in the Bob Marshall Wilderness Area in northwest Montana and flows northwesterly for more than 100 miles, joining the North Fork of the Flathead River approximately four miles upstream from the unincorporated community of Hungry Horse. The upper reaches of the watershed are bordered by the Flathead Range and the Continental Divide. The river drains an area of more than 1,130 square miles and has no impoundments on the mainstem or its tributaries. Middle Fork Flathead River forms the southern boundary of Glacier National Park from a point just east of the unincorporated community of Essex to the unincorporated community of West Glacier. It is classified under the National Wild and Scenic Rivers Act of 1968 as a wild river from its headwaters to Bear Creek, a distance of 46.6 miles, and as a recreational river from Bear Creek to its confluence with South Fork, a distance of 54 miles.

Middle Fork Flathead River flows through deep, narrow canyons in the upper stream segments with bed slopes of 40 to 50 feet per mile. In the lower segments, the valley widens and the gradient is approximately 15 feet per mile.

The mean annual precipitation for the watershed is approximately 60 inches. It is not uncommon for the watershed to receive several hundred inches of snow annually in the higher elevations. Runoff from snowmelt, occasionally combined with rainfall, provides high streamflows in the spring.

Soils in the watershed tend to be rocky, thin, and low in nutrients. They do, however, support a densely populated conifer forest where drainage and depth are suitable.

The detailed study area for the portion of Middle Fork Flathead River at West Glacier has a golf course with a clubhouse and related structures in the floodplain. There is also a small number of private homes. The floodplain in the detailed study areas at the unincorporated community of Nyack has a small number of structures (primarily farm structures).

Stillwater River is in west-central Flathead County. The river originates in the Salish Range within the Flathead National Forest. It flows generally southeasterly toward Kalispell, and joins Whitefish River approximately 5.2 miles upstream of the confluence with Flathead River.

Stillwater River has a drainage area of approximately 580 square miles upstream of the mouth. Elevations in the watershed range from a maximum of approximately 7,000 feet to a minimum of 2,900 feet. Average channel slope upstream of the upper detailed study segment near the unincorporated community of Olney (referred to as Stillwater River near Olney) is approximately 84 feet per mile. For the total watershed, the channel slope averages 20 feet per mile. The average annual precipitation for the watershed is approximately 32 inches.

The drainage area is predominantly rolling plateau land extensively developed for dry farming. There are moderate to extensive timber stands throughout the area, especially at higher elevations. Along the river, there are a few lakes, which are essentially unregulated. Historically, however, splash dams at lake outlets in the upper valley have provided some regulation in order to accommodate log drives. There are a few structures in the floodplain of the Stillwater River detailed study areas.

The Swan River originates from Gray Wolf Lake in the Mission Range and flows generally in a northwesterly direction before emptying into Flathead Lake. At the inlet and outlet of Swan Lake, the river drains a watershed area of approximately 540 and 671 square miles, respectively.

The Swan River Valley bottom in Flathead County was formed by glacial melt waters and reworked by fluvial processes. The valley is bounded in the east by the Swan Mountain Range and on the west by the Mission Range.

The vegetation in the valley is dominated by subalpine firs with slopes ranging from 0 to 20 percent. The slope of the Swan River from the USGS gage near Bigfork to the diversion dam is 0.07 percent. Development along the Swan River within the study reach is limited to small farms and a few houses and cottages.

Swift Creek originates in the Whitefish Range and flows southeasterly for approximately 24 miles before flowing into Whitefish Lake. The total drainage area above the mouth is 78 square miles, and the average annual precipitation for the watershed is approximately 41 inches. Elevations range from 7,400 feet in the upper stream segments to 3,000 feet at the mouth. The average channel slope through the drainage area is approximately 87 feet per mile. Swift Creek is considered to be the main inflow stream to Whitefish Lake.

Near the mouth, there is a mix of grassland and timber stands. Timber density increases with elevation throughout the watershed. There is essentially no development in the floodplain in the Swift Creek detailed study area.

Spring Creek which is immediately west of Kalispell is called West Spring Creek in this study. This nomenclature was adopted both for convenience and to distinguish it from East Spring Creek along the eastern side of the city.

The basic water supply source for West Spring Creek is a group of springs in the foothills of the Salish Range of the Flathead National Forest. West Spring Creek flows southeasterly for approximately 4 miles before being intercepted and piped to Ashley Creek. The average streambed slope for West Spring Creek, through the detailed study stream segment, is 18.5 feet per mile. The weighted-average annual precipitation for the watershed is 15.5 inches.

The watershed is generally characterized by alluvial soils, which are sparsely vegetated by bunchgrasses and scattered trees or groves of trees. Stands of timber occur with increasing elevation in the Salish Range. There are residential and commercial structures within the floodplain of the West Spring Creek detailed study area.

The Whitefish River originates at the south end of Whitefish Lake and flows southerly for approximately 24 miles before joining Stillwater River near Kalispell. From there, the combined flows travel approximately 5.2 miles to join Flathead River. An average bed slope for the river as it passes through Whitefish is 0.79 foot per mile (0.00015 foot per foot). Just upstream of Kalispell, the average bed slope is 2.5 feet per mile.

The drainage area above the gage site midway between Whitefish and Flathead River is approximately 170 square miles. The average annual precipitation for the watershed is 37 inches.

The upper reaches of the Whitefish River watershed are generally characterized by dense timber stands. Brown Podzolic soils and gray wooded soils occur principally in the mountain regions where the annual precipitation is relatively high (Reference 8). Soils in the remaining portions of the watershed consist of Chestnut and Chernozem types in the Valley, and alluvial soils along the stream and in the immediately adjacent areas that may be flooded periodically. Development in the floodplain along the Whitefish River detailed study area consists of only a few structures.

Whitefish Lake, in west-central Flathead County, has a surface area of approximately 5 square miles and a shoreline length of approximately 15 miles. The normal pool level is considered to be 2,996.4 feet. Whitefish Lake is an unregulated system; the lake stage, geometry, and hydraulic characteristics of Whitefish River determine the amount of downstream releases. The main stream feeding Whitefish Lake is Swift Creek.

City of Kalispell

The City of Kalispell is situated in the south-central portion of Flathead County. Approximately 7 miles northeast of Kalispell is the community of Columbia Falls, and approximately 7 miles to the southeast is Somers. The community is located in Flathead Valley, which is part of the Rocky Mountain Trench, a large structural depression extending from British Columbia south to the Missoula, Montana area. Kalispell is located in the trench-like depression between Columbia Falls and Flathead Lake.

Kalispell is currently growing and is expected to continue this trend. The 1960 incorporated area population for Kalispell was 10,151, with an estimated jurisdictional or planning area population of 13,320. In 1970, the incorporated and jurisdictional populations were 10,526 and 15,431 (estimated), respectively. According to the 1990 U.S. census, the population for the incorporated area was up to 11,917 and the planning area for 23,600. By 2000, the population was 14,999 and by 2004 this number had risen to 17,381 (Reference 7).

Approximately one-half of Kalispell planning area is composed of slopes in excess of 20 percent, floodplains, and soils with severe limitations for development. Because of the general physical and chemical properties of the soil, certain portions of the jurisdictional area are not suited for development. With this in mind, and the fact that Kalispell is experiencing a rapid growth rate, pressure will undoubtedly be placed on the zoning authorities and desirable valley land, some of which lies within floodplains. Planning agencies are actively stressing the importance of coordination and control of floodplain development. These agencies are suggesting that greenbelt-parkway systems be developed which focus on natural and man-made water features. Hence, planning and control agencies recognize the pressure being placed on floodplain lands and recognize the urgency and importance of this study.

City of Whitefish

Whitefish is located in central Flathead County. The community lies in the Rocky Mountain Physiographic Province, along the west side of the Continental Divide. Mountains in the area include the Whitefish Mountains and the Salish Mountains to the west.

Whitefish is also currently growing rapidly and this trend is expected to continue. The 1970 census indicated a population of 3,349 for the incorporated area. By 1980, the population was 3,703. By 1990, the number had increased to 4,368, a 15 percent increase in ten years. By July 2000, the number had grown to 5,032. The most substantial increase was from July 2000 to July 2004. The estimate in July 2004 was 6,151. This was an increase of 18 percent in only four years.

The majority of this area is either part of the Flathead National Forest or is generally classified as undevelopable due to steep slopes. If special consideration is given to the type of construction and service facilities, some areas with steep slope may be developed. Historically, a significant force in the Whitefish area has been peripheral growth, with the lakeshore growth being most important. The limited amount of satisfactory land and the development sentiments for lakeshore property are obviously a test for flood zone planning and regulations.

2.3 Principal Flood Problems

Typically, the most severe flooding in Flathead County occurs in the spring and early summer months as a result of snowmelt and/or rainfall runoff. On rare occasions, ice jams cause some overbank flooding. In addition to the flooding along streams, shallow flooding periodically occurs in other isolated, developed areas of Flathead County due to the relatively high ground water table, rapid snowmelt, heavy sustained rainfalls, and other factors. Areas in the county where this type of flooding occurs are generally on the down side of sloping topography or in low lying areas of the Flathead River Valley where there is minimal topographic relief.

It appears that the worst flooding in the west Kalispell area occurred in 1948. Except for 1948, Ashley Creek does not have a history of severe flooding.

West Spring Creek has historically been classified as a stream of only potential flood hazard. However, it appears that rather recent changes in land use and additions to storm drain systems have intensified the flood problems.

At one time, the watershed was essentially undeveloped, with minimal manmade alterations along its natural course. Recently, however, development of varying nature and intensity has occurred in the area. Storm runoff has intensified and is being routed either directly into West Spring Creek or into areas that historically had to accommodate only the natural runoff amounts. Rather frequent flooding was being experienced in the urbanizing area, which necessitated flood protection works. The most significant modification involves a piping system at the end of the detailed study which was installed to redirect West Spring Creek flows and carry miscellaneous local storm runoff to Ashley Creek. The piping system has such a limited capacity that periodic flooding continues to be experienced in this area.

For the period of record, which spans approximately 30 years, the largest flow in the Whitefish River occurred in June 1974, with a record flow of 1580 cubic feet per second (cfs). This was approximately a 3.33-percent annual chance event. The historic peak elevation on Whitefish Lake also occurred in 1974, when the pool was at 3003.4 feet. Other minor floods on the Whitefish River occurred in 1932, 1948, 1950, and 1964.

Floods on Whitefish River often last for extended periods, occasionally in excess of two weeks. The Whitefish River generally rises and recedes gradually due to the effects of Whitefish Lake. It was reported that, during the 1948 flood, the Whitefish River had an estimated average rate of rise of 0.25 foot per day.

Historically, six severe flood events have occurred along Flathead River. The six years of most significance are 1894, 1982, 1933, 1948, 1964, and 1975 (Reference 9).

In the Flathead River basin, very little quantitative information exists for floods prior to 1910. The 1894 flood of 142,000 cfs on Flathead River at Columbia Falls was the largest flood event known until a discharge of 176,000 cfs was recorded in 1964 (Reference 9).

The lower portion of Flathead River between the discontinued gaging station near Kalispell and Flathead Lake has been subjected to high flood-crest elevations in all of the six years listed previously. A summary and comparison of flood-crest elevations for some of the historical flood events along Flathead River are given in Table 2.

Table 2 – Historic Flood Elevations on Flathead River

Name of Gaging Station	Miles Above Mouth	Elevations (feet-NAVD) and Year of Flood[1]			
		1928	**1933**	**1948**	**1964**
Flathead River					
Near Kalispell	26.3	2,916.66	2,915.98	2,916.70	2,919.01
At Demersville	21.7	2,907.00	2,907.52	2,906.80	2,909.14
At Damon Ranch	13.7	2,902.20	2,903.55	N/A	2,903.23
At Therriault Ferry	7.5	N/A	2,901.07	2,900.40	2,901.06
At Keller Ranch[2]	3.8	2,900.10	2,899.70	2,899.50	2,897.84
Flathead Lake					
At Somers[3]		2,894.92	2,895.26	2,895.01	2,893.27

[1]From Reference 10
[2]The 1948 measurements were made at a site 3.0 miles above mouth
[3]Flathead Lake elevation based on Somers datum (Subtract one foot for consistency with USGS regional datum); not converted to NAVD 88

Several historic flood events in Flathead County are discussed in the following pages. Damages from flooding generally have been most severe along Flathead River.

Very few official records exist regarding the impact of the 1894 flood on the sparsely populated county. Newspaper accounts documented that the winter of 1893 through 1894 in the Columbia River Basin was colder than usual, and record depths of snow accumulated in the mountains. Precipitation in some parts of the basin was approximately 150 percent of normal. Unusually high temperatures during late May and early June greatly increased snowmelt runoff. Thunderstorms of cloudburst proportions added to flood volumes in many smaller streams while the mainstems were still rising. Flood damage in Montana was reportedly great.

The peak discharge of Flathead River for the 1894 event was determined to be 142,000 cfs at the Columbia Falls gage (Reference 10). This value was determined from floodmarks and an extended rating curve. The event was the second largest during the reporting period, with the 1964 flood being the largest.

The flood of May to June 1948 was caused by a combination of conditions conducive to the production of high runoff. Cold, wet weather prevailed until mid-May. Snow surveys showed that the mountain snowpack, already above normal, increased in water content during April and early May (Reference 11). The following is an excerpt from the June 3, 1948, issue of the Flathead Monitor:

> Except for a few short periods of warm, sunny weather, the month (May) was generally cloudy with frequent light to heavy rains. Total precipitation for the month was 4.36 inches, the second wettest of record for May, greatest being 4.50 inches in 1902. Precipitation since June 1 of last year totals 23.14 inches, the wettest of any 12 months in 50 years (Reference 12).

During April and the early part of May, temperatures had been subnormal so that snowmelt in the high mountains was delayed. After May 15, temperatures increased abruptly throughout the area. The maximum daily temperatures during the following week were near 70° F. On May 21, a temperature of 80° F was recorded at Kalispell (Reference 13). The warm weather and heavy rains produced peak flows of 102,000 cfs as early as May 23 on Flathead River at Columbia Falls. A minor recession occurred, followed by another general peak on tributary streams a few days later. Specifically, Stillwater River near Whitefish peaked on May 26 (at 4,330 cfs), Ashley Creek near Kalispell peaked on May 27 (at 749 cfs), and Whitefish River near Kalispell peaked on May 30 (at 1,290 cfs) (Reference 11). The following is an excerpt from the Flathead Monitor of June 3, 1948:

> About 40 families were forced to leave their homes and around 100 head of livestock were drowned. Total losses of property, crops, livestock, etc., is estimated at near one million dollars (Reference 12).

The Swan River near Bigfork had a peak discharge of 8,400 cfs on May 24, 1948, which was the largest measured discharge since recording began in 1922 at this station (Reference 11). The previous maximum discharge at this station was 8,280 cfs, which occurred on June 18, 1933.

The most severe flooding in modern times of the Flathead River basin upstream from Flathead Lake occurred during the 1964 flood event. The peak flow of Flathead River at

Columbia Falls was 176,000 cfs, as compared to the previous high of 142,000 cfs in 1894 (Reference 10). Studies by the USACE indicated that the 1964 peak at Columbia Falls would have been approximately 245,000 cfs if South Fork Flathead River had not been regulated by Hungry Horse Dam (Reference 13).

Flooding in the Swan River was not nearly as severe as that in the Flathead River during the 1964 flood. A peak discharge of approximately 4 percent less (8,100 cfs) than the 1948 peak discharge at Bigfork was recorded on June 10. Upstream at Strom's Store near Condon the measured discharge was 1,670 cfs.

Total damage in Montana was estimated by the USACE to be $55 million, of which $24.5 million reflects flood damage west of the Continental Divide. Between Columbia Falls and Flathead Lake, Flathead River flooded an extensive area of low lands totaling approximately 25,000 acres. More than 350 homes were flooded east of Kalispell in the Days Acres and Evergreen areas. Dikes along the lower Flathead River Valley near Flathead Lake held, but they were badly cut by the high flows (Reference 13).

The primary cause of the record flood flows of 1964 was the intense high volume rain of June 7 and 8, although antecedent streamflow, mountain snowmelt, and abundant soil moisture were also factors. During a 30-hour period on June 7 and 8, rainfall of more than 15 inches occurred in some areas of Flathead River basin (Reference 10). Streams were already at high stages on June 6 in most of the mountain area because of snowmelt runoff and the scattered rains of late May. There was also considerable snow cover in well sheltered areas at slightly lower elevations prior to the heavy rains. Intense rain falling on the remaining mountain snowpack produced sharp peaks which were the highest recorded at many gaging stations and greatly exceeded historical maximum stages on many streams.

According to hydrologists and meteorologists, it would be difficult to design a set of physical conditions that would be more favorable for heavy rainfall that that of the 1964 storm. Because of the timing of the interacting physical forces and other parameters, the dimensions of this storm were considered to closely approximate the probable maximum precipitation as described by the U.S. Weather Bureau (Reference 10).

In the Upper Flathead River basin, the peak discharges (as determined by the USGS shortly after the flood) ranged from two to four times that of the previously estimated 2-percent annual chance flood, except in the Middle Fork Flathead River Basin where the ratios approached nine (Reference 10). Because of their greater distance from the storm center and their lower elevations, conditions in the Stillwater and Whitefish River basins were less severe during the 1946 storm/runoff event.

Gullying and debris flows in the mountains and on steep valley slopes were pronounced in the drainage area of Middle Fork Flathead River between Summit and West Glacier, Montana. The peak discharge of Bear Creek near Essex was 8,380 cfs from a drainage area of 20.7 square miles. The previous maximum discharge recorded was 696 cfs (Reference 10). It is estimated that the 1964 flood along Bear Creek caused channel scour of approximately 3 feet and some minor widening. A 1964 issue of the Hungry Horse News contained the following comments:

> Rain-swollen Bear Creek swept down from the Continental Divide to obliterate large sections of U.S. Highway 2, some of it construction of recent years…What once was a timbered valley along Bear Creek was now a wide gravel and rock trough (Reference 14).

Extremely high runoff in the Middle Fork Flathead River drainage basin caused extensive damage to highways and railroads in narrow valleys along the southern edge of Glacier National Park. A steel bridge on U.S. Highway 2 across the river at the unincorporated community of Essex was washed away. The river at Essex peaked at 75,300 cfs, which was five times the maximum discharge of the previous 25 years of record (Reference 10). In the Nyack Flats area downstream of Essex, 30 residents were evacuated by air.

It was reported that one of the homes and some barns at Nyack had only roofs above water on June 8. Farther downstream along Middle Fork Flathead River at West Glacier, the main highway bridge to west entrance of Glacier National Park was damaged beyond repair. An old, low single arch concrete bridge was completely submerged, but the arch was not seriously damaged. Downstream from West Glacier, a rock canyon constricted flow, and for a time, part of the river flowed upstream along McDonald Creek into Lake McDonald in Glacier National Park. The peak flow of Middle Fork Flathead River near West Glacier (downstream from the McDonald Creek confluence) was approximately 140,000 cfs, or four times the maximum peak of the previous 25 years of record (Reference 10).

Flow of South Fork Flathead River was completely regulated at Hungry Horse Dam. Upstream from the dam, widespread flooding damaged forest roads, trails, logging operations, and resort facilities. An excerpt from a 1964 issue of the Hungry Horse News describes the flooding and dam effects as follows:

> One of the nation's great dams, Hungry Horse, completed in 1953 (flow regulation began in 1951), saved Flathead from worse catastrophe June 8-9. The 564-foot high Bureau of Reclamation Dam backs a 34-mile long lake, full each summer. Inflow June 8-9 peaked at 81,000 cubic feet per second and outflow of the South Fork was reduced to 500 cubic feet (Reference 14).

As alluded to earlier, the peak flow at Columbia Falls would have been approximately 245,000 cfs if the South Fork Flathead River had not been regulated.

Even with one of the three forks regulated, there was extreme flooding in the Flathead River Basin upstream from Flathead Lake. As stated in the Kalispell News of June 11, 1964:

> Almost beyond comprehension is the devastating flood damage to residents of the Flathead Valley along the banks of the Flathead River and the hundreds of people living in the Evergreen area along the highline. The flood parallels that of 1948 when the same area was flooded (Reference 15).

The peak stage of Flathead Lake, for the 1964 event at the unincorporated community of Somers, was 2,893.27 feet (Somer datum), recorded on June 12. This is the highest lake stage observed since upstream regulation by Hungry Horse Dam began in September 1951. The USACE estimated that a maximum stage of 2,895.8 would have occurred in 1964 if there had been uncontrolled outflow from Flathead Lake after May 1 and if there had been no flood control storage in Hungry Horse Reservoir. The stage of 2,895.26 feet in 1933 was the highest lake stage observed since continuous recording began in April 1909. The historic peak stage of 1894 was 2,899 feet (Reference 13).

Flooding also occurred in Flathead River Valley in 1975. Unofficial estimates made by the County Civil Defense Director placed the damage at approximately $2 million or more for this event. Maximum discharge for Flathead River at Columbia Falls was 77,600 cfs, with a maximum stage of 16.8 feet (high-water stage is at 13 feet) (Reference 16). As reported in the Kalispell Weekly News of June 25, 1975:

> More than 200 trailer homes were either flooded or pulled from high-water areas, particularly at Spruce Park (Evergreen area) which ended up under more than four feet of water. About 50 residences in the Evergreen area were surrounded by rising waters (Reference 17).

It was reported and can be observed from flood photographs that water passed over Helena Flats Road in Evergreen and flowed west toward Bernard Road. A short distance downstream, flow in old river channels and backwater threatened Meadow Manor and the adjacent area causing many people to pull their mobile homes to higher ground. It was reported that a USACE flood specialist estimated the 1975 flood as closely approximating the 1-percent annual chance flood flow and boundaries (Reference 16). This study estimates the magnitude of the 1975 flood flow to more closely approximate the 4-percent annual chance event.

In addition to the Flathead River Valley flooding, severe flows and damage were experienced along Bear Creek and Middle Fork Flathead River in 1975. Bear Creek had a peak discharge of 1,840 cfs at the gaging station near Essex (Reference 9).

For Middle Fork Flathead River near West Glacier, the maximum discharge was 63,600 cfs based on flood marks and an extrapolated rating curve for the site (Reference 9). Middle Fork Flathead River was considered to be well above flood stage, however, five homes were inundated and the county road was damaged near the West Glacier Golf Course. Rushing water also collapsed the old bridge near the Glacier National Park Headquarters. In order to associate the flood severity of Bear Creek and Middle Fork Flathead River with event frequency, this study estimates the 1975 flooding for the two streams to approximate that of the 1.33-percent annual chance frequency.

In 1997, snowmelt flooding causes numerous road closures and road washouts throughout the region. At least three road washouts were reported and one bridge was damaged. At least 50 homes were flooded, mainly along Ashley Creek and the Stillwater, Swan, and Whitefish Rivers. Fifty people were isolated along Truman Creek, which washed out an access road.

In 2005, a home was flooded from Hemlar Creek over topping its banks. Other creeks that flooded were Krause and Handkerchief where homes were also threatened by high water. Flooding of low lying areas was reported near Swan Lake. In Big Fork Bay, the combination of high creek flows and high water in Flathead Lake caused rising water and minor damage to docks in the bay. In Glacier National Park, the Going to the Sun Road was closed due to rockslides from heavy rainfall.

After reviewing some of the most severe flood events in Flathead County, it becomes obvious that most significance is placed on the Flathead River and its flooding because of the relatively undeveloped nature of other flood hazard streams and because of the Flathead Valley geomorphology. Surface landforms and underground aquifers through the Flathead River Valley occasionally have an effect on valley flooding. High water levels of Flathead River during regional flood events affect the free flowing characteristics of tributary streams, especially Ashley Creek, East Spring Creek, and Stillwater and Whitefish Rivers. High stages of Flathead River create backwater effects along the surface channels and raise the groundwater table in the valley, a combination of factors which cause valley flooding.

2.4 Flood Protection Measures

There are minimal flood protection works within the detailed study reaches of the following streams: Ashley Creek, Bear Creek, Lazy Creek, Middle Fork Flathead River, Swift Creek, West Spring Creek, and Whitefish River near Kalispell.

However, Ashley Lake, located in the upper reaches of the watershed, provides some flood storage. Also, there are some occasional, meandering reaches along Ashley Creek that have experienced rather severe cutting into the valley floor. This cutting has progressed to such an extent that the natural topographic features contain the flows in the channel for all but the most severe flood events.

There are no flood protection works along West Spring Creek other than the hydraulic features described in the previous section. The original intent of the rerouting and piping system was to alleviate the West Spring Creek flooding. However, as was noted earlier, this intent has been somewhat negated by the change in land use and storm drain network.

Whitefish River has no manmade flood protection structures in the area of detailed study near Whitefish. However, the naturally occurring high banks through the town provide adequate flood protection. Whitefish Lake provides flood storage detention and some flow regulation along Whitefish River near Whitefish.

The significant dams and reservoirs that affect Flathead River Valley flooding are Hungry Horse Dam and Reservoir on South Fork Flathead River, and Kerr Dam on Flathead Lake on Flathead River.

The Hungry Horse Dam and Reservoir have a very significant moderating effect on the flood flows on Flathead River. The 1- and 0.2-percent annual chance peak flows are reduced to approximate the 8.33- and 10-percent annual chance unregulated flows, respectively.

Flathead Lake, which is controlled by the Kerr Dam Project, has been regulated by an operation agreement between the PPL Montana, LLC (formerly Montana Power Authority) and the USACE since 1966. The agreement calls for the cooperation of the licensee and the USACE to exchange data and coordinate operations for flood control. Limited flood control is provided by operation of the Kerr Dam spillway gates.

Upstream of the Swan River detailed study reach is Swan Lake. The lake is natural and provides some flood detention and flood peak attenuation for the study reach.

Stillwater River has several small lakes which are capable of providing some flood detention in the upper reaches of the watershed, particularly near the Upper Stillwater River study reach. Just north of Kalispell, there is a dike running along the left bank (looking downstream) of Stillwater River in the area of the golf course. This dike has changed physical dimensions several times recently due to recreational development in the area. The photogrammetric and hydraulic models reflect field conditions and data at the time of the survey. This dike is not certified and is not reflected in the hydraulic model or on the FIRM. Along Stillwater River, there are other minor flood protection features, which are intended to reduce overbank flooding and stabilize streambanks.

Flathead County is provided some protection from floods through flood warning and forecasting by the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NWS).

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, and 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent annual chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

There have been 19 years of peak discharge measurements recorded for Ashley Creek at a gage which is approximately 6 miles upstream of the detailed study stream segments (Reference 9). The record was not continuous, however, as it spanned a total of 45 years. The different record segments were analyzed as a continuous record with a length equal to the sum of all segments because there appeared to be nothing which indicated nonhomogeneity. A log-Pearson Type III statistical analysis was performed on the above data set using a skew factor of 0.23 (Reference 18).

Several other flood magnitude frequency determination methods were used. Regional regression relationships developed by E.R. Dodge (Reference 19) and the USGS (Reference 20) were used, as well as the SCS precipitation/runoff technique (Reference 21). Results obtained from the prediction equations and rainfall/runoff model were adjusted by using a reduction factor to allow for the flood storage provided by Ashley Lake. Values for the 10-, 2-, 1-, and 0.2-percent annual chance peak discharges were derived by using these methods. These results are applicable to the gaging site, which has an upstream watershed area of approximately 195 square miles. A hydrologic data transfer was performed by the USGS (Reference 20). The final transferred results reflect magnitude-frequency values for the detailed study reaches along Ashley Creek.

When Ashley Creek was restudied in 2003, a specific objective of that study was to determine if peak streamflow produced by the flood of May 1997 was large enough to require a revision to the Ashley Creek discharge frequency statistics calculated for the previous FIS. The Ashley Creek gage record was discontinued in 1974 so the streamflow data had to be assessed indirectly by examining other stream gages in the vicinity of Kalispell. The Stillwater River near Whitefish and the Whitefish River near Kalispell were selected based on similar drainage area, elevation, shape, runoff characteristics, and proximity to Ashley Creek. These streams were assessed by two methods: 1) applying a log-Pearson type III statistical procedure to the annual maximum instantaneous flow data at the gaging stations for the period through 1996, and also through 2001; 2) testing the 1997 peak discharge as a high outlier in the annual maximum series including years through 2001. From this analysis, it was concluded that exceedence frequency statistics developed for the previous FIS were still valid (Reference 22).

The gaging station within the detailed study reach of Bear Creek (Gage No. 12356500) is referred to as "Bear Creek near Essex." The record covers a 9-year period from 1946 through 1952, 1964, and 1975. The maximum flow in June 1964 was estimated by the USGS to be 8,380 cfs. In 1975, the peak discharge was estimated to be 1,840 cfs (Reference 9).

To determine the discharge values of the 10-, 2-, 1-, and 0.2-percent annual chance floods, a log-Pearson Type III statistical analysis was performed on eight years of record by using a regional skew factor of -0.15.

Other methods of hydrologic analysis were used to accompany the log-Pearson Type III analysis, because the length of record was relatively short. These methods included the Dodge and USGS regional regression equations and the SCS precipitation/runoff technique. The values for the 10-, 2-, 1-, and 0.2-percent annual chance peak discharges were obtained by weighting the results of the log-Pearson Type III analysis with the prediction-equation results.

Flathead River upstream of Flathead Lake is under a partially regulated condition. Hungry Horse Dam and Reservoir has been regulating South Fork Flathead River, one of the three forks of Flathead River, since September 1951. The Flathead River hydrologic analysis includes consideration of both the unregulated and regulated condition because the Flathead River Valley has historically experienced severe flooding under both conditions, and it was felt that both should be considered for comparison and prediction purposes.

The unregulated flow condition analysis considers short and extended streamflow record periods, analysis with the log-Pearson Type III statistical technique, and implementation of other U.S. Water Resources Council Bulletin 17 guidelines and weighting procedures (Reference 18).

An initial analysis was performed by using the short period of records (1922, 1923, and 1928 through 1951) at the Columbia Falls gage on Flathead River and by considering the 1894 and 1964 floods as high outliers. Unregulated flow for the 1894 and 1964 floods were estimated to be 142,000 cfs and 245,000 cfs, respectively (Reference 10). The analysis used the log-Pearson Type III statistical technique with a weighted skew coefficient of -0.15.

Results from a second analysis were obtained in a similar manner to that just described, except that an extended period of record was generated using a log-log regression analysis of the Columbia Falls and Polson gages. The historical period again dated back to 1894, and the 1894 and 1964 events were considered as high outliers. The extended systematic period included 40 events, 1908 to 1923 and 1928 to 1951.

Discharges for the 10-, 2-, 1-, and 0.2-percent annual chance recurrence intervals for unregulated flow conditions were determined by using a weighted average of results obtained from the methods described previously.

The regulated flow condition considers the effects of Hungry Horse Dam and Reservoir, which began hydrologic operation in the fall of 1951. The hydrologic study of regulated flow conditions included results obtained by considering short, partially extended, and fully extended streamflow record periods; by using the log-Pearson Type III statistical analysis; by implementing the Water Resources Council Bulletin 17 guidelines; and by weighting the result to obtain final frequency-discharge values.

An initial analysis was performed by considering a partially extended record period at the Columbia Falls gage and by using the log-Pearson Type III technique. The partially extended period of record was developed by using a log-log regression analysis of the Columbia Falls and Polson gages, and subtracting the South Fork Flathead River flows. The historical period again dated from 1894, and the 1894 and 1964 events were considered as high outliers. The partially extended period of record included the 54-year discontinuous period of 1911 to 1916, 1923, and 1928 to 1975. Only years having measured records for South Fork Flathead River were included. A method suggested by Water Resources Council Bulletin 17 resulted in a skew coefficient of -0.10.

A second analysis was performed by using the log-Pearson Type III techniques on a fully extended period of record (i.e., 1908 to 1923 and 1928 to 1975). The 1894 and 1964 events were considered as high outliers. The fully extended period of record was obtained by using the log-log regression equation to derive the extended Flathead River flows at the Columbia Falls gage. A regulated condition was obtained by subtracting the South Fork Flathead River flows. Where river flows were not available as a measured record, flows were assumed to be approximately one-third of the total Flathead River flow. This ratio was obtained by observing the historical records. The skew coefficient for this analysis was -0.10.

A third analysis of regulated conditions on Flathead River was made in a manner similar to those previously described for the fully extended record period, except that the 1964 event was completely eliminated from the analysis. This elimination presupposed that the 1964 flood was so severe and statistically biased that it was not reasonable to include it in the analysis. Precipitation for the 1964 event was estimated to be approximately the probable maximum precipitation in some areas.

Each of the three methods gave similar results, and discharges associated with the 10-, 2-, 1-, and 0.2-percent annual chance floods were derived from a weighted average of the results obtained by using the three methods.

It is the regulated condition results that are used in this flood study because it is this condition that most accurately reflects existing and projected flood flows in the Flathead River Valley above Flathead Lake.

Lazy Creek does not have a systematic stream flow record or any other historical measurements. Therefore, the 1972 Dodge prediction equations and the 1976 USGS prediction equations were the primary hydrologic methods employed. These methods were supplemented by the SCS rainfall/runoff methods and a comparison with hydrologically and meteorologically similar watersheds.

There are two gaging stations on Middle Fork Flathead River with stream flow records in the study area. One gage site is near West Glacier immediately downstream of the McDonald Creek confluence (Gage No. 12358500). The period of record for this gage is from October 1939 to 1975, and the drainage area is 1,128 square miles.

Measurements at the second gage were terminated in 1948. This gaging station was referred to as Gage No. 4480-Middle Fork Flathead River at Belton, Montana. The site was approximately two miles upstream of the McDonald Creek confluence, and the drainage area was 943 square miles. The record period was discontinuous and extended from 1911 to 1948. Only 23 years of peak discharge measurements are available.

As recommended by the USGS, a hydrologic data transfer was performed in order to obtain an extended period of record. One scheme involved transferring the Belton measurements downstream using the ratio of the drainage basin ratios raised to the 0.6 exponent. The other scheme consisted of developing a log-log regression relationship based on the years of record concurrent at the two gage sites. Using this regression relationship, the Belton records from 1911 to 1923 were transferred downstream to the West Glacier site in order to obtain an extended period of record. The end result of both schemes was a total systematic period length of 53 years. The resulting data base for each scheme was subjected to a log-Pearson Type III statistical analysis and the Water Resources Council Bulletin 17 guidelines for treating high outliers. Final frequency-discharge results for Middle Fork Flathead River near West Glacier were derived from these calculations.

The other detailed study segment along Middle Fork Flathead River is several miles upstream at Nyack. The watershed upstream of this study segment is approximately 850 square miles. The geographic location and difference in drainage area size dictated that the final results discussed previously should be adjusted when studying flows. A hydrologic data transfer of the final frequency-discharge results near West Glacier was made by using the technique suggested by the USGS. This technique uses the drainage area ratio to an appropriate exponential power.

The period of record for the gaging station on Stillwater River (Gage No. 12365000 near Whitefish) extended from 1929 to 1950. In October 1972, the gaging station was reinstituted, but was moved slightly downstream. Hence, there were several more peak-discharge values available to improve the database. Also, peak-discharge measurements were made on Stillwater River near Kalispell in 1922, 1929, and 1930, and one measurement was made in 1964 at Gage No. 12365000.

A hydrologic analysis was performed in order to incorporate the later information and to verify previous results or make improvements in previous studies. The investigation involved a log-Pearson Type III analysis of all available peak-discharge values (27 years total), prediction equation methods by Dodge and the USGS, and a check with the SCS rainfall/runoff technique. All streamflow data were adjusted to a common location (i.e., to Gage No. 12365000) by using drainage area proportionality to an exponential power before implementing the log-Pearson Type III analysis. The final frequency-discharge values were transferred downstream to the study reach near Kalispell by using technique suggested by the USGS.

There were only 3 years of peak-discharge measurements (Gage No. 12363900) available for the Stillwater River near Olney detailed study area. Because there were so few measurements, these were considered historical measurements and were used primarily for comparative purposes. Primary emphasis for the hydrology study of Stillwater River near Olney was placed on the following methods: Dodge flood-prediction equations; USGS prediction equations; SCS rainfall/runoff technique; and a comparison with other similar watersheds. The 10-, 2-, 1-, and 0.2-percent annual chance discharges were determined by using a weighted average of the values produced by the cited methods with consideration of historical discharge values and neighboring and similar watershed discharge values.

The period of record for the gaging station on the Swan River (Gage No. 1237000 near Bigfork) extended from 1922 to 1983. With such a long recording period and because of the natural regulation above the study area, a frequency analysis was used to determine peak flows. A log-Pearson Type III distribution was used with the 62 years of data based upon the Chi-Squared statistic for best fit to obtain estimates of the 10-, 2-, 1-, and 0.2-percent annual chance flood values. Since the Bigfork gage is so close to the detailed study reach in Flathead County, the peak discharges were not modified for the hydraulic analysis.

Swift Creek has only a small number of peak-discharge measurements because the gaging station (Gage No. 12365800) was instituted in October 1972 (Reference 9). These measurements were used for comparative purposes, and were supplemented with various techniques in order to obtain estimates for the 10-, 2-, 1-, and 0.2-percent annual chance flood values. In particular, the Dodge and USGS prediction equation methods and the SCS rainfall/runoff model were used to complete the hydrologic analysis for Swift Creek.

No systematic or nonsystematic peak-flow measurement record is available for West Spring Creek. Hence, the regional regression equations of Dodge and the USGS and the SCS rainfall/runoff technique were used in order to obtain values for the 10-, 2-, 1-, and 0.2-percent annual chance peak discharges. Because there are no records for the storage ponds along West Spring Creek, allowance was made for detention storage effects.

The gaging station (Gage No. 121366000) on Whitefish River, approximately 8.0 miles north (upstream) of Kalispell, provided peak-flow measurement data. The period of record is from April 1929 to September 1950, 1964, and from October 1972 to 1975. The segments of record were grouped into one complete data set of 26 years as there appeared to be nothing to indicate nonhomogeneity. A log-Pearson Type III analysis was performed on these records by using a regional skew factor of -0.15.

The USACE published an updated hydrologic report on Whitefish River in August 1974 (Reference 13). The data in this report concurred with the determination of the study contractor of the flood discharges in the study area. The work of the USACE was accepted by the study contractor as representative of the 10-, 2-, 1-, and 0.2-percent annual chance discharges.

The locations of the detailed study segments and upstream watersheds were observed in order to determine whether specific floodflow estimates away from the gage site were necessary. Because of the effects of Whitefish Lake and the relatively insignificant differences in contributory drainage areas, the results obtained at the gage were considered to be applicable to the upstream and downstream detailed study reaches along Whitefish River.

Peak discharge-drainage area relationships for streams studied in detail are shown in Table 3.

Table 3 – Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
Ashley Creek					
At Kalispell	280.0	490	1,050	1,430	2,210
Bear Creek					
At USGS Gage No. 12345400 near Essex	20.7	1,120	1,700	1,990	2,620
Flathead River					
At USGS Gage No. 1236300 at Columbia Falls	4,464.0	66,000	79,000	84,500	140,000[1]
Lazy Creek					
Near Whitefish Lake	11.5	335	580	710	1,015
Middle Fork Flathead River at Nyack					
At Nyack	850.0	32,200	48,700	56,900	78,700
Middle Fork Flathead River at West Glacier					
At USGS Gage No. 12358500, 0.8 Mile Downstream of McDonald Creek	1,128.0	38,200	57,700	67,400	93,300
Upstream of McDonald Creek	953.0	33,900	51,200	59,800	82,800
Stillwater River Near Kalispell					
At USGS Gage No. 1236500, 6.2 Miles Southwest of Whitefish	524.0	3,600	5,400	6,200	8,200
Stillwater River Near Olney					
Near Olney	146.0	1,720	2,660	3,100	4,010
Swan River					
At USGS Gage No. 12370000 Near Bigfork	671.0	7,200	8,500	9,000	10,000
Swift Creek					
At USGS Gage No. 12365800	78.0	1,340	1,880	2,100	2,640

[1] Approximated as the 0.2-percent annual chance flood. This flood has been estimated by USACE to be 121,000 cfs.

Table 3 – Summary of Discharges (Continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
West Spring Creek					
At Meridian Road Near Kalispell	3.5	125	210	260	360
Whitefish River at Whitefish					
At Whitefish	125.0	1,280	1,615	1,740	2,090
Whitefish River near Kalispell					
At USGS Gage No. 12366000	168.1	1,189	1,487	1,606	1,875

Two frequency analyses were made of Flathead Lake. The first analysis involved determining the starting lake level coincident with the maximum discharge in Flathead River, and the second analysis involved assessing the maximum water level in the lake.

Flathead Lake levels have been recorded since 1908, but the lake regulation was modified by an agreement between the PPL Montana, LLC (formerly Montana Power Company) and the USACE in 1966. Because of the modification to the operation rule, the record since 1966 was used for the frequency analysis. In assessing the lake level coincident with the peak discharge in the river, a one-day lag period between the peak discharge at Columbia Falls and the Flathead Lake level is considered representative because of the travel time of the peak discharge from Columbia Falls to the lake. A Pearson Type III distribution was used with the 17 years of data (1966-1983) to determine water levels in Flathead Lake that coincide with the peak discharge in the Flathead River for the 10-, 2-, 1-, and 0.2-percent annual chance floods. These lake levels are used as the downstream boundary condition for computation of backwater profiles for the 10-, 2-, 1-, and 0.2-percent annual chance floods.

The annual maximum lake level study completed in 1965 by the USACE, Seattle District, was adopted for this study. Flathead Lake levels for different recurrence intervals were assessed by developing hypothetical floods in the 10- to 0.2-percent annual chance range upstream of the lake and simulating regulation with the Hungry Horse and Kerr projects. The maximum annual lake level analysis, adopted from the USACE study, was used to map inundated areas in the Flathead River at each frequency level until the backwater profile intercepted the lake level.

The Whitefish Lake watershed hydrology was examined previously by the SCS (Reference 23). Results of these investigations have been incorporated into this FIS.

Elevations for floods of the selected recurrence intervals on Flathead Lake and Whitefish Lake are shown in Table 4.

Table 4 – Summary of Stillwater Elevations

	Elevation (feet)			
Flooding Source and Location	**10-Percent Annual Chance**	**2-Percent Annual Chance**	**1-Percent Annual Chance**	**0.2-Percent Annual Chance**
Flathead Lake[1] Coincident with Peak Charge in Flathead River	2,892.3	2,893.1	2,893.4	2,893.9
Flathead Lake[1] Annual Maximum Level	2,891.7	2,893.3	2,893.9	2,895.2
Whitefish Lake At Whitefish	3,002.4	3,003.73	3,004.23	3,005.40

[1]Somers datum (subtract one foot for consistency with USGS regional datum-not converted to NAVD 88).

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Water-surface elevations were developed using the HEC-2 step-backwater computer model (Reference 24) for all detailed study areas except for Flathead River below the City of Columbia Falls to Demersville, Stillwater River below its confluence with Whitefish River, and Whitefish River below the Burlington Northern Railroad.

The computer program SOCHMJ (Reference 25) was used to develop water-surface elevations for Flathead River between Columbia Falls and the unincorporated community of Demersville; Stillwater River below the confluence with Whitefish River; and Whitefish River below the Burlington Northern Railroad. This program performs analyses of the complex unsteady conditions by using a hydraulic routing procedure based on St. Venant's equation. This program requires time dependent input of stage or discharge at the outer boundaries to calculate the resultant stage, discharge, and velocity hydrographs. This accommodates a system containing several branches and junctions.

Forty-five channel and overbank sections were used to describe the geometrics used in the SOCHMJ model. These cross sections, with the exception of the channel section at the Columbia Falls gage, were surveyed in the spring of 1979 with some additional work done in March 1980. The section at the gage was reconstructed from USGS discharge measurements taken in April 1980.

Calibration of the SOCHMJ numerical model was based on observed high water-surface elevations recorded at established profile points along the Flathead River between Columbia Falls and Demersville for the June 1975 flood. This flood had a peak discharge of 77,600 cfs at the Columbia Falls gage and a recurrence interval of approximately 25 years.

Model input for this calibration consists of discharge hydrographs as recorded at the Columbia Falls gage as the upstream boundary and a rating curve as the downstream boundary.

A rating curve was used at the downstream boundary to reflect the influence of Flathead Lake on the water-surface elevation in the downstream area. The rating curve is based on observed water-surface elevations at established profile points in the reach between Kalispell and Flathead Lake. Discharges corresponding to these water-surface elevations reflect peak flow at the Columbia Falls gage.

Roughness coefficients (Manning's "n"), conveyance, and storage were variables that served as a means of adjustment in calibrating the SOCHMJ model to 1975 flood conditions.

The model reproduced the June 1975 recorded flood data to within 1.0 foot, with as little as 0.1 foot difference at some locations. The calibrated model was used to model the June 1964 flood and compared to observed data from that event. This flood had a peak discharge of 176,000 cfs at the Columbia Falls gage, a discharge which exceeds the estimated 0.2-percent annual chance flood. For this event, the maximum stages computed by the model were within 3.5 feet of observed high water elevations. The model's ability to reconstitute this event was considered satisfactory because the 1964 event was of such a large magnitude.

For the Flathead River between Flathead Lake and Demersville, HEC-2 computer models were used to predict water-surface profiles for the 1928, 1933 and 1948 floods to within 2.4 feet, 0.5 feet, and 1.4 feet, respectively. Considering the change in channel cross section and location from 1928 to 1984 (most recent survey), the model's accuracy for predicting flood events is considered satisfactory.

Water-surface profiles for the 2-, 1-, and 0.2-percent annual chance floods for these reaches were computed from the SOCHMJ model at designated intervals called nodes. Water-surface elevations for the 10-percent annual chance flood were developed using the HEC-2 computer program and the same cross sections as input.

Stream cross sections were located by using topographic maps (References 26, 27, and 28) and aerial photographs (References 29 and 30). Most of the below-water cross section data were obtained by field observations or measurements. Cross section data for Whitefish River at Whitefish were supplemented with data previously accumulated by the SCS (Reference 23). A hydrographic survey was performed for the Flathead River between Flathead Lake and Demersville and the Swan River between Bigfork and the Lake County line by Simons, Li, & Associates, Inc., in October 1984. Overbank data were measured in the field on the following streams: Ashley Creek, Bear Creek, Lazy Creek, Swift Creek, Stillwater River near Olney, and West Spring Creek. Cross section data for Flathead River upstream of Columbia Falls were obtained from the USACE (Reference 13).

Photogrammetric techniques were used on all other streams in order to obtain topographic information for overbank areas. Hydraulic structures were measured in the field to determine elevations and geometry unless data summaries or plans were available.

In the Ashley Creek detailed study, eight hydraulic structures were included: under Cemetery Road two corrugated metal pipes (CMPs) with diameters of 7.6 ft. and 7.75 ft, a road bridge approximately 3,500 ft. upstream of Cemetery Road, a bridge at Airport Road, a 3-arch bridge system at Begg Park Drive, a road bridge approximately 3,750 ft upstream of Begg Park Drive, a bridge at Sunnyside Drive, an eliptical concrete pipe 14.8 ft. x 10.7 ft. at Foys Lake Road, and a bridge with two piers at the Burlington Northern Railroad crossing. Many of the footbridges along Ashley Creek were not considered in the model (Reference 31).

In the detailed study of Bear Creek, only one hydraulic structure, a highway bridge on U.S. Highway 2, was included.

Five bridges were included in the detailed study reach of Flathead River: The Somers-Bigfork Highway bridge, the three-span Conrad Drive bridge (near Kalispell), the U.S. Highway 2 bridge (near Kalispell), the three-span 4th Avenue bridge (Red Bridge) south of Columbia Falls, and the State Highway 40 bridge at Columbia Falls (a four-span structure).

Lazy Creek has two bridge structures within the detailed study reach, but only the downstream structure at Delrey Road is considered significant in the hydraulic model. The upstream bridge is an old and relatively small timber crossing, and is not expected to withstand heavy flooding.

There are no bridge structures on Middle Fork Flathead River at Nyack or near West Glacier which affect the study.

The following structures were included in the 8 mile study of Stillwater River near Kalispell: a steel truss bridge on Conrad Drive; twin bridges for the U.S. Highway 2 crossing; the Burlington Northern Railroad bridge, which has a steel superstructure and timber bents in the abutment areas; an old single span timber bridge at a point 6.36 miles upstream of the Stillwater River mouth; and the Whitefish Stage Road bridge.

Stillwater River near Olney has one hydraulic structure in the short detailed study reach. This hydraulic structure, at the lower Stillwater Lake outlet, is a timber dam which operates as an overflow weir. The dam and downstream plank chute were used in the past for a logging operation.

The Swan River has two bridge crossings within the county. The old steel bridge, which is located approximately 6,200 feet upstream of the Bigfork Dam, is just downstream of the detailed study reach and was not modeled. The other bridge crosses Highway 209 at the Flathead/Lake County line and is considered significant in the model.

For the 0.75 mile study reach along Swift Creek, only one bridge structure was included. This bridge is along Delrey Road which services the northern and northwestern sides of Whitefish Lake.

Structural modifications have been made at the bridge and in its immediate vicinity subsequent to the field measurements, but these changes are not significant enough to affect hydraulic modeling. There is another bridge structure along Swift Creek in the detailed study reach that was not included in the model. This bridge is near the gaging station and is in relatively poor shape. It is not expected to withstand medium to heavy flooding.

West Spring Creek has two structures within the detailed study reach and one structure at the downstream limit of the study. The structure at the downstream limit is a 60 inch reinforced concrete pipe with a concrete headwall and trash rack at the inlet. The two structures within the study area consist of a 54 inch corrugated steel pipe under U.S. Highway 2.

Six hydraulic structures were included in the two mile study of Whitefish River at Whitefish; the Columbia Avenue timber bridge, in the downstream reaches of the study; three 15 foot corrugated steel culverts at Spokane Avenue; a new single-span, reinforced-concrete bridge at Baker Avenue, a wooden footbridge with timber pilings; the Second Street bridge along U.S. Highway 93; and the Burlington Northern Railroad trestle near the upper end of the study area.

Stream cross sections were located using available topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (Reference 26) and aerial photographs at a scale of 1:12,000; (Reference 29). Most below-water cross section data were obtained by field observations and measurements made by the study contractor. Overbank data for the Whitefish River were primarily obtained using photogrammetric techniques. These cross section data were supplemented with data previously accumulated by the SCS.

Water-surface profiles on Whitefish River near Kalispell were developed using the USACE HEC-2 step-backwater computer model (Reference 32). To obtain starting water-surface elevations for the HEC-2 model, a rating section was developed approximately 1,200 feet downstream of the original study delineation. Rating section information was developed by a uniform flow analysis, but modified appropriately to reflect field observations and measurements. The field work consisted primarily of a temporary stream gaging program implemented by the U.S. Bureau of Reclamation and field reconnaissance work of the study contractor. The U.S. Bureau of Reclamation program was extensive enough to provide stage and water-surface profile information at specific flow levels and locations. Rating section geometry and hydraulics were adjusted until satisfactory concurrence was obtained between the study results and HEC-2 profiles in the downstream study reaches. Starting water-surface elevations for the 1-percent annual chance encroachment conditions were obtained by adding 0.5 foot to the elevations for the 1-percent annual chance natural flood condition.

There were six structures considered on Whitefish River near Kalispell: the timber bridge, approximately 600 feet upstream of the mouth; the Burlington Northern Railroad bridge, which has a steel truss superstructure and concrete pilings in the abutment areas; the West Evergreen Drive timber bridge; a county bridge on West Reserve Drive; a steel bridge at Rose Crossing; and a steel bridge at Birch Grove Road.

Roughness coefficients (Manning's "n") were estimated by field inspection and review of aerial photographs (References 29 and 30). Roughness value selection was made by using one or a combination of the following approaches depending on the stream segment in question: a detailed development and weighting technique which considers all factors affecting the value of "n", consultation of tables with typical "n" values for channels of various types (Reference 33), comparison and familiarity with certain channel hydraulics and associated roughness coefficients, and comparison with work previously completed by the USGS (Reference 34) and the USACE (Reference 10).

For Ashley Creek, the main channel roughness value is 0.04, and the overbank roughness value is 0.048. Corrugated steel pipes were assigned a value of 0.03 and concrete pipes were assigned a value of 0.025.

For Bear Creek, channel roughness values range from 0.042 to 0.045, and overbank values range from 0.028 to 0.100. The 0.028 relates specifically to road sections, and the extreme value of 0.100 corresponds to heavily forested areas with some underbrush.

The Flathead River from Columbia Falls to Demersville has roughness values ranging from 0.025 to 0.055 for the channel, and from 0.023 to 0.120 for the overbank areas. These values were obtained primarily from previous work performed by the USACE.

For the Flathead River between Flathead Lake and Demersville, the main channel roughness value is 0.03 and the overbank roughness ranges from 0.045 to 0.06.

For Lazy Creek, channel roughness values range from 0.033 to 0.036, and from 0.030 to 0.080 for overbank values.

Channel roughness values for Middle Fork Flathead River at Nyack range from 0.043 to 0.047. A minimum value for overbank of 0.020 relates to highway sections and a maximum value of 0.150 is associated with dense timber stands.

For Middle Fork Flathead River near West Glacier, channel values range from 0.038 to 0.045, and overbank values range from 0.035 for the golf course area to 0.090 for timbered areas.

Channel roughness values for Stillwater River near Kalispell range from 0.045 to 0.067. Some of the higher channel values were actually weighted values in order to reflect brush cover near bank points. Overbank values range from 0.032 to 0.150.

The Stillwater River study segment near Olney typically has channel values ranging from 0.032 to 0.055. A special channel value of 0.025 is used along the timber outlet chute from Lower Stillwater Lake. Roughness values for overbanks range from 0.030 to 0.090.

The Swan River from the old steel bridge to the Flathead/Lake County line has a main channel roughness value of 0.030 and overbank roughness values ranging from 0.045 to 0.070. The roughness values are reasonable given that the measured stage (7.34 feet) in the June 20, 1974, discharge of 8,890 cfs at Bigfork was within 0.3 feet of the simulated stage for the 1-percent annual chance discharge of 9,000 cfs.

For Swift Creek, channel roughness values range from 0.036 to 0.045, and overbank values range from 0.032 for pasture to 0.090 for timbered and heavy undergrowth areas.

Channel roughness values for West Spring Creek range from 0.038 to 0.055; 0.024 was selected for the corrugated pipe and 0.020 was selected for the old steel pipe. Overbank values range from 0.034 to 0.060. The 0.055 channel "n" value is applied at the downstream limit of the detailed study, where Meridian Road forms a major obstruction. At that point, the flow changes direction by 90 degrees, and other flow disturbances are caused by storm drain pipes feeding into the inlet.

The Whitefish River study segment near Whitefish has roughness values ranging from 0.024 to 0.045 in the channel and from 0.035 to 0.080 in the overbank areas. The value of 0.024 in the channel refers specifically to the corrugated steel culverts.

The Whitefish River study segment near Kalispell has roughness values ranging from 0.035 to 0.070 for the channel, and from 0.035 to 0.090 for the overbanks. Some of the higher channel "n" values are weighted in order to reflect heavy brush cover near the bank points.

Starting water-surface elevations for the Ashley Creek study were determined by water surface profiles of the Flathead River from the previous FIS. The Ashley Creek model extends downstream to its confluence with the Flathead River. However, Ashley Creek is only considered a detailed study from just downstream of Cemetery Road to just upstream of the Burlington Northern Railroad crossing.

Starting water-surface elevations for the Bear Creek study were obtained by performing a uniform flow analysis at the cross section farthest downstream. A stage-discharge table/curve was developed at this section to provide an estimated stage for a particular discharge and associated frequency. This method of taking the first cross section as a rating section was used because the downstream channel and overbank morphology were not conducive to developing and obtaining a good rating section.

The stage-frequency information provided in Table 4 for lake levels coincident with maximum river discharges were used as the downstream boundary condition for backwater profiles computed for the Flathead River between Flathead Lake and Demersville (Reference 35). The downstream boundary condition for the Flathead River reach between Demersville and Columbia Falls was established by developing a rating curve from the last cross section of the backwater profile computed in the reach between Flathead Lake and Demersville. This rating curve was developed during the initial approximate study of the Flathead River between Flathead Lake and Demersville.

Because the Lazy Creek drainage area is relatively small in comparison to the Whitefish Lake hydrologic system, it was considered reasonable to assume that there would not be exact concurrence of flood events between the lake and Lazy Creek (Reference 35). The event frequencies were staggered to obtain the most reasonable prediction of starting conditions for particular Lazy Creek flooding events. The following listing indicates the associated event frequencies and the starting water-surface elevations:

Lazy Creek Flood Frequency	Whitefish Lake Stage Frequency	Starting Elevation (Feet)
10-percent annual chance	50-percent annual chance	3,000.90
2-percent annual chance	10-percent annual chance	3,002.40
1-percent annual chance	2-percent annual chance	3,003.73
0.2-percent annual chance	1-percent annual chance	3,004.23

The stage-frequency data for Whitefish Lake were obtained from the SCS (Reference 23). Because the corresponding recurrence interval elevations on Whitefish Lake are higher than those on Lazy Creek, elevations on the lower two-thirds of the detailed study segment of Lazy Creek are controlled by elevations on Whitefish Lake.

Starting conditions for the hydraulic model of Middle Fork Flathead River at Nyack were developed by using a rating section at the farthest downstream cross section. This particular section was constructed by using the survey vertical control network, topographic maps (References 26 and 27), and ground level and aerial photographs (Reference 36). A uniform flow analysis was performed at the rating section to develop a stage-discharge relationship. Any deviations from uniform flow conditions during actual flood events were expected to be compensated for through the HEC-2 calculation process before proceeding into the detailed study segment. The hydraulic model was compared to the 1975 flood event, and concurrence was obtained for both the flood stage and boundaries.

A rating curve for Middle Fork Flathead River at West Glacier was developed at the gage site, which is approximately one mile downstream from the original detailed study delineation. A cross section was also estimated at this location by using topographic maps and aerial photographs (References 26, 27, and 29). The rating section stage-discharge data provided starting elevations for the appropriate flood events, including the 1975 model event. This model event was selected instead of the 1964 flood event because it was later and also falls within the range of flows being considered in this study. The 1964 event was not used because of its extreme nature and the degree of extrapolation that would be required on the rating curve. Concurrence was obtained between the hydraulic model and the 1975 event.

For Stillwater River near Olney, a uniform flow analysis was performed at an estimated cross section in order to develop stage-discharge information. This information provided the starting water-surface elevations for the appropriate study event. The cross section was developed by using aerial and ground level photographs and topographic maps.

The starting water-surface elevation for the Swan River is based on the rating curve at Bigfork Dam. Pacific Power and Light Company provided plans of the diversion structure from which the rating curve was developed. The starting water-surface elevations for flood with 10-, 2-, 1-, and 0.2-percent annual chance frequencies are shown below:

Swan River Flood Frequency	Swan River Starting Water-Surface
10-percent annual chance	3,015.3
2-percent annual chance	3,015.7
1-percent annual chance	3,015.8
0.2-percent annual chance	3,016.0

A cross section was estimated on Swift Creek near the entrance to Whitefish Lake. The starting water-surface elevations of this section for specific flood events were made concurrent with the lake stage-frequency data. This procedure was suggested by the SCS because Swift Creek is the main contributory drainage to Whitefish Lake, and historical data indicate a close coincidence of event frequencies (Reference 23).

The flood on June 1974 on Swift Creek was modeled and concurrence was observed between the gage reading and the HEC-2 results. Peak-stage measurement at the gage was 3013.63, and the HEC-2 model estimated the stage to be 3013.64 feet.

Because there are only minimal backwater effects from Whitefish Lake above Cross Section A during the 1-percent annual chance event, it was classified as a natural or free flowing condition.

Unusual circumstances exist at the downstream end of the detailed study reach on West Spring Creek. Historically, West Spring Creek flowed southeasterly following a natural course along the western edge of the Kalispell community. As the City of Kalispell expanded to the west, the natural course of the stream was altered in order to accommodate the development and to minimize flooding. At Meridian Road, West Spring Creek is redirected to the south through a 60-inch diameter reinforced concrete pipe. This pipe also is intended to carry storm runoff from other portions of western Kalispell. The pipe extends south for approximately 750 feet before connecting with storm runoff from other portions of West Kalispell. The east-west line varies in size from 57 inches to 60 inches in diameter and is believed to be a combination of corrugated steel and reinforced concrete material. It runs for approximately 700 feet before emptying into an open channel ditch which carries the flows past a lumber mill to Ashley Creek.

Analyzing the model starting conditions for West Spring Creek was unusual and complex. The flood hydrology and hydraulics of the complex storm pipe were analyzed independently of the HEC-2 computer program. The 10-, 2-, 1-, and 0.2-percent annual chance events were examined for the rural and urban watersheds in order to determine the flow conditions and stage at the downstream limit of the West Spring Creek study. Careful selection of contributing urban areas was required because of the little available topographic information in western Kalispell and because of the inadequate storm drain system in the area. Careful selection of event and peak concurrence between rural and urban flooding was also required.

The storm drain system in western Kalispell would be at or near the surcharged condition for the 10-percent annual chance event. It was determined that the stage at the structure inlet would be at the pipe crown of the 60 inch pipe. For the more severe events, calculations were made in order to determine the amount of head or surcharging required on the 60 inch reinforced concrete pipe for the estimated flows to pass. The head requirements eventually would become so great that Meridian Road would be overtopped; therefore, weir flow to the east was combined with pipe flow to the south until the stage was defined. This was used as the starting water-surface elevation for the HEC-2 model for that particular flood frequency event.

The 1-percent annual chance free flowing condition was defined as that condition which reflected minimal to no backwater effect from the pipe network and inlet structure. An elevation at the pipe crown for the 60 inch reinforced concrete pipe was selected for this condition.

A peculiarity occurred in the West Spring Creek study at the U.S. Highway 2 crossing. U.S. Highway 2 slopes downward to the east at this location, and there is a depression in the left overbank area of the West Spring Creek near an access road to a local shopping center. Flows can be released through the depression and travel easterly along U.S. Highway 2 before overtopping the highway perpendicularly (i.e., in the same direction as the 54 inch culvert flow line). Hence, an iterative procedure was required, using the HEC-2 model and hand calculations in order to determine headwater heights upstream of the 54 inch culvert and to proportion weir pressure pipe flows.

A possible study limitation for the Kalispell detailed study is the fact that a limited number of cross sections were field measured due to budgetary constraints for the Kalispell and Flathead County survey task. The spacing between field-measured cross sections does not appear excessive when analyzing map layouts, and when considering stream channel characteristics. However, while developing and executing the HEC-2 model, it was found necessary to occasionally interpolate a cross section to improve the modeling.

In conjunction with the field data limitations discussed above, there were also inadequate topographic information in west Kalispell to accurately define surface storm runoff patterns and West Spring Creek overflow flooding. Available plans, vertical control information, and topographic mapping were used in the routing analysis.

Another common study limitation is the fact that the Kalispell study streams do not have an impressive peak flow measurement program. The Ashley Creek data set included 20 measurements, which is quite marginal when trying to perform a statistical analysis and predict extreme events. This is especially true when one would like a more complete database to develop a better understanding of the upstream flood storage capabilities. West Spring Creek has no peak flow measurements to its credit. Its location and the nature of its basic supply source limit the value of hydrologic regionalization.

A specific limitation for the West Spring Creek study is the questionable nature of contributory urban watershed areas and storm drain system in West Kalispell. Both of these features have a significant effect on the regional hydrologic and hydraulic analyses.

As described earlier, the Stillwater River is a tributary to the Flathead River. Flows along the Flathead River have a significant effect on tributary flow conditions, and the Stillwater River is no exception. It is unreasonable to assume exact event concurrence for both streams; basically because of different sizes and locations of respective watersheds. This theory is substantiated by historical data. Hence, event frequencies were staggered to obtain the most reasonable prediction of starting conditions for the Stillwater River flood events. The following tabulation indicates the associated event frequencies and the starting water-surface elevation:

Stillwater River Flood Frequency	Flathead River Flood Frequency	Starting Elevation (Feet)
10-Percent Annual Chance	10-Percent Annual Chance	2,908.1
2-Percent Annual Chance	4-Percent Annual Chance	2,908.5
1-Percent Annual Chance	2-Percent Annual Chance	2,908.8
0.2-Percent Annual Chance	1-Percent Annual Chance	2,909.2

A uniform flow analysis was performed to develop a stage-discharge relationship. The friction slope in Manning's equation was assumed equal to the bedslope. The results of this stage-discharge analysis were used to define the 1-percent annual chance free-flowing condition. One-half foot was added to the uniform flow 1-percent annual chance stage for the encroachment exercise.

To obtain starting water-surface elevations for the HEC-2 model for Whitefish River at Whitefish, a rating section was developed approximately 1,200 feet downstream of the original detailed study limit. Rating section information was developed by a uniform flow analysis, but was modified to reflect field observations and measurements. The fieldwork consisted primarily of a temporary stream gaging program implemented by the U.S. Bureau of Reclamation (USBR) as well as by field reconnaissance. The USBR's program was extensive enough to provide stage and water-surface profile information at specific flow levels and locations. The rating section geometry and hydraulics were adjusted until satisfactory concurrence was obtained between the above study results and HEC-2 profiles in the downstream study stream segment.

Whitefish River joins Stillwater River near Kalispell. Because of the watershed similarity with respect to geography, meteorology, hydrology, and other factors, it was assumed that exact event concurrence would be realized. The 1-percent annual chance event on Whitefish River would be likely to occur simultaneously with the 1-percent annual chance event on Stillwater River and likewise for other designated frequencies.

In spring 1978, a water-surface profile measurement was made on Whitefish River. The flow at the time of measurement was referenced to bridge decks along the detailed study stream segment. Concurrence was obtained between the field measured information and a hydraulic model which used survey data exactly as field measured for this relatively low flow. For higher flows, adjustments were occasionally made in the channel and overbank areas for noneffective flow areas in order to improve stage and boundary predictions.

Streams studied by approximate methods received a cursory field investigation including hydraulic-structure geometry estimates and ground level photographic documentation. A brief hydraulic analysis was performed in the areas of interest. In order to develop typical cross sections and perform a stage-discharge analysis, field estimated channel geometry was supplemented by topographic information (References 26 and 27).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 2) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the finalization of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are being prepared using the NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD88. Elevation Reference Marks (ERMs) shown on the FIRM represent those used during the preparation of this and previous FIS reports. Users should be aware that these ERM elevations may have changed since the publication of this FIS report. To obtain up-to-date elevation information on National Geodetic Survey (NGS) ERMs shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov. Map users should seek verification of non-NGS ERM monument elevations when using these elevations for construction or floodplain management purposes. It is important to note that adjacent communities may be referenced to NGVD. This may result in differences in Base Flood Elevations (BFEs) across the corporate limits between communities.

For this revision, a vertical datum conversion was completed for each studied reach. The range of conversion factors was prohibitively high; therefore, a standard conversion factor was not applied for the entire community. The Profile Panel and FDT conversion from NGVD29 to NAVD88 was carried out in accordance to the procedure outlined in the FEMA document Map Modernization – Guidelines and Specifications for Flood Hazard Mapping Partners Appendix B: Guidance for Converting to the North American Vertical Datum of 1988.

Using the multiple conversion factor approach, an average conversion factor for each flooding source was developed by establishing separate conversion factors at the upstream end, at the downstream end and at an intermediate point of the studied reach. From this data, the average conversion factors for each reach were developed. In some cases, it was necessary to divide each reach into multiple sections in order for the maximum offset from the average conversion factor to be less than or equal to 0.25 feet.

For more information on NAVD88, see the FEMA publication entitled *Converting the National Flood Insurance Program to the North American Vertical Datum of 1988* (FEMA, June 1992), or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access this data.

Conversion factors for each studied reach are shown in Table 5.

Table 5 – Datum Conversion Factors

Stream/Reach	Minimum Conversion	Maximum Conversion	Average Conversion	Maximum Offset	Begin Station	End Station
Ashley Creek	3.7	3.7	3.7	0.014	Entire Reach	
Bear Creek	4.2	4.3	4.2	0.024	Entire Reach	
Flathead River	3.6	3.9	3.7	0.154	Entire Reach	
Lazy Creek	3.9	3.9	3.9	0.002	Entire Reach	
Middle Fork Flathead River at Nyack	3.9	3.9	3.9	0.025	Entire Reach	
Middle Fork Flathead River at West Glacier	3.8	3.8	3.8	0.014	Entire Reach	
Stillwater River near Kalispell	3.7	3.7	3.7	0.015	Entire Reach	
Stillwater River near Olney	4.0	4.0	4.0	0.027	Entire Reach	
Swan River	3.7	3.7	3.7	0.013	Entire Reach	
Swift Creek	3.9	3.9	3.9	0.000	Entire Reach	
West Spring Creek	3.7	3.7	3.7	0.002	Entire Reach	
Whitefish Lake	3.8	3.9	3.9	0.073	Entire Reach	
Whitefish River near Kalispell	3.7	3.8	3.8	0.031	Entire Reach	
Whitefish River at Whitefish	3.8	3.8	3.8	0.004	Entire Reach	

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent annual chance flood elevations and delineations of the 1- and 0.2-percent annual chance floodplain boundaries and 1-percent annual chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles and Floodway Data Tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. For Flathead County, between cross sections, boundaries were interpolated using topographic maps at a scale of 1:24,000, with contour intervals of 20 and 40 feet (References 26 and 27, respectively), and developed photogrammetrically, using aerial photographs at a scale of 1:12,000 (Reference 29).

Flood boundaries were delineated using topographic maps at a scale of 1:4,800, with a contour interval of two feet for the Flathead River between Flathead Lake and the unincorporated community of Demersville and the Swan River between the Steel Bridge and the county line (Reference 30).

For the Cities of Kalispell and Whitefish, between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, enlarged to a scale of 1:12,000, with a contour interval of 20 feet (Reference 26).

Shallow flooding boundaries on West Spring Creek, as discussed in Section 3.2, were also delineated using these topographic maps (Reference 26).

For Flathead River between Columbia Falls and the unincorporated community of Demersville, and for Stillwater and Whitefish Rivers downstream of the Burlington Northern Railroad, 1- and 0.2-percent annual chance flood boundaries were delineated using flood elevations determined at nodes from the SOCHMJ model (Reference 25). Boundaries were interpolated between nodes using topographic maps at a scale of 1:1,200, with a contour interval of 2 feet (Reference 28), and at a scale of 1:24,000, with a contour interval of 20 feet (Reference 26).

Flood boundaries determined by the study contractor for streams studied by approximate methods flowing through undeveloped areas were delineated using topographic maps

(References 26 and 27).

Approximate flood boundaries in some portions of the study area were taken from the Flood Hazard Boundary Maps (Reference 37).

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE); and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated at selected cross sections (Table 6). In cases where the floodway and 1-percent annual chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The floodways were computed by assuming that no ice jamming or severe debris accumulation at hydraulic structures or in meandering stream reaches would occur. Except as noted in the following, starting water-surface elevations for the floodway analysis were determined by adding 0.5 foot to the 1-percent annual chance starting water-surface elevation as discussed in Section 3.2.

For the Bear Creek floodway calculation, the equal-conveyance reduction calculation routing was considered appropriate even though there were imbalances in overbank flood areas for opposite sides of the stream. The encroachment routine was run with a starting allowance of 0.3 foot, with an upstream change of the target value to 0.5 foot in order to satisfy allowable increases in elevation throughout the study reaches to 0.5 foot.

Calculation of the floodway on the basis of equal-conveyance reduction from each side of the floodplain on Middle Fork Flathead River at both Nyack and West Glacier was considered appropriate even though there was an imbalance of flow in the overbank areas, such as at the golf course near West Glacier. It was required to change the target value on occasion from 0.5 foot to 0.3 or 0.4 foot in order to satisfy allowable increases in elevation throughout the study reaches to 0.5 foot.

SOCHMJ is a better model for predicting flood elevations for floodplains such as those along the Flathead River between Demersville and Columbia Falls. However, this model does not have the capacity to compute a floodway; therefore, the HEC-2 program was used for the floodway determination only. Cross sections in those reaches employing the SOCHMJ model may list different elevations in the "Regulatory" column of the Floodway Data Tables than those listed in the "Without Floodway" column.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1 below.

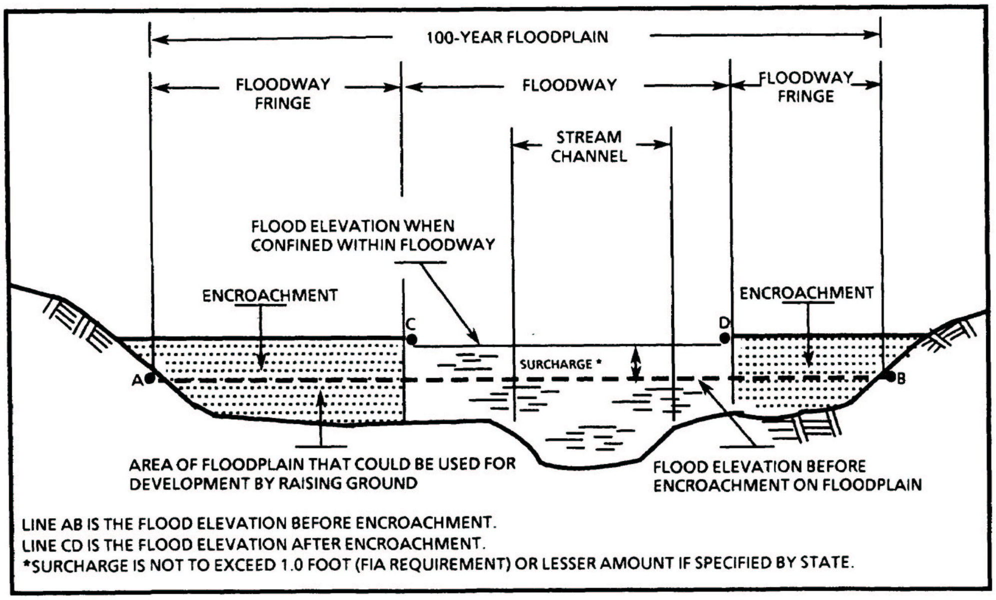

Figure 1 – Floodway Schematic

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
ASHLEY CREEK								
A	40	41	266	5.5	2,920.4	2,920.4	2,920.9	0.5
B	150	41	588	2.4	2,928.3	2,928.3	2,928.8	0.5
C	1,733	196	1,793	1.0	2,928.4	2,928.4	2,928.9	0.5
D	3,497	202	1,311	1.6	2,928.5	2,928.4	2,928.9	0.5
E	4,634	336	2,935	0.7	2,928.5	2,928.5	2,929.0	0.5
F	6,065	405	4,134	0.5	2,928.5	2,928.5	2,929.0	0.5
G	6,801	277	2,043	1.0	2,928.5	2,928.5	2,929.0	0.5
H	7,485	271	1,018	1.5	2,928.5	2,928.5	2,929.0	0.5
I	7,665	262	622	2.5	2,928.6	2,928.5	2,929.0	0.5
J	9,074	346	1,585	1.4	2,928.7	2,928.7	2,929.2	0.5
K	9,199	346	1,600	1.4	2,928.8	2,928.7	2,929.2	0.5
L	10,208	288	1,718	1.2	2,928.8	2,928.8	2,929.2	0.5
M	11,969	512	2,833	0.8	2,928.8	2,928.8	2,929.3	0.5
N	15,446	202	914	2.2	2,928.9	2,928.9	2,929.4	0.5
O	17,487	77	312	4.9	2,929.5	2,929.5	2,929.9	0.4
P	17,924	54	346	4.1	2,930.2	2,930.2	2,930.7	0.5
Q	18,088	139	724	2.5	2,930.7	2,930.7	2,931.0	0.4
R	22,218	169	646	3.2	2,931.7	2,931.7	2,932.2	0.4
S	25,018	433	1,365	1.8	2,932.3	2,932.3	2,932.8	0.5
T	26,948	56	327	4.4	2,932.9	2,932.9	2,933.3	0.4
U	27,996	15	99	14.5	2,936.2	2,936.2	2,936.2	0.0
V	28,076	15	155	9.2	2,940.6	2,940.6	2,940.6	0.0

[1]Feet Above Limit of Detailed Study

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

ASHLEY CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
ASHLEY CREEK (cont.)								
W	28,421	91	819	1.8	2,942.4	2,942.4	2,942.5	0.1
X	28,798	87	802	1.8	2,942.5	2,942.5	2,942.5	0.1

[1]Feet Above Limit of Detailed Study

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

ASHLEY CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BEAR CREEK								
A	28,400	245	472	4.2	4,327.6	4,327.6	4,327.9	0.3
B	31,025	516	547	3.6	4,344.1	4,344.1	4,344.3	0.2
C	33,000	80	275	7.2	4,359.2	4,359.2	4,359.7	0.5
D	34,220	318	400	5.0	4,370.3	4,370.3	4,370.3	0.0
E	34,680	80	237	8.4	4,374.6	4,374.6	4,374.8	0.2
F	35,380	218	650	3.1	4,378.3	4,378.3	4,378.6	0.3
G	37,120	300	343	5.8	4,395.1	4,395.1	4,395.1	0.0
H	38,650	116	361	5.5	4,410.6	4,410.6	4,410.6	0.0
I	38,920	85	233	8.5	4,414.7	4,414.7	4,414.7	0.0
J	39,200	83	216	9.2	4,419.3	4,419.3	4,419.3	0.0
K	39,320	68	205	9.7	4,421.1	4,421.1	4,421.1	0.0
L	39,340	72	293	6.8	4,421.8	4,421.8	4,422.3	0.5
M	39,450	67	200	9.9	4,424.3	4,424.3	4,424.3	0.0
N	39,940	198	495	4.0	4,429.1	4,429.1	4,429.5	0.4
O	41,240	150	284	7.0	4,448.9	4,448.9	4,449.4	0.5
P	43,200	168	334	6.0	4,475.3	4,475.3	4,475.3	0.0
Q	45,250	47	179	11.1	4,504.8	4,504.8	4,504.8	0.0
R	47,050	100	247	8.1	4,534.6	4,534.6	4,534.8	0.2
S	48,975	61	194	10.3	4,581.5	4,581.5	4,581.5	0.0

[1]Feet above confluence with Middle Fork Flathead River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

BEAR CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
FLATHEAD RIVER								
A	11,120	1,420	36,139	2.5	2,896.6	2,896.1[2]	2,896.6	0.5
B	11,735	1,290	31,859	2.8	2,896.6	2,896.1[2]	2,896.6	0.5
C	12,340	1,240	34,469	2.6	2,896.6	2,896.2[2]	2,896.7	0.5
D	12,985	1,095	29,534	3.0	2,896.6	2,896.2[2]	2,896.7	0.5
E	13,670	835	17,885	5.0	2,896.6	2,896.0[2]	2,896.5	0.5
F	14,370	766	16,681	5.3	2,896.6	2,896.1[2]	2,896.6	0.5
G	15,665	955	22,499	4.0	2,896.6	2,896.5[2]	2,897.0	0.5
H	16,270	900	18,216	4.9	2,896.6	2,896.5[2]	2,897.0	0.5
I	17,055	750	18,228	4.9	2,896.7	2,896.7	2,897.2	0.5
J	17,715	735	17,242	5.2	2,896.8	2,896.8	2,897.2	0.4
K	18,375	645	18,189	4.9	2,896.9	2,896.9	2,897.3	0.4
L	18,475	645	18,197	4.9	2,896.9	2,896.9	2,897.3	0.4
M	19,380	671	20,233	4.4	2,897.1	2,897.1	2,897.5	0.4
N	20,220	624	18,834	4.7	2,897.1	2,897.1	2,897.5	0.4
O	20,970	660	17,049	5.2	2,897.2	2,897.2	2,897.6	0.4
P	21,480	637	16,708	5.3	2,897.2	2,897.2	2,897.6	0.4
Q	22,880	1,216	33,555	2.7	2,897.3	2,897.3	2,897.7	0.4
R	26,550	1,399	18,244	4.9	2,897.8	2,897.8	2,898.2	0.4
S	27,355	1,698	19,468	4.6	2,897.9	2,897.9	2,898.3	0.4
T	28,185	2,173	24,699	3.6	2,898.2	2,898.2	2,898.6	0.4
U	29,185	1,424	20,306	4.4	2,898.3	2,898.3	2,898.7	0.4
V	30,060	1,240	22,518	4.0	2,898.5	2,898.5	2,898.9	0.4

[1]Feet above confluence with Flathead Lake, [2]Elevation computed without consideration of backwater effects from Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

FLATHEAD RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
FLATHEAD RIVER (cont.)								
W	32,670	1,445	27,700	3.2	2,898.9	2,898.9	2,899.3	0.4
X	34,970	1,370	25,727	3.5	2,899.1	2,899.1	2,899.5	0.4
Y	36,340	1,097	23,603	3.8	2,899.2	2,899.2	2,899.6	0.4
Z	37,785	1,110	24,022	3.7	2,899.4	2,899.4	2,899.8	0.4
AA	39,120	1,100	24,777	3.6	2,899.5	2,899.5	2,899.9	0.4
AB	40,595	1,203	33,702	2.6	2,899.7	2,899.7	2,900.1	0.4
AC	42,840	1,262	39,364	2.3	2,899.8	2,899.8	2,900.2	0.4
AD	44,110	769	20,515	4.3	2,899.7	2,899.7	2,900.1	0.4
AE	45,565	539	21,774	4.1	2,899.8	2,899.8	2,900.2	0.4
AF	46,970	599	20,724	4.3	2,899.9	2,899.9	2,900.3	0.4
AG	48,190	552	18,343	4.9	2,899.9	2,899.9	2,900.3	0.4
AH	49,175	730	21,699	4.1	2,900.2	2,900.2	2,900.6	0.4
AI	51,135	873	21,620	4.1	2,900.3	2,900.3	2,900.7	0.4
AJ	53,710	679	20,394	4.4	2,900.5	2,900.5	2,900.9	0.4
AK	56,640	650	25,120	3.5	2,900.8	2,900.8	2,901.2	0.4
AL	62,320	1,269	22,661	3.9	2,901.1	2,901.1	2,901.5	0.4
AM	68,815	1,901	25,308	3.5	2,901.6	2,901.6	2,902.0	0.4
AN	70,535	886	20,570	4.3	2,901.7	2,901.7	2,902.1	0.4
AO	75,190	610	19,190	4.6	2,902.1	2,902.1	2,902.5	0.4
AP	76,670	1,120	37,389	2.4	2,902.5	2,902.5	2,902.9	0.4
AQ	79,590	1,135	23,878	3.7	2,902.5	2,902.5	2,902.9	0.4
AR	80,355	1,056	21,430	4.2	2,902.5	2,902.5	2,902.9	0.4

[1]Feet above confluence with Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

FLATHEAD RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
FLATHEAD RIVER (cont.)								
AS	85,770	4,108	43,230	2.1	2,903.0	2,903.0	2,903.4	0.4
AT	91,285	1,469	24,275	3.7	2,903.2	2,903.2	2,903.6	0.4
AU	93,960	1,583	24,804	3.6	2,903.6	2,903.6	2,904.0	0.4
AV	97,558	2,817	31,735	2.8	2,904.0	2,904.0	2,904.4	0.4
AW	99,650	2,631	29,895	3.0	2,904.1	2,904.1	2,904.5	0.4
AX	105,515	4,103	30,593	2.9	2,904.9	2,904.9	2,905.3	0.4
AY	106,350	4,227	41,392	2.2	2,905.0	2,905.0	2,905.4	0.4
AZ	107,275	4,289	39,182	2.3	2,905.1	2,905.1	2,905.5	0.4
BA	107,950	3,779	36,748	2.4	2,905.1	2,905.1	2,905.5	0.4
BB	111,200	6,229	57,365	1.6	2,905.4	2,905.4	2,905.8	0.4
BC	115,950	6,297	54,736	1.6	2,905.9	2,905.9	2,906.3	0.4
BD	118,650	4,713	30,243	3.0	2,906.6	2,906.6	2,907.0	0.4
BE	121,650	5,258	25,934	3.5	2,909.1	2,909.1	2,909.5	0.4
BF	125,650	3,421	28,725	2.9	2,914.8	2,914.8	2,915.3	0.5
BG	126,750	1,600	15,147	5.6	2,916.0	2,916.0	2,916.5	0.5
BH	131,343	1,660	16,404	5.2	2,920.1	2,920.1	2,920.4	0.3
BI	133,740	690	10,312	8.2	2,922.0	2,922.0	2,922.9	0.9
BJ	134,260	850	12,129	7.0	2,923.1	2,923.1	2,923.8	0.7
BK	136,850	1,848	14,942	5.6	2,925.3	2,925.3	2,925.6	0.3
BL	138,550	2,130	18,720	4.5	2,927.2	2,927.2	2,927.6	0.4
BM	140,050	3,300	22,264	3.8	2,928.6	2,928.6	2,928.8	0.2
BN	143,350	4,044	21,301	3.9	2,932.0	2,932.0	2,932.0	0.0

[1]Feet above confluence with Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

FLATHEAD RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
FLATHEAD RIVER (cont.)								
BO	145,150	3,251	18,754	4.5	2,933.7	2,933.7	2,934.0	0.3
BP	147,050	2,925	15,369	5.4	2,935.5	2,935.5	2,935.8	0.3
BQ	148,550	3,657	20,632	4.0	2,937.2	2,937.2	2,937.6	0.4
BR	151,050	3,931	9,143	9.1	2,940.7	2,940.7	2,940.7	0.0
BS	153,950	3,194	12,346	6.8	2,945.1	2,945.1	2,945.1	0.0
BT	156,550	2,604	18,187	4.6	2,947.3	2,947.3	2,947.3	0.0
BU	158,650	2,002	7,356	11.4	2,949.5	2,949.5	2,949.5	0.0
BV	160,350	1,252	10,087	8.3	2,953.2	2,953.2	2,953.2	0.0
BW	162,150	971	7,894	10.6	2,956.3	2,956.3	2,956.3	0.0
BX	163,700	1,750	14,184	5.9	2,957.9	2,957.9	2,957.9	0.0
BY	165,550	1,850	7,621	11.0	2,960.2	2,960.2	2,960.2	0.0
BZ	167,300	1,608	12,297	6.8	2,962.7	2,962.7	2,962.7	0.0
CA	170,100	2,013	12,744	6.5	2,966.7	2,966.7	2,966.7	0.0
CB	172,400	1,280	12,883	6.5	2,969.8	2,969.8	2,970.3	0.5
CC	174,500	1,377	12,545	6.6	2,972.7	2,972.7	2,973.2	0.5
CD	178,000	2,506	20,757	4.0	2,977.6	2,977.6	2,978.1	0.5
CE	180,700	2,416	17,097	4.9	2,980.9	2,980.9	2,981.4	0.5
CF	183,600	2,775	19,317	4.4	2,984.0	2,984.0	2,984.3	0.3
CG	186,700	2,125	15,714	5.4	2,988.0	2,988.0	2,988.5	0.5
CH	191,400	730	9,788	8.6	2,993.7	2,993.7	2,994.2	0.5
CI	197,900	469	8,694	9.7	2,997.8	2,997.8	2,998.3	0.5
CJ	200,070	1,181	12,310	7.7	3,004.1	3,004.1	3,004.3	0.2

[1]Feet above confluence with Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

FLATHEAD RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
FLATHEAD RIVER (cont.)								
CK	201,680	640	12,478	7.6	3,004.9	3,004.9	3,005.1	0.2
CL	202,080	441	8,232	11.5	3,004.9	3,004.9	3,005.1	0.2
CM	202,220	442	8,475	11.2	3,005.0	3,005.0	3,005.5	0.5
CN	203,140	850	14,729	6.4	3,007.8	3,007.8	3,008.1	0.3
CO	205,180	1,578	14,221	6.7	3,009.3	3,009.3	3,009.5	0.2
CP	207,020	1,065	12,117	7.8	3,012.5	3,012.5	3,012.7	0.2
CQ	209,530	778	11,041	8.6	3,015.8	3,015.8	3,015.9	0.1
CR	215,290	1,048	11,007	8.6	3,022.1	3,022.1	3,022.1	0.0
CS	220,070	794	9,683	9.8	3,028.9	3,028.9	3,029.1	0.2
CT	222,580	689	11,167	8.5	3,032.3	3,032.3	3,032.3	0.0
CU	226,150	426	9,852	9.6	3,035.4	3,035.4	3,035.4	0.0

[1]Feet above confluence with Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

FLATHEAD RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
LAZY CREEK								
A	690	760	2,021	0.4	3,004.2	3,000.9[2]	3,001.4	0.5
B	820	27	164	4.3	3,004.2	3,000.9[2]	3,001.4	0.5
C	850	27	179	4.0	3,004.2	3,001.3[2]	3,001.8	0.5
D	900	169	713	1.0	3,004.2	3,001.7[2]	3,002.2	0.5
E	1,950	53	174	4.1	3,004.2	3,002.0[2]	3,002.4	0.4
F	3,660	34	127	5.6	3,005.9	3,005.9	3,006.3	0.4

[1]Feet above confluence with Whitefish Lake, [2]Elevations computed without consideration of backwater effects from Whitefish Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

LAZY CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
MIDDLE FORK FLATHEAD RIVER AT NYACK								
A	0	613	6,666	8.5	3,287.9	3,287.9	3,288.4	0.5
B	1,700	1,624	9,784	5.8	3,295.1	3,295.1	3,295.6	0.5
C	3,950	2,772	15,546	3.7	3,299.3	3,299.3	3,299.8	0.5
D	5,840	2,901	10,882	5.2	3,302.1	3,302.1	3,302.6	0.5
E	6,830	3,187	13,163	4.3	3,304.1	3,304.1	3,304.6	0.5
F	9,950	2,956	9,074	6.3	3,312.7	3,312.7	3,313.2	0.5
G	14,750	3,706	14,083	4.0	3,325.9	3,325.9	3,326.3	0.4
H	18,260	3,255	9,908	5.7	3,332.3	3,332.3	3,332.8	0.5
I	21,780	4,041	15,206	3.7	3,343.5	3,343.5	3,343.6	0.1
J	24,760	4,002	18,008	3.2	3,352.0	3,352.0	3,352.1	0.1
K	28,500	1,329	9,409	6.0	3,362.6	3,362.6	3,362.9	0.3

[1]Feet above downstream study limit

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

MIDDLE FORK FLATHEAD RIVER AT NYACK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
MIDDLE FORK FLATHEAD RIVER AT WEST GLACIER								
A	19,000	645	11,735	5.7	3,152.7	3,152.7	3,153.2	0.5
B	22,180	839	12,101	5.6	3,155.1	3,155.1	3,155.6	0.5
C	25,130	1,118	7,147	8.4	3,158.2	3,158.2	3,158.7	0.5
D	26,560	531	5,325	11.2	3,163.7	3,163.7	3,164.0	0.3
E	27,760	671	6,922	8.6	3,168.3	3,168.3	3,168.5	0.2
F	29,180	864	9,048	6.6	3,171.8	3,171.8	3,172.1	0.3

[1]Feet above confluence with North Fork Flathead River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

MIDDLE FORK FLATHEAD RIVER AT WEST GLACIER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
STILLWATER RIVER NEAR KALISPELL								
A	20,250	257	2,527	2.1	2,909.2	2,909.2	2,909.6	0.4
B	25,050	474	1,685	3.0	2,911.4	2,911.4	2,911.7	0.3
C	25,550	154	1,040	4.3	2,911.4	2,911.4	2,911.8	0.4
D	26,650	155	621	2.6	2,911.6	2,911.6	2,911.8	0.2
E	27,620	373	1,134	1.4	2,913.0	2,913.0	2,913.2	0.2
F	28,350	408	2,692	2.3	2,916.2	2,916.2	2,916.7	0.5
G	29,510	102	823	7.5	2,918.2	2,918.2	2,918.6	0.4
H	31,060	262	1,408	4.4	2,924.5	2,924.5	2,924.7	0.2
I	33,630	107	786	7.9	2,932.1	2,932.1	2,932.6	0.5
J	33,740	79	749	8.3	2,932.7	2,932.7	2,933.2	0.5
K	33,820	240	2,282	2.7	2,934.3	2,934.3	2,934.6	0.3
L	35,050	156	683	9.1	2,935.6	2,935.6	2,935.8	0.2
M	35,100	87	600	10.3	2,936.2	2,936.2	2,936.5	0.3
N	35,150	90	657	9.4	2,937.0	2,937.0	2,937.2	0.2
O	35,220	382	1,946	3.2	2,938.8	2,938.8	2,938.9	0.1
P	35,700	1,291	2,026	3.1	2,940.0	2,940.0	2,940.1	0.1
Q	36,100	1,200	3,215	1.9	2,941.1	2,941.1	2,941.5	0.4
R	36,320	322	1,273	4.9	2,941.4	2,941.4	2,941.9	0.5
S	36,730	355	1,282	4.8	2,943.7	2,943.7	2,944.2	0.5
T	37,880	612	2,595	2.4	2,946.5	2,946.5	2,947.0	0.5

[1]Feet above confluence with Flathead River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

STILLWATER RIVER NEAR KALISPELL

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
STILLWATER RIVER NEAR KALISPELL (cont.)								
U	39,000	318	1,445	4.3	2,948.5	2,948.5	2,949.0	0.5
V	41,330	1,447	4,378	1.4	2,952.3	2,952.3	2,952.5	0.2
W	43,080	777	2,287	2.7	2,953.9	2,953.9	2,954.1	0.2
X	44,600	742	2,724	2.3	2,956.1	2,956.1	2,956.6	0.5
Y	46,880	134	1,153	5.4	2,961.4	2,961.4	2,961.8	0.4

[1]Feet above confluence with Flathead River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

STILLWATER RIVER NEAR KALISPELL

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
STILLWATER RIVER NEAR OLNEY								
A	185,700	70	473	6.5	3,036.8	3,036.8	3,037.3	0.5
B	186,170	79	630	4.9	3,037.9	3,037.9	3,038.3	0.4
C	187,130	430	3,073	1.0	3,038.6	3,038.6	3,038.9	0.3
D	188,180	93	631	4.9	3,038.6	3,038.6	3,038.9	0.3
E	189,610	120	958	3.2	3,039.9	3,039.9	3,040.3	0.4
F	190,050	160	1,448	2.1	3,040.2	3,040.2	3,040.6	0.4
G	190,080	80	633	4.9	3,040.2	3,040.2	3,040.6	0.4
H	190,100	89	457	6.8	3,040.7	3,040.7	3,041.1	0.4

[1]Feet above confluence with Flathead River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

STILLWATER RIVER NEAR OLNEY

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SWAN RIVER								
A	15,065	285	2,432	3.7	3,015.8	3,015.8	3,016.3	0.5
B	15,580	360	3,173	2.8	3,016.0	3,016.0	3,016.5	0.5
C	16,175	335	3,033	3.0	3,016.2	3,016.2	3,016.7	0.5
D	16,755	335	3,157	2.9	3,016.3	3,016.3	3,016.7	0.4
E	17,365	315	3,034	3.0	3,016.4	3,016.4	3,016.8	0.4
F	17,965	300	2,923	3.1	3,016.5	3,016.5	3,016.9	0.4
G	18,555	435	3,976	2.3	3,016.7	3,016.7	3,017.1	0.4
H	19,135	575	6,067	1.5	3,016.8	3,016.8	3,017.2	0.4
I	19,720	275	2,835	3.2	3,016.8	3,016.8	3,017.2	0.4
J	21,035	310	3,423	2.6	3,017.0	3,017.0	3,017.4	0.4
K	21,640	375	4,145	2.2	3,017.1	3,017.1	3,017.5	0.4
L	22,180	395	4,414	2.0	3,017.2	3,017.2	3,017.6	0.4
M	24,060	335	4,092	2.2	3,017.3	3,017.3	3,017.7	0.4
N	27,585	235	3,182	2.8	3,017.6	3,017.6	3,017.9	0.3
O	28,190	200	2,149	4.2	3,017.6	3,017.6	3,017.9	0.3
P	28,815	370	3,307	2.7	3,017.9	3,017.9	3,018.3	0.4
Q	29,415	430	3,490	2.6	3,018.0	3,018.0	3,018.4	0.4
R	30,005	318	2,927	3.1	3,018.1	3,018.1	3,018.4	0.3
S	30,605	355	3,642	2.5	3,018.3	3,018.3	3,018.7	0.4
T	31,240	340	3,388	2.7	3,018.3	3,018.3	3,018.7	0.4
U	31,835	504	4,472	2.0	3,018.4	3,018.4	3,018.8	0.4
V	32,305	475	3,529	2.6	3,018.4	3,018.4	3,018.8	0.4

[1]Feet above confluence with Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

SWAN RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SWAN RIVER (cont.)								
W	32,955	250	2,921	3.1	3,018.5	3,018.5	3,018.9	0.4
X	33,515	385	3,362	2.7	3,018.6	3,018.6	3,019.0	0.4
Y	34,165	437	3,708	2.4	3,018.7	3,018.7	3,019.1	0.4
Z	34,585	360	3,810	2.4	3,018.8	3,018.8	3,019.2	0.4
AA	35,155	695	5,772	1.6	3,018.9	3,018.9	3,019.3	0.4
AB	35,750	724	6,250	1.4	3,018.9	3,018.9	3,019.3	0.4
AC	36,360	732	5,679	1.6	3,019.0	3,019.0	3,019.4	0.4
AD	37,070	810	6,081	1.5	3,019.0	3,019.0	3,019.4	0.4
AE	37,710	979	6,214	1.4	3,019.1	3,019.1	3,019.5	0.4
AF	38,755	1,371	8,500	1.1	3,019.2	3,019.2	3,019.6	0.4
AG	42,330	1,813	8,962	1.0	3,019.4	3,019.4	3,019.8	0.4
AH	42,860	1,660	6,706	1.3	3,019.4	3,019.4	3,019.8	0.4
AI	43,630	2,000	9,608	0.9	3,019.5	3,019.5	3,019.9	0.4
AJ	46,540	1,870	6,642	1.4	3,019.6	3,019.6	3,020.0	0.4
AK	50,395	615	3,003	3.0	3,020.3	3,020.3	3,020.7	0.4
AL	52,300	750	3,659	2.5	3,021.1	3,021.1	3,021.5	0.4
AM	54,765	967	4,046	2.2	3,021.9	3,021.9	3,022.1	0.2
AN	55,385	635	2,497	3.6	3,022.2	3,022.2	3,022.4	0.2
AO	55,945	270	1,387	6.5	3,022.7	3,022.7	3,022.8	0.1
AP	56,560	270	1,422	6.3	3,023.8	3,023.8	3,024.0	0.2
AQ	57,075	195	1,042	8.6	3,024.7	3,024.7	3,024.8	0.1
AR	57,680	260	1,513	5.9	3,026.3	3,026.3	3,026.7	0.4

[1]Feet above confluence with Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

SWAN RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SWAN RIVER (cont.)								
AS	58,260	240	1,390	6.5	3,027.3	3,027.3	3,027.6	0.3
AT	58,990	225	1,327	6.8	3,028.7	3,028.7	3,028.8	0.1
AU	59,345	230	1,422	6.3	3,029.4	3,029.4	3,029.5	0.1
AV	60,315	240	1,447	6.2	3,030.7	3,030.7	3,031.0	0.3
AW	60,930	250	1,433	6.3	3,031.7	3,031.7	3,032.0	0.3
AX	61,500	275	1,602	5.6	3,032.6	3,032.6	3,032.9	0.3
AY	62,085	185	1,014	8.9	3,033.3	3,033.3	3,033.5	0.2
AZ	62,675	203	1,335	6.7	3,035.1	3,035.1	3,035.4	0.3
BA	63,890	258	1,883	4.8	3,037.2	3,037.2	3,037.4	0.2
BB	64,365	172	1,356	6.6	3,037.4	3,037.4	3,037.5	0.1

[1]Feet above confluence with Flathead Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

SWAN RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SWIFT CREEK								
A	400	200	760	2.8	3,004.2	3,004.2	3,004.7	0.5
B	1,140	210	315	6.7	3,008.2	3,008.2	3,008.2	0.0
C	2,090	254	711	3.0	3,012.0	3,012.0	3,012.5	0.5
D	3,350	84	226	9.3	3,018.8	3,018.8	3,018.8	0.0
E	3,460	50	309	6.8	3,020.3	3,020.3	3,020.3	0.0
F	3,490	50	315	6.7	3,021.1	3,021.1	3,021.1	0.0
G	3,540	75	482	4.4	3,021.6	3,021.6	3,021.6	0.0
H	3,640	103	645	3.3	3,021.8	3,021.8	3,021.8	0.0
I	4,180	183	1,012	2.1	3,022.0	3,022.0	3,022.0	0.0
J	4,700	173	605	3.5	3,022.1	3,022.1	3,022.1	0.0

[1]Feet above confluence with Whitefish Lake

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

SWIFT CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WEST SPRING CREEK								
A	0	62	150	1.3	2,957.7	2,957.7	2,957.7	0.0
B	602	77	171	1.1	2,957.7	2,957.7	2,957.7	0.0
C	883	77	207	0.9	2,957.9	2,957.9	2,957.9	0.0
D	1,763	352	1,694	0.2	2,965.5	2,965.5	2,966.0	0.5
E	2,813	122	389	0.7	2,965.5	2,965.5	2,966.0	0.5
F	3,913	45	44	6.0	2,966.7	2,966.7	2,966.8	0.1

[1]Feet above Upstream End of Reinforced Concrete Pipe Near Meridian Road

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

WEST SPRING CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WHITEFISH RIVER AT WHITEFISH								
A	102,000	165	1,225	1.5	3,000.9	3,000.9	3,001.4	0.5
B	103,200	223	1,285	1.4	3,001.1	3,001.1	3,001.6	0.5
C	103,689	145	1,169	1.6	3,001.2	3,001.2	3,001.7	0.5
D	104,050	127	845	2.2	3,001.3	3,001.3	3,001.8	0.5
E	104,287	66	329	5.6	3,001.3	3,001.3	3,001.8	0.5
F	104,562	67	332	5.5	3,001.8	3,001.8	3,002.3	0.5
G	105,224	142	1,320	1.4	3,002.9	3,002.9	3,003.0	0.1
H	105,874	397	2,167	0.8	3,003.0	3,003.0	3,003.1	0.1
I	106,124	135	1,416	1.3	3,003.0	3,003.0	3,003.1	0.1
J	106,555	89	611	3.0	3,003.0	3,003.0	3,003.1	0.1
K	106,592	89	613	3.0	3,003.0	3,003.0	3,003.1	0.1
L	106,998	230	1,718	1.1	3,003.2	3,003.2	3,003.3	0.1
M	107,348	88	782	2.3	3,003.3	3,003.3	3,003.4	0.1
N	107,364	89	816	2.2	3,003.3	3,003.3	3,003.8	0.5
O	108,114	281	2,008	0.9	3,003.5	3,003.5	3,004.0	0.5
P	108,564	302	1,633	1.1	3,003.5	3,003.5	3,004.0	0.5
Q	108,882	150	1,475	1.2	3,003.5	3,003.5	3,004.0	0.5
R	108,926	146	1,452	1.3	3,003.5	3,003.5	3,004.0	0.5
S	109,944	160	1,435	1.3	3,003.6	3,003.6	3,004.1	0.5
T	110,944	140	1,339	1.4	3,003.7	3,003.7	3,004.2	0.5

[1]Feet above confluence with Stillwater River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

WHITEFISH RIVER AT WHITEFISH

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WHITEFISH RIVER AT WHITEFISH (cont.)								
U	111,431	196	1,523	1.2	3,003.8	3,003.8	3,004.3	0.5
V	111,457	196	1,532	1.2	3,003.8	3,003.8	3,004.3	0.5
W	111,636	166	1,559	1.2	3,003.8	3,003.8	3,004.3	0.5
X	112,444	207	1,759	1.0	3,003.9	3,003.9	3,004.4	0.5
Y	112,519	333	1,740	1.1	3,003.9	3,003.9	3,004.4	0.5

[1]Feet above confluence with Stillwater River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

WHITEFISH RIVER AT WHITEFISH

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WHITEFISH RIVER NEAR KALISPELL								
A	150	373	1,134	1.4	2,912.6	2,913.9[2]	2,914.1	0.2
B	800	55	455	3.5	2,913.3	2,914.2[2]	2,914.4	0.2
C	1,450	130	608	2.6	2,914.0	2,915.1[2]	2,915.3	0.2
D	3,350	155	778	2.1	2,915.6	2,916.4[2]	2,916.5	0.1
E	5,730	234	1,027	1.8	2,917.1	2,916.4[2]	2,916.7	0.3
F	8,030	76	587	3.1	2,917.7	2,917.3[2]	2,917.7	0.4
G	8,080	76	587	3.1	2,917.9	2,917.3[2]	2,917.7	0.4
H	9,300	114	663	2.8	2,918.5	2,918.2[2]	2,918.5	0.3
I	12,460	118	955	1.9	2,919.4	2,919.2[2]	2,919.5	0.3
J	14,200	85	646	2.8	2,919.7	2,919.6[2]	2,919.9	0.3
K	14,250	87	676	2.7	2,919.8	2,919.7[2]	2,920.2	0.5
L	17,000	70/860[3]	3,477	0.5	2,920.2	2,920.1[2]	2,920.6	0.5
M	19,280	255	1,206	1.5	2,920.4	2,920.3[2]	2,920.8	0.5
N	23,350	50	260	6.2	2,922.4	2,922.4	2,922.8	0.4
O	26,540	91	506	3.2	2,925.4	2,925.4	2,925.8	0.4
P	27,050	77	277	6.6	2,926.2	2,926.2	2,926.6	0.4
Q	27,080	79	298	6.1	2,926.5	2,926.5	2,926.9	0.4
R	28,250	255	767	2.4	2,929.9	2,929.9	2,929.9	0.0
S	32,890	259	580	3.2	2,937.6	2,937.6	2,937.6	0.0
T	36,190	360	829	2.2	2,942.8	2,942.8	2,943.2	0.4

[1]Feet above confluence with Stillwater River, [2]Elevation computed without consideration of backwater effects from Stillwater River, [3]Left channel/right channel

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

WHITEFISH RIVER NEAR KALISPELL

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WHITEFISH RIVER NEAR KALISPEL (cont.)								
U	38,640	184	502	3.6	2,947.2	2,947.2	2,947.7	0.5
V	42,000	237	845	2.2	2,950.7	2,950.7	2,951.2	0.5
W	43,070	76	471	3.9	2,951.3	2,951.3	2,951.8	0.5
X	43,100	76	474	3.9	2,951.3	2,951.3	2,951.8	0.5
Y	43,760	99	421	4.3	2,952.2	2,952.2	2,952.5	0.3

[1]Feet above confluence with Stillwater River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

WHITEFISH RIVER NEAR KALISPELL

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance risk zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or base flood depths are shown within this zone.

Zone AE

Zone AE is the flood insurance risk zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance risk zone that corresponds to the areas of 1-percent annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot base flood depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance risk zone that corresponds to areas outside the 0.2-percent annual chance floodplain, areas within the 0.2-percent annual chance floodplain, areas of 1-percent annual chance flooding where average depths are less than 1 foot, areas of 1-percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or base flood depths are shown within this zone.

Zone D

Zone D is the flood insurance risk zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance risk zones as described in Section 5.0 and, in the 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent annual chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The current FIRM presents flooding information for the entire geographic area of Flathead County. Previously, separate FIRMs were prepared for each identified flood prone incorporated community and for the unincorporated areas of the County. Historical data relating to the maps prepared for each community are presented in Table 7.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Columbia Falls, City of	February 8, 1974	April 23, 1976	October 15, 1985	
Flathead County (Unincorporated Areas)	September 13, 1974	June 28, 1977 March 19, 1976	September 5, 1984	September 28, 1990 September 30, 1992 October 16, 1996 July 15, 1988
Kalispell, City of	February 15, 1974	May 21, 1976	September 17, 1980	September 30, 1992
Whitefish, City of	May 31, 1974	January 9, 1976	July 16, 1979	

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLATHEAD COUNTY, MT AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

The revised hydraulic analysis along Ashley Creek was performed by Pacific International Engineering in February, 2004. It was updated by Pacific International Engineering in June, 2006, and then again by Michael Baker Jr., Inc. in August, 2006.

The revised hydraulic analysis was based on the same discharge values used for Ashley Creek in the previous FIS. The USACE HEC-RAS computer program was used to perform the revised hydraulic analysis. Flood profiles were revised for Ashley Creek. This new study starts just downstream of Cemetery Road and ends just upstream of the Burlington Northern Railroad crossing, a reach of 28,800 ft. As a result, the 1- and 0.2-percent-annual-chance floodplain and floodway boundaries were revised.

A previous study along Ashley Creek (superseded by the above study) was performed by Billmayer Engineering on September 30, 1992. This revised analysis incorporated the effects of updated topographic information, channel improvements, and the addition and replacement of stream hydraulic structures.

This study was based on the same discharge values used for Ashley Creek in the FIS for the unincorporated areas of Flathead County, Montana, dated September 28, 1990. The USACE HEC-2 step-backwater computer program was used to perform the revised hydraulic analysis. Flood profiles were revised for Ashley Creek from a point approximately 6,000 feet downstream of Airport Road to Foys Lake Road, a reach of approximately 28,000 feet. As a result, the 1- and 0.2-percent annual chance floodplain and 1-percent annual chance floodway boundaries were also revised. Topographic maps entitled "Ashley Creek Flood Study," Panels 1 through 4 of 4, with a scale of 1:1,200 and a contour interval of 2 feet, produced by B.E., dated May 10, 1991, and revised September 12, 1991 (Reference 38), were utilized to determine the revised 1-percent annual chance floodplain and floodway boundaries. A topographic map, entitled "Ashley Creek Flood Study, 500-year Delineation," with a scale of 1:6,000 and a contour interval of 20 feet, also produced by B.E., dated January 29, 1991 (Reference 39), was utilized to determine the revised 0.2-percent annual chance floodplain boundaries.

In Floods of June 1964 in Northwestern Montana (Reference 10), it was estimated that the 1964 floodflow was 8,380 cfs on Bear Creek and that the flow was 8.67 times as large as the 2-percent annual chance flood. This estimate of the 2-percent annual chance discharge was apparently based on streamflow records from 1946 to 1952, where the maximum discharge was 696 cfs. The 1964 and 1975 floods had estimated discharges of 8,380 and 1,840 cfs, respectively. Additional data were incorporated in the estimation of recurrence intervals for this study.

Flathead River has been studied previously by the USACE, Seattle District. The results of their investigation are presented in the 1969 Floodplain Information Report (Reference 13). A detailed hydrologic and hydraulic analysis of Flathead River was performed from near Columbia Falls to Flathead Lake.

The hydrologic investigation in this study considered regulated and unregulated conditions along Flathead River. Discharge estimates for the recurrence intervals of interest are considered to be too low because the 1894, 1923, 1928, and 1964 floods were not included in the database. For example, the 1-percent annual chance discharge was estimated to be 79,000 cfs (later increased by the USACE to 82,000). However, four times in the last 82 years, flows have approximately equaled or exceeded 70,000 cfs. Three times in 82 years, flows have approximately equaled or exceeded the original USACE 1-percent annual chance flood estimate of 79,000 cfs. Floods of 95,000 cfs have been equaled or exceeded twice in the same period.

This FIS uses flood data and photographs unavailable at the time of the USACE report and uses different starting water-surface elevations.

A private consulting firm worked with the Montana Floodplain Management Bureau in the early to middle 1970's and modified the 1-percent annual chance flood boundary for Flathead River. The scope of this work was not as broad as the USACE report and the methodology employed was approximate. The community officials and citizens found this new boundary delineation to be more favorable; therefore, they adopted it as part of their floodplain zoning and regulation program.

The Flathead River study was revised on September 28, 1990, to show modifications to the 1-percent annual chance floodway along the Flathead River between cross sections CW and CZ as shown on Panel 1820 of the Flood Boundary Floodway Map for the unincorporated areas of Flathead County, dated July 15, 1988. This revision is based on the removal of high ground within the existing floodway between cross sections CW and CZ as the result of a revised HEC-2 hydraulic analysis, modified and submitted by the Floodplain Management Section of the Montana Department of Natural Resources and Conservation. The HEC-2 model, originally developed by Simons, Li and Associates (SLA), was modified by adding a cross section between cross sections CW and CZ and by assigning the floodway limits on the right overbank at the riverward limits of the high ground. This resulted in little change to the 1-percent annual chance base flood elevations but reduced the width of the floodway. The topographic information for the overbank area in the vicinity of the extra cross section was derived from a topographic workmap, scale 1"= 40', taken from the original workmap for a previous restudy in Flathead County, Montana, dated June 1985 and prepared by SLA.

Although this revision resulted in a slight increase in base flood elevations, due to the profile scale limitations, the profile panels were not changed. The Floodway Data Table for the Flathead River was, however, revised.

The Flathead River study was revised on October 16, 1996, by Billmayer Engineering to show modifications to the 1- and 0.2-percent annual chance floodplain boundaries, the floodway, and the BFEs along the Flathead River between cross sections CF and F as shown on Panels 1810D, 1820F, 1830E, 1840E, 1845E, and 2280E of the FIRMs for the unincorporated areas of Flathead County, dated September 30, 1992. The revised analysis incorporated the effects of corrected topographic information between sections BU and CX along the Flathead River.

The revised hydraulic analysis was based on the same discharge values used for the Flathead River in the FIS for the unincorporated areas of Flathead County, Montana, dated September

30, 1992. The HEC-2 model, originally developed by SLA in June 1985, was modified to incorporate corrected topographic information. Flood profiles were revised for the Flathead River from a point 45,565 feet above the mouth to a point 125,650 feet above the mouth. Topographic information for the overbank areas in the vicinity of the cross sections was derived from a topographic workmap, scale 1"= 40', taken from the original workmap for a previous restudy in Flathead County, Montana, dated June 1985 and prepared by SLA.

This revision resulted in a decrease in the BFEs, and these changes were reflected in the Floodway Data Table and Flood Profiles for Flathead River.

The USGS published some frequency-discharge values for Middle Fork Flathead River in 1976 (Reference 20), but their report consisted exclusively of records from Gage No. 12358500 (record period 1939 to 1973). Those results required adjustments for later streamflow data from the 1975 flood event.

Two hydrologic studies have been published on Stillwater River, the 1969 Floodplain Information Report (Reference 13) and the 1976 USGS Report (Reference 20). The hydrology in both studies related specifically to the gaging station near Whitefish (Gage No. 12365000). The USACE used the period of record from 1929 to 1950 and did a correlation analysis with Swan River near Bigfork in order to obtain an extended period of 29.6 years. The USGS apparently used the record period 1931 to 1950. More recent streamflow data are now available and have been used in this study. This study has also incorporated several peak-discharge measurements not included in the previous investigations.

The USACE investigation used different starting water-surface elevations for their hydraulic analysis and did not assume nonconcurrency of flood events between Stillwater River and Flathead River. Hydraulic structures along Stillwater River have also been replaced since the previous investigation.

A number of local engineering consulting firms have studied West Spring Creek hydraulics. One investigation examined the possibility of rerouting West Spring Creek in order to accommodate further urbanization. Other work was done concerning regional and site specific urban storm drain design.

The USGS performed a log-Pearson Type III hydrologic analysis of Whitefish River by using the data at the Whitefish River gage (eight miles upstream of Kalispell) and published the results in 1976 (Reference 20). However, because more measurements have been taken since their report, the previously published results are considered to be of limited value.

The USBR established a temporary stream gaging program along Whitefish River. The program consisted of a series of gages strategically located so as to provide specific and meaningful data. Some of these data were incorporated in this study in order to provide target values and profiles in establishing the hydraulic model.

The SCS has performed extensive hydrologic studies on the Whitefish River watershed and combined this with flood routing and backwater profile analyses. However, except for the 1974 Flood Prone Area Map of Whitefish (Reference 40) most of their work has not been published.

The USACE performed a hydrologic and hydraulic investigation of Whitefish River (particularly for the reaches near Kalispell) in 1969 (Reference 13). The report was updated in 1974. The hydrologic analysis considered the period of record to be 1929 to 1950, 1973, and 1974 (24 years). The period of record was extended to the equivalent of 37 years by correlation with 52 years of record for the North Fork Flathead River near Columbia Falls.

The Whitefish River profile from the USACE 1969 report (Reference 13) was only a general information aid because different hydrologic values and different starting conditions were implemented in this study. The hydrologic value used here is the same as that suggested by the USACE in August 1974 as being an improved prediction. The starting conditions used here consider the water-surface elevations and an associated magnitude-frequency event on Stillwater River at the confluence with Whitefish River. It appears that the USACE used the concept of nonevent concurrency for the two streams and/or considered less severe backwater effects along Stillwater River upstream of U.S. Highway 2 bridge than history would indicate.

Approximate studies have been performed in Flathead County by the USGS and the SCS for the purpose of developing Flood Prone Area Maps (References 41 and 42).

Previously Flood Insurance Studies have been prepared for Flathead County, the Cities of Kalispell and Whitefish and are in agreement with this study (References 1, 2 and 3).

This FIS report either supersedes or is compatible with all previous studies on streams studied in this report and should be considered authoritative for purposes of the NFIP.

Table 8 contains all Letters of Map Change (LOMCs) that have been incorporated into the FIS since the previous effective date.

Table 8 – Summary of LOMCs

Type of LOMC	Case Number	Effective Date	Project Identifier
LOMR	95-08-051P	March 3, 1995	Flathead River
LOMR	02-08-300P	July 2, 2003	Kalispell Hampton Inn Floodplain Development
LOMR	04-08-0223P	November 11, 2004	Blue Heron Estates
LOMR	04-08-0450P	November 11, 2004	Purdy Development
LOMR	04-08-0663P	November 11, 2004	Doug Johnson Development
LOMR	05-08-0481P	November 14, 2005	New West Properties SubDiv

Note: LOMRs 04-08-0223P, 04-08-0450P and 04-08-0663P are one and the same.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Flood Insurance and Mitigation Division, FEMA, Denver Federal Center, Building 710, Box 25267, Denver, Colorado 80225-0267.

9.0 BIBLIOGRAPHY AND REFERENCES

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2. U.S. Department of Housing and Urban Development Federal Insurance Administration, Flood Insurance Study City of Whitefish, Montana, Flathead County, January, 1979.

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10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To ensure that any user is aware of all revisions, it is advisable to contact the community repository of flood hazard data.

10.1 First Revision

This study was revised on June 18, 2013 to incorporate a Physical Map Revision (PMR) for a restudy of the Flathead River near the Evergreen area of Flathead County, MT, including a split flow from the Flathead River that occurs during low-frequency flood events. The flooding sources impacted by the PMR were Flathead River, Flathead River Overflows, and Spring Creek. The PMR was based on data provided in the engineering report entitled “Flathead River Evergreen Area Restudy Hydraulic Analysis Technical Support Notebook Flathead County, Montana”, prepared by PBS&J, dated April, 2010 (Reference 43).

The analysis for the PMR includes hydraulic modeling of a split flow that occurs on the Flathead River as it flows beneath U.S. Highway 2 (MT Highway 35) until it intersects with Spring Creek and then converges with the Flathead River. Hydraulic analyses for the revision utilized field survey information collected in 2008 along the study reach (Reference 44). No new hydrologic analysis was performed. A supplemental hydraulic analysis was performed by BakerAECOM to extend the analysis to encompass hydraulic modeling of additional overflows from Spring Creek to approximately 1 mile downstream to its confluence with the Stillwater River (Reference 45). Hydraulic computations were carried out using the USACE HEC-RAS River Analysis System, version 4.0 (Reference 46). The hydraulic analysis resulted in revisions to the Flathead River floodway from approximately 2,000 ft upstream of Montana Hwy 35 to approximately 6,000 feet downstream. Floodplain mapping was completed using LiDAR topographic survey data flown in October 2008 and provided by Montana DNRC (Reference 47).

This revision incorporated the Letter of Map Revision (LOMR) issued on June 2, 2008, (Case No. 08-08-0430P) for a portion of the Whitefish River affecting the River Bend Village property located in the unincorporated areas of Flathead County, Montana. The LOMR revised flood hazard information for a reach from approximately 5,000 feet upstream of Reserve Drive to 40 feet upstream of Rose Crossing.

In addition, this revision incorporated the LOMR issued on July 15, 2008, (Case No. 08-08-0134P) for portions of Trumbull Creek and an adjacent Overflow Channel affecting the Trumbull Creek subdivision in the unincorporated areas of Flathead County, Montana. The LOMR revised flood hazard information for a reach of Trumbull Creek from approximately 4,280 feet downstream to approximately 330 feet upstream of Rose Crossing, and a reach of the Overflow Channel from approximately 170 feet downstream to approximately 5,380 feet upstream of Reserve Drive.