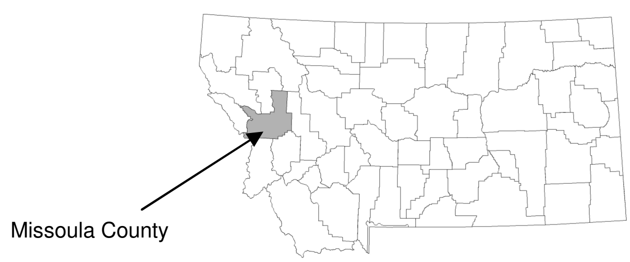
FLOOD INSURANCE STUDY

VOLUME 1 OF 2

MISSOULA COUNTY, MONTANA

AND INCORPORATED AREAS

Community Name	*Community Number*
MISSOULA, CITY OF	300049
MISSOULA COUNTY (UNINCORPORATED AREAS)	300048



Preliminary: October 23, 2008

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
30063CV001A

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 Effective Date: December 23, 2009

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FLOOD INSURANCE STUDY

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) in the geographic area of Missoula County, Montana, including the City of Missoula, and unincorporated areas of Missoula County (hereinafter referred to collectively as Missoula County) 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 Missoula 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 Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The original hydrologic and hydraulic analyses for Missoula County and the City of Missoula were performed by HKM Associates for the Federal Emergency Management Agency (FEMA), under Contract Nos. H-4126 and H-4026, respectively. The original Flood Insurance Studies (FIS) were completed in October 1978.

The revised hydrologic and hydraulic analyses for the 1988 FIS were performed by Morrison-Maierle, Inc. for FEMA under Contract EMW-84-R-1636. This work was completed in March 1986.

The revised hydrologic and hydraulic analyses for this FIS which include studies along the Clark Fork, Butler Creek, La Valle Creek and Lolo Creek were performed by PBS&J, Inc. for FEMA under Mapping Activity Statement (MAS) No. 2005-01 for the State of Montana. The Department of Natural Resources contract number was No. WO-PBSJ-040. This work was completed in April, 2006. New hydraulic analysis included a floodway encroachment analysis on the Clark Fork between Cross Section A (Station 0.0) and Cross Section X (Station 81,400).

The DOQQ (Digital Orthophoto Quarter Quadrangle) base map for Missoula County was provided by two sources; NRCS Data Gateway (http://datagateway.nrcs.usda.gov/GatewayHome.html) and USGS Earth Explorer (http://edcsns17.cr.usgs.gov/EarthExplorer/).

The black and white DOQQ mosaic for the County was acquired from the NRCS Data Gateway website. The U.S. Department of Agriculture produced this orthophoto mosaic at 1:12,000 scale. 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. However, this mosaic was not complete for the entire county.

Areas of Missoula County not covered by the above orthophotography mosaic were covered by the USGS DOQQs. These images are also at 1:12,000 scale and were photographed between 1999 to 2003. They have a 1-meter ground resolution, quarter-quadrangle image cast on the UTM on the North American Datum of 1983. DOQQs from both of the above base map providers were used to provide coverage for the entire county of Missoula.

1.3 Coordination

Streams for the original FIS requiring study by approximate and detailed methods were identified in a prestudy meeting held in Missoula County on April 13, 1976. This initial coordination meeting was attended by representatives of FEMA, the Montana Department of Natural Resources and Conservation, the Floodplain Management Bureau, and local city and county officials.

Telephone and personal contacts were made throughout the duration of both studies in an effort to coordinate activities and to accumulate pertinent information. Agencies and offices contracted in addition to those mentioned previously included the U.S. Geological Survey (USGS); local newspapers, the University of Montana; The U.S. Army Corps of Engineers (USACE), Seattle District; the U.S. Soil Conservation Service (SCS); local photographers; the local unit of the Lolo National Forest; local engineering firms; and Burlington Northern Railroad.

The results of the original FIS were reviewed at a final community meeting held on September 13, 1979, and attended by representatives from the City of Missoula, Missoula County, FEMA, the Montana Department of Natural Resources and Conservation, the study contractor, and residents of the City of Missoula and Missoula County. No objections or appeals were raised at this meeting.

In May 1980, flooding along Pattee Creek was at the highest level ever observed. The resulting sheet flooding through the Missoula area differed from the original FIS and prompted a restudy of Pattee Creek. Along with several other new stream reaches, a group of potential flooding sources were identified at a coordination meeting held on April 12, 1984. The meeting was attended by representatives of the City of Missoula, Missoula County, FEMA, the Montana Department of Natural Resources and Conservation, and the study contractor.

On September 2, 1987, the results of the 1988 FIS were reviewed and accepted at a final coordination meeting attended by representatives of the community, FEMA, and the study contractor.

For the countywide FIS, the initial Consultation Coordination Officer (CCO) meeting was held on October 6, 2005, and was attended by representatives of FEMA, Montana DNRC, Missoula County, City of Missoula, and the study contractor.

The results of the study were reviewed at the final CCO meeting held on date to be determined, and attended by representatives of FEMA, the Montana Department of Natural Resources, and the study contractor. All problems raised at the meeting have been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Missoula County, Montana including the City of Missoula, and unincorporated areas of Missoula County. The Flathead Indian Reservation 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.

Also studied by detailed methods is the Missoula South Hills area, a special study area in the southern tip of the City of Missoula, and adjacent areas in Missoula County. These areas include shallow flooding from Pattee Creek; major drainage coulees such as Moose Can Gully, South Drainage East, and South Drainage West; and streets having inadequate storm-drain systems.

Areas studied by approximate methods include segments of Blackfoot River, Butler Creek, La Valle Creek, Carlton Creek, Clark Fork, Clearwater River, Grant Creek, Lolo Creek, Miller Creek, Nine Mile Creek, O’Brian Creek, Pattee Creek, Petty Creek, Rock Creek, Six Mile Creek, Sleeman Creek Swan River and Union Creek. However, analysis showed that the 1-percent annual chance floodplain was consistently less than 200 feet wide for upstream segments of Carlton Creek, O’Brian Creek, Pattee Creek, and Petty Creek. 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 Missoula County.

Table 1 – Streams Studied by Detailed Methods

Stream	Limits of Detailed Study
Bitterroot River	From its confluence with Clark Fork (west of the City of Missoula) upstream to the Missoula-Ravalli County line, covering approximately 20 miles of stream
Blackfoot River	From its confluence with the Clark Fork (east of the City of Missoula) to a point approximately 1 mile upstream of Marco Flat Bridge, covering a total distance of 4.2 miles
Clark Fork	From the Missoula-Mineral County line upstream to the Missoula-Granite County line (southeast of the City of Missoula), covering approximately 68 miles of stream
Clearwater River	From a point 450 feet below the bridge at Placid Lake Road upstream approximately 6 miles to a point 4600 feet above the bridge at Riverview Road
Grant Creek	From the bridge at Interstate Highway 90 to a point approximately 3.5 miles upstream
Honeysuckle Drainage Swale	From 100 feet east of Reserve Street to 150 feet south of Cohosset Drive within the City of Missoula
La Valle Creek	From the Frenchtown Irrigation District Ditch upstream for a total of 18,447 feet
Lolo Creek	From its confluence with the Bitterroot River to a point approximately 6.5 miles southwest of the City of Missoula
Miller Creek	From the confluence with the Bitterroot River to a point approximately 6 miles upstream
Pattee Creek	From Southwest Higgins area in the City of Missoula upstream approximately 4000 feet to a point inside Missoula County
Rattlesnake Creek	From its confluence with the Clark Fork to a point upstream approximately 5.6 miles north of the City of Missoula
Rock Creek	From its confluence with the Clark Fork upstream ,including its entire length in Missoula county, a distance of 5.6 miles to the Missoula-Granite County line

2.2 Community Description

Missoula County is in the Columbia River Basin of Western Montana, west of the Continental Divide. It is bordered by the State of Idaho (to the southwest) and Mineral, Sanders, Lake, Flathead, Powell, Granite, and Ravalli Counties in Montana.

The growth rate from 1970 to 1980 substantially exceeded that of the State of Montana. The population of Missoula County was 58,263 in 1970 (Reference 1) and 76,016 in 1980, a growth rate of 13 percent. This trend has continued. In 1990, the population of Missoula County was 78,687; by 2000 this number had increased to 95,802. By 2007, the figure had grown to 105,650, making Missoula County one of the fastest growing counties in the state.

River valley floors are wide throughout most of Missoula County, but little floodplain development has occurred in the past. Most of the land was used for hay crops and pasture. However, housing developments have been built in the vicinity of Lolo Creek and near the Missoula-Ravalli County line.

The county is very mountainous; more than 25 miles of the southwestern county boundary lie along the summit of the Bitterroot Divide.

The county's valleys are well defined, and the rugged topography contributes to the wide range of climatic conditions. The major rivers are as follows: Bitterroot River, which enters the county south of Missoula; Clark Fork, which enters the county southeast of Missoula and extends west-northwest through Alberton into Mineral County; Blackfoot River, which flows into Clark Fork at Milltown; Swan River, which flows north into Lake County; and Clearwater River, which flows south to the Blackfoot River.

Elevations range from approximately 3,000 feet where Clark Fork leaves the county to more than 10,000 feet on some of the higher peaks of the Mission Range in northern Missoula County.

Missoula County's location between the Bitterroot and Continental Divide results in a climate classification that is neither continental nor maritime. The county may experience weather that is characteristic of both types of climate. Most of the time, the climate has characteristics of the Pacific Maritime. The valleys generally have warmer annual temperatures than most of the Montana, largely because many of the winter polar air invasions that penetrate the area east of the Continental Divide do not extend as far west as Missoula County. As is the case in most of Montana, the wettest month of the year is June, followed closely by May. Characteristically, there are large variations in the average annual precipitation between the valleys and mountains, and also between the lower and higher valleys. Precipitation averages approximately 13 inches annually within Missoula County, but at Upper Holland Lake (in the northeastern corner of the county, elevation 6,000 feet) a few annual averages have been nearly 65 inches. It is probable that larger amounts of precipitation fall in some sections of the mountains. Snowfall accumulations commonly reach several hundred inches in the mountain ranges. Average annual snowfall for parts of the Bitterroot Range is approximately 500 to 600 inches (References 2 and 3).

Spring and early summer are generally cool and cloudy, and there is frequent rain in the valleys. Some snow falls in the mountains as late as July. In late summer and early autumn, there are clear skies and warm days, interrupted occasionally by afternoon showers or thunderstorms. Thunderstorms during summer may result in energetic squalls. Hail has been observed in summer, but it is seldom large enough or widespread enough to cause much damage. Mountain areas generally receive their first snowfall before the end of September, and autumn is marked by considerably cloudy, damp, and occasionally foggy weather. By late autumn or early winter, snow begins to accumulate in mountain areas; and until early spring, nearly all of the precipitation is snow above approximately 4,500 feet (References 2 and 3).

The county consists of high mountains and wide, sediment-filled valleys. Sediments in the valleys are glacial deposits and alluvium. Glacial deposits are most extensive in northeastern Missoula County, but such deposits are also common at several other locations in the county.

Tributary streams come from the Bitterroot Range on the western side of the river valley and from the Sapphire Mountains to the east. Elevations are more than 10,000 feet in the Bitterroot Mountains, and streambed slopes decrease sharply as tributaries reach the valley floor. Bitterroot River empties into Clark Fork at an elevation of approximately 3,100 feet and has an average slope of 4.1 feet per mile (0.0008 foot per foot) through the Missoula County study reach. The drainage area of Bitterroot River at the Missoula-Ravalli County line is approximately 2,396 square miles. The weighted-average annual precipitation over the entire drainage area is 33 inches, most of which is snow at the higher elevations (References 2 and 3).

Blackfoot River originates on the western slope of the Continental Divide and drains into parts of Lewis and Clark, Powell, and Missoula Counties. Several major tributaries rising in the Mission, Swan, and Garnet Ranges combine as the river flows generally westerly towards its confluence with Clark Fork at Milltown (approximately 7 miles east of the City of Missoula). The total length of Blackfoot River is approximately 140 miles, and it has a drainage of 2,317 square miles at its mouth. Total vertical drop from the headwaters to the mouth is nearly 6,750 feet. Steep mountain streams characterize the upper drainages, but slopes in the main valleys are much less steep and have an average slope of 12.1 feet per mile (0.0023 foot per foot) for the 4.35 mile study reach directly above the mouth. The overall weighted-average annual precipitation is 29 inches for the Blackfoot River watershed (References 2 and 3).

Blackfoot River is contained in a narrow, mountainous valley through most of the study reach and opens into the wider Clark Fork Valley at the confluence. The Blackfoot River banks are generally high and well defined, and development is mainly confined to terraces and fans created by tributary streams. The small amount of land suitable for development is used mainly for houses, and there is virtually no agricultural activity in the study reach areas. Conifer forests cover the steep mountainsides on both sides of the valley.

Clark Fork Valley is very wide throughout most of the study reach, but there has been little floodplain development. The floodplain areas have been used mainly for hay crops and pasture. The floodplain varies in width from a few hundred feet at Missoula to approximately 2 miles downstream of the city. Immediately upstream of Missoula, the Clark Fork is generally classified as a braided stream and occupies a rather narrow floodplain bounded intermittently by alluvial terraces and mountains. Much of the floodplain is artificially constrained between two railroad beds or between railroad and highway embankments. Residential development is concentrated mainly in the area from above the Town of Turah to the Town of Clinton and the area west of the City of Missoula. The City of Missoula occupies both banks of the Clark Fork as it passes through the community. The principal residential development of Missoula is on high ground, but there is commercial and some residential development on lands along the Clark Fork. The Hoerner-Waldorf Paper Mill, at the downstream end of the study reach near Frenchtown, represents a major industrial development affecting the floodplain. The weighted-average annual precipitation over the Clark Fork watershed is 27 inches (References 2 and 3). Clark Fork originates on the western slope of the Continental Divide. Tributary streams flow from several ranges of the Rocky Mountains to form the main stem of Clark Fork, which flows northwesterly through Missoula County. Peaks in the headwaters of Silver Bow and Powell Counties rise to nearly 10,000 feet, but the mountain streams fall rapidly to the more gently sloping valley floors. Clark Fork enters Missoula County at an elevation of approximately 3,625 feet and crosses the western boundary of the county at approximately 3,000 feet. Streambed slopes range from 16.2 feet per mile near Clinton at the upstream limit of the study area to 7.2 feet per mile near Alberton at the downstream limit of the study area. The total drainage area increases from 3,602 square miles above Clinton to approximately 9,300 square miles at the downstream limit of the study reach near Frenchtown. The entrances of both Blackfoot and Bitterroot Rivers into Clark Fork within the study reach accounts for the large increase in drainage area.

Clearwater River is in the extreme northeastern corner of Missoula County, flowing south-southeast for a distance of approximately 50 miles from its source to its confluence with Blackfoot River. Headwaters of the drainage area are in the Mission Range on the western side of the valley and in the Swan Range to the east. Mountain tributaries flow steeply from peaks of more than 10,000 feet, but slopes decrease sharply at the main valley floor. The river flows through several lakes, and the study reach is 10.5 feet per mile (0.002 foot per foot). The total drainage area at the downstream end of the study reach is 220 square miles, and the weighted-average annual precipitation is 35 inches, most of which is snow at the higher elevations (References 2 and 3).

Clearwater River Valley in the study area consists of forest and pasture land. There is virtually no agricultural land use other than for hay crops. Because of the presence of numerous lakes, Clearwater Valley is a popular summer recreation area.

La Valle Creek originates in the Mission Range and flows southwest to its confluence with the Clark Fork approximately 12 miles west of the City of Missoula. Butler Creek flows into La Valle Creek as sheet flow below the Grass Valley French Ditch. Butler Creek flows approximately 10 miles and drains an area of 12.63 square miles. From its source, La Valle Creek flows approximately 14 miles and drains an area of 11.68 square miles. Elevations range within the watershed range from above 7800 to 3070 feet and have an average channel slope of approximately 340 feet per mile. The channel gradient flattens to approximately 4.5 feet per mile in the reach studied by detailed methods. The weighted-average annual precipitation for the drainage area is 22 inches, most of which is snow at the higher elevations (References 2 and 3).

Lolo Creek originates in the Bitterroot Range and flows easterly to its confluence with the Bitterroot River approximately 10 miles south of the City of Missoula. Lolo Creek Valley forms a natural pass through the Bitterroot Valley and has been used by local inhabitants for centuries when traveling west from the Bitterroot Valley. Lolo Peak stands above the valley at more than 9,000 feet, and the tributaries descend steeply to the main stem of Lolo Creek, which enters Bitterroot River at an elevation of approximately 3,150 feet. From its source to its mouth, Lolo Creek flows approximately 42 miles and drains an area of 272 square miles. The average slope of the streambed through the 7 mile study reach above the mouth is 31.2 feet per mile (0.0059 foot per foot). Snowfall totals 100 inches or more at the high elevations; therefore, the weighted-average annual precipitation is 52 inches for the entire watershed (References 2 and 3).

The Lolo Valley is confined by mountains at the upper limit of the study reach and gradually widens as it nears the Bitterroot River Valley. Hayfields and pasture cover most of the valley floor in the upper reach, but residential development is increasing around the rapidly expanding community of Lolo.

Rattlesnake Creek originates in the Mission Range of Western Montana, flowing south-southwest to its confluence with Clark Fork at Missoula. The total drainage area is 80 square miles, and elevations range from more than 7,600 feet at McLeod Peak to approximately 3,200 feet at Missoula. Streambed slopes are steep throughout the drainage area, and the average gradient is 82 feet per mile (0.0156 foot per foot) through the reach studied by detailed methods. The weighted-average annual precipitation for the drainage area is 34 inches, most of which is snow at the higher elevations (References 2 and 3).

Rattlesnake Creek is one of the principal sources for the municipal water-supply system of the City of Missoula. Therefore, development in the upper reaches is severely restricted, and activities affecting the watershed, such as logging, are prohibited. Substantial development has occurred only in the farthest downstream areas near the city. This distribution of development is likely to exist as long as Missoula is dependent upon Rattlesnake Creek for its water supply.

Pattee Creek originates in the Sapphire Range and flows northwest for approximately 6 miles before it fans out into a lowland area and eventually joins an irrigation system. There are several road crossings throughout the detailed study reach. Most of these crossings involve culverts that were installed at right angles to the road rather than more closely confirming to the original channel alignment. Many of these culverts are obstructed with gravel and cobbles to approximately 25 percent of their depth. Additional stream crossings include small footbridges and other decorative structures in residential yards.

Pattee Creek Basin elevations within the watershed range from 6,200 to 3,200 feet and have an average channel slope of approximately 200 feet per mile. The channel gradient flattens to approximately 170 feet per mile in the reach studied by detailed methods. The weighted-average annual precipitation for the Pattee Creek drainage basin is 21 inches (References 2 and 3). The basin has medium to dense stands of timber in the upper reaches of the watershed and along the mountain ridges of Pattee Creek Canyon. Residential development is at the mouth of the canyon and upstream along the valley bottom.

South Hills study area consists of the foothills and lowland area immediately south-southwest of the City of Missoula. The area is subdivided into three separate drainage components: South Drainage East, Moose Can Gully, and South Drainage West. Their drainage areas are 1.3, 2.4 and 1.7 square miles, respectively.

Basin elevations for South Hills range from approximately 6,200 feet in the extreme upper part of the watershed to 3,180 feet at the urban fringe. The average channel slopes are 825 feet per mile, 600 feet per mile, and 500 feet per mile for South Drainage East, Moose Can Gully, and South Drainage West, respectively. The South Hills drainage basin has a weighted-average annual precipitation of 20 inches (References 2 and 3).

The foothills topography consists of steep, narrow drainage channels and wide, barren slope faces. The drainage channels (coulees) maintain their definite geometric characteristics in the sloped area, but they either combine with irrigation ditches or fan out after reaching the more heavily developed urban area in the lowlands. The flatter valley floor consists of alluvial fans created from these drainage areas. These alluvial fans are composed of gravels overlain by a relatively thin layer of topsoil.

2.3 Principal Flood Problems

Warming periods, which may be accompanied by rainfall, cause tributaries to swell rapidly. The resulting flood flows may be localized or basin wide and may last from hours to several days depending on temperature, amount of rainfall, soil moisture content, and soil permeability.

Flooding along the Clark Fork drainage, which encompasses all study streams in Missoula County, generally occurs in May and June as the winter snow accumulation in the higher elevations begins to melt.

In addition to the stream flooding, shallow flooding may also occur because of a high ground-water table and the impounding of runoff water in low areas with poor drainage. This is particularly the case in the low-lying areas along Bitterroot River and Clark Fork. Winter flooding due to ice jams has also occurred in isolated areas, especially Blackfoot River and Clark Fork above the confluence with Blackfoot River.

Several factors contribute to the flood problems in South Hills, including the area along Pattee Creek:

- Steep hills adjacent to the lowland alluvial area.
- Relatively large size of the contributory drainage area.
- Rapid urbanization of the formerly rural and agricultural land, including development on the hillsides.
- An inadequate stormwater drainage system in the developing area.

Disposal of stormwater has generally been accomplished by the natural infiltration process, transfer to small percolation pits, street storage, or diversion to natural drainages or irrigation ditches in the area.

South Hills flooding can generally occur during any season and at any time, but the autumn season is least probable. Flooding due to ice jams and/or nonseasonal temperatures (possibly combined with rain) can occur in winter. Flooding in the spring is due to snowmelt runoff (occasionally combined with rainfall runoff). Because of the factors discussed previously which contribute to South Hills flood problems, flooding in summer can occur as a result of almost any combination of relatively severe rainfall intensity and long duration.

The largest flood event known to occur in Missoula County was in May and June of 1908, and it involved nearly every major stream and river. Although gage records are few, newspaper accounts describe extremely high river stages that washed away houses, roads, and bridges and disrupted travel and communications for several weeks throughout the county. This great flood, caused by unseasonably warm temperatures combined with 33 consecutive days of rain, had an estimated peak flow for Clark Fork above Missoula of 48,000 cubic feet per second (cfs) at the PPL Montana, LLC (formerly Montana Power Company) Dam in Milltown. The 1908 peak discharge was slightly greater than the 1-percent annual chance event. Newspaper accounts from the flood of 1908 tell of some damage to houses and property along Rattlesnake Creek, but no flow estimate was made for this flood.

There have been several other years when flooding has occurred in the county, but it was not as widespread as the 1908 event. More commonly, one of the major streams floods; and other streams remain at near normal levels. The June 1974 flooding along Bitterroot River was estimated at 29,000 cfs (the 2-percent annual chance frequency), but Clark Fork flow above Missoula was less than the 5-percent annual chance frequency. Likewise, flows for June 1964 and June 1975 were among the highest ever gaged on Clark Fork above Missoula, but simultaneous flows on Bitterroot River did not approach significant flood magnitudes. This pattern is not surprising when the overall size and geographic location of the various drainages are taken into consideration.

Rock Creek near Clinton has had two floods in recent years; one on June 20, 1975, recorded at 5,520 cfs and one in June 1972 that reached a peak of 6,500 cfs (Reference 4). Both are of an approximate 10-percent annual chance recurrence interval. Local residents reported a flood in 1927 that recorded a stage of approximately 9.5 feet and an approximate flow of 8,000 cfs (Reference 4), which is approximately a 2-percent annual chance event.

The maximum flows ever recorded for Rattlesnake Creek were in June 1948 and June 1974. Measurements at the Montana Power Company Dam, 4 miles upstream from the mouth, estimated the flow on both occasions to be 2,400 cfs. The 1974 event caused bank erosion but very little property damage in Greenough Park in Missoula.

Flooding in the South Hills area near Missoula has occurred along Pattee Creek (May, 1980); in the Wapikiya Subdivision (December 1964); along Briggs Street (December 1967, March 1976, and February 1986) and in Moose Can Gully and along the adjacent lowland area where the Gully looses its defined flowpath (March 1976 and February 1986). Other areas that have occasionally experienced flooding are the Gibson’s building and parking lot and a relatively low area near Briggs, Cardinal, and Gharrett Streets.

In 1997, snowmelt flooding caused numerous road closures and road washouts throughout the county. At least four bridges were damaged, including a collapsed bridge on Sun Ray Lane in Lolo. Hardest hit was property along the Clark Fork, Lolo and Rock Creeks. Several culverts and dikes were damaged.

2.4 Flood Protection Measures

Minimum flood protection measures along Bitterroot River consist of an earthfill dike in the vicinity of a housing development near the Lolo sewage-treatment plant. However, this dike was partially washed away in the 1975 flooding. Railroad and highway fills form artificial constraints to overbank flows in a few areas near Missoula, but they were not intended to be flood protection devices.

A small dam at the Champion International Mill at Bonner is the only structure on Blackfoot River that might be considered a flood-control measure. Its usefulness as such is very slight, as it consists of a weir with flashboards that are used to maintain a constant pond elevation during periods of low flow. There is essentially no storage capability, and the flashboards are lowered during high-runoff periods to allow passage of all of the flow.

Flood protection measures on the Clark Fork in the areas studied by detailed methods consist of the following:

- A system of dikes around the settling ponds at the Hoerner-Waldorf Paper Mill northwest of Missoula. The dikes protect the settling ponds against the 1-percent annual chance flood.

- Approximately 1.5 miles of earthfill dike along the northeast bank of the Steigler Ranch near Primrose.

- An earthfill dike along the south bank in the vicinity of the Chicago, Milwaukee, St. Paul & Pacific Railroad bridge near the Orchard Homes community west of Missoula. The dike protects the sewage-treatment plant against the 1-percent annual chance flood.

- Bank shaping and rock riprap stabilization in the areas of the new Reserve Street Bridge west of the City of Missoula.

- The PPL Montana LLC (formerly Montana Power Company) Dam at Milltown has virtually no storage capabilities for flood control and is used mainly for maintaining a minimum pond elevation during low-flow periods.

- A certified dike/levee on the north bank of the Clark Fork within the city limits from Madison Street to Orange Street.

- A certified dike/levee on the north bank of the Clark Fork within the city limits from the California Pedestrian Bridge to Russell Street.

There are other isolated sections of rock riprap throughout the study area, but they are not of major significance. Railroad and highway embankments have resulted in some channel realignments in some areas, particularly from east of Milltown to Clinton, but they were not intended as flood-control measures.

There are no flood-control measures on the Clearwater River study reach. The numerous lakes in the drainage system of the Clearwater River Valley provide some natural storage at times of high flow.

An earthfill dike has been constructed on the north bank of Lolo Creek immediately downstream of the Burlington Northern Railroad bridge, affording minor protection to a number of houses in the area. Other small dikes and riprap sections are scattered along the study reach, but they are of little significance in flood protection or control.

There are virtually no flood protection measures along Rattlesnake Creek. Rock walls, built many years ago, provide bank stabilization near the downstream end of Greenough Park. The PPL Montana, LLC (formerly Montana Power Company) Dam 4 miles upstream from the mouth of the creek provides a reservoir for the Missoula municipal water system, but its capacity is too small to provide appreciable floodwater storage.

No flood protection measures of any significance are located in the lowland area of South Hills within Missoula County. Floodplain management regulations are exercised in Missoula County and are based on previous USACE studies (References 5 and 6).

No other structures such as dams, levees, dikes, canals, or other flood control devices were found to provide protection from the 1-percent annual chance flood event.

Missoula 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.

Several gaging sites have existed for various periods of time along Bitterroot River. For this study, peak-flow data from an old site near the mouth (Gage No. 3525; period of record, 1900-1904) were combined with data from the gage near Darby (Gage No. 3440; period of record, 1937-1975) by using a transfer technique suggested by the USGS (Reference 7) to move the Darby information to the mouth. A historically weighted log-Pearson Type III distribution analysis (Reference 8) was run on these data. As a second method, a 10-year period of record for Bitterroot River was synthesized by subtracting flows gaged on Clark Fork above Missoula and Rattlesnake Creek at Missoula from the Clark Fork gage below the confluence with Bitterroot River. By correlation with a Clark Fork gage at St. Regis, this 10-year period was extended to 19 years; and the log-Pearson Type III analysis was performed (Reference 8). These two approaches were weighted according to significance and reliability in order to obtain values for the 10-, 2-, 1- and 0.2-percent annual chance peak discharges.

Data are available for several gaging sites along Blackfoot River. Peak-discharge data from the gage near the Town of Bonner (Gage No. 3400) were used for the detailed study. This gage, which is 2 miles upstream from the study limit, has continuous records from 1940. Six years of records (1899-1901, 1903-1905) from an old gage downstream of the present site were also considered representative and were included in the data. The resulting 42 peak flows were considered as continuous records for the log Pearson Type III analysis. Two other periods were also employed to estimate discharge-frequency for Blackfoot River. Values were obtained using the USGS regional flood prediction equation (Reference 7) and the equation suggested by Dodge (Reference 9). These three methods were weighted according to their levels of reliability and significance in order to obtain values for the 10-, 2-, 1- and 0.2-percent annual chance frequencies. After consideration of the location of the reach studied by detailed methods and the relatively small change in drainage area from start to end, no adjustments in flow values was considered to be necessary through the detailed study area.

The hydrologic analysis of Clark Fork was based on gage data from several gaging stations in and downstream from the detailed study area. The gage below Missoula (Gage No. 3530) has been operated continuously since 1929, providing 46 years of records at the time of this study. This information was used in a log-Pearson Type III analysis (Reference 8) for the study reach below the confluence of Bitterroot River.

A gage above Missoula (Gage No. 3405) has also been in continuous operation since 1929. Data from this gage were used in the study for the reach from above Bitterroot River up to the confluence of Blackfoot River (Reference 7). No gage sites exist on Clark Fork above the Blackfoot River confluence. In order to determine magnitudes and frequencies for this reach, a discharge-drainage area relationship was developed for Clark Fork drainage using the data from the two gages previously cited plus two others downstream of the study area. These additional gages are at St. Regis River (Gage No. 3545) with a period of record at

1911 to 1923 and 1929 to 1975, and at Plains (Gage No. 3890) with a period of record of 1912 to 1975. From curves generated by these data, discharge-frequency predictions were developed that were considered to be representative of the study reach above the confluence with Blackfoot River. In a report by the USACE (Reference 6), data from Gage No. 3405 were used to determine the intermediate regional 1-percent annual chance flood. The value was identical to that determined for this study and, therefore, used where applicable. Other frequency events not determined by the USACE (10-, 2-, and 0.2-percent annual chance events) were estimated by using this historically weighted log-Pearson type III distribution technique (Reference 8) based upon data from the previously mentioned gaging site (Gage No. 3405).

Discharges for Clark Fork (for the reach upstream of Clinton) and Rock Creek were taken from a USACE study (Reference 10).

Very little gage data are available for Clearwater River. An old gage was operated near the mouth in 1921-1923, but only one peak flow was recorded. A new gage (Gage No. 3945) was established in 1974, but these few years of record do not provide a significant data base for a log-Pearson Type III analysis. In order to determine appropriate discharge-frequency values, a number of techniques were employed. These included the 1976 USGS regional peak-flow equation (Reference 6), the Dodge Equation (Reference 9), and the SCS rainfall runoff method (Reference 11). Two other methods using peak-flow data from gaging stations within the general region of Clearwater River drainage were also developed. The first method used Blackfoot River gage near Helmville (Gage No. 3350; period of record, 1940-1953) in order to develop a discharge-per-square-mile figure for given frequency events. This figure was then applied to Clearwater River drainage, assuming similarity of drainages. The second method involved a log-Pearson Type III analysis (Reference 8) of six gaging sites within the region of Clearwater River drainage, from which curves depicting runoff/drainage area ratios were developed for the region. These curves were then used for Clearwater River drainage to predict flow magnitudes at the appropriate frequencies. All of these methods were then weighted according to reliability and significance in order to obtain final values for the 10-, 2-, 1-, and 0.2-percent annual chance peak drainages.

Because the drainage area of Clearwater River increases significantly through the study reach (from 140 square miles to 220 square miles), discharge-frequency values were determined independently at the upstream end of the study reach and at a point below the confluence with Morrell Creek, a major tributary, using the methods and weighting technique descried previously. As a check of the results of these two points, a transfer of values using a factor based on the ratio of areas as suggested by the USGS (Reference 7) was performed. The results obtained from this transfer were very close to those determined by independent analysis. For example, transferring the upstream 1-percent annual chance value to the downstream site gave a result of 4,160 cfs as compared to 4,170 cfs determined by the analysis.

Given the lack of site-specific frequency data to establish effective discharges, peak discharge frequency relationships were developed for the reference gage sites in the vicinity of La Valle and Butler Creeks according to Bulletin 17B (Reference 12). Weighted skew coefficients and historical peak adjustments were used in the effort. An area-discharge relationship for the 0.1, 0.02, 0.01, and 0.002 probability floods was then developed from the peak flow values calculated. A power equation was fitted to the relationship for effective hydrology flood prediction. Effective discharges were then identified using the curve. Calculated values were compared with both the 1992 and 1998 USGS regression equations and an independent hydrology/hydraulics report for La Valle and Butler Creeks to ensure validity of the results (Reference 13).

The hydrologic analysis of Lolo Creek was based on gage records from the station above Sleeman Creek (Gage No. 3520). Peak-flow measurements are available from 1950 through 1960. Three years of records from an old gage near the Town of Lolo are also available for the years 1911-1914, and these data were considered in part of the analysis. Log-Pearson Type III distributions (Reference 8) were performed on the data sets, as well as regional frequency correlations with gaging stations on Bitterroot River at Darby (Gage No. 3440) and on Clark Fork at St. Regis (Gage No. 3545). The regional prediction equation developed by the USGS (Reference 7) and by Dodge (Reference 9) was also included in the study. The methods were then weighted according to statistical reliability and significance in order to obtain 10-, 2-, 1-, and 0.2-percent annual chance peak flows.

The hydrologic analysis for Rattlesnake Creek was based on peak-flow records from two gages that were in operation in the past. Ten peak-flow measurements from the gage at Vine Street Bridge (Gage No. 3410; period of record, 1958-67), together with a peak-flow measurement gaged near the same site in 1899, were used with the estimated peaks of 1948 and 9174 to develop a historically weighted log-Pearson Type III distribution (Reference 8). For a second method, the 10 years of continuous record for Gage No. 3410 were extended to 18.7 years through correlation with Clark Fork gage at St. Regis (Gage No. 3545). The discharge-frequency predictions from these two methods were then weighted according to statistical reliability and significance in order to determine final values.

A peak-runoff analysis was performed for all major drainage areas with discernible channels or coulees in the South Hills (i.e., Moose Can Gully, South Drainage East, and South Drainage West). Stream-flow records were not available on any of these coulees because of their intermittent nature and typical flow magnitudes. Hence, regionalization techniques, using prediction equations (References 5 and 14) and similar drainages, were considered for the rural watershed analysis, as well as the SCS hydrograph generation technique (Reference 9). For the similar drainages analyses, flood-prediction information provided by the USGS on Eightmile, Hayes, and Rattlesnake Creeks (Reference 6) was used. A weighted average of the USGS information on the basis of runoff per square mile for associated event frequencies was applied to the respective drainage area. The results from the regionalization technique and the SCS rainfall-runoff technique were weighted according to an interpreted level of reliability and significance in order to obtain values for the 10-, 2-, 1-, and 0.2-percent annual chance discharges for the rural watershed areas. The remaining areas of the South Hills study were that not associated with discernible channelization were studied strictly on a runoff-volume basis. This area consisted of approximately 1,700 acres (partly urbanized; partly steep hillsides, developed and undeveloped; and partly greenbelt areas in the urban environment). The total acreage was further subdivided into smaller study areas in order to allow consideration of development densities, topography, and other factors. It was estimated that the 1,700 acres would generate 129 acre-feet of water during the 1-percent annual chance event. This volume, when combined with the runoff volumes from Pattee Creek, Moose Can Gully, South Drainage East, and South Drainage West, would require storage and routing through the lowland area.

A hydrologic study of the Pattee Creek was conducted for the original FIS and involved both a peak runoff and runoff volume analysis. The analysis divided the drainage area into an upstream watershed, primarily rural (9.0 square miles) and several downstream watersheds, primarily urbanized (7.0 square miles). The distinctions were made because the natural drainage process, including quantity and direction of flow, had been disturbed by urbanization.

Separate analyses for the individual watersheds were employed to obtain values for the 10-percent, 2-percent, 1-percent and 0.2-percent annual chance floods. The rural watershed received a weighted result of all regional studies performed for the Pattee Creek Basin, including regression relationships developed by Dodge (Reference 9), regional equations based upon independent variables developed by the USGS, and the SCS rainfall-runoff method (Reference 11).

Peak runoff predictions for the urbanized areas were originally made using the rational method and an intensity-duration-frequency curve specific to the Missoula area. In a subsequent South Hills Drainage study (Reference 15) the USACE HEC-1 Hydrograph method was used to combine all runoffs, including the rural and urban watersheds. The result was a combined total discharge at the confluence with the Bitterroot River.

The South Hills Drainage Study verified the 1-percent annual chance peak flood on Pattee Creek at Higgins Avenue as equal to the original FIS value. The drainage study utilized rainfall amounts to develop different frequency events. A conclusion of the drainage study was that the storm of May 25-26, 1980 produced the flood of record on the Pattee Creek watershed, considered to be greater than the 1-percent annual chance flood. The precipitation during this period set a record in Missoula for a 24-hour period (1.92 inches). Although less than the Weather Bureau's published 24-hour 1-percent annual chance precipitation amount (3.2 inches), this storm produced a substantial peak flow directly related to preceding storm events. May 1980 is the wettest month on record (7.14 inches) including 3.64 inches from May 22 to May 26. An indirect measurement by the USGS indicated that Pattee Creek above Higgins Avenue produced a peak flow of over 200 cfs, including 150 cfs roadway overflow and about 100 cfs through a culvert crossing at Pattee Creek Drive.

Peak discharges on Miller and Grant Creeks were developed using the USGS Open File Report 81-917 (Reference 16). Regional equations based upon drainage area size and mean annual precipitation were applied to these streams to determine the 10-, 2-, and 1-percent annual chance floods. The results compared favorably to other streams in the Missoula area where gaged data has been used to determine flood frequency relationships. The 0.2-percent annual chance flood was determined from a straight line extension of the peak discharge versus recurrence interval of the 10-, 2-, and 1-percent annual chance events.

Peak discharge-drainage area relationships for streams studied in detail are shown in Table 2.

Table 2 – 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
Bitterroot River					
At confluence with Clark Fork	2,842	20,900	29,700	31,800	42,000
At 4.3 miles below confluence of Lolo Creek	2,720	20,400	29,000	31,000	41,000
Just upstream of confluence of Lolo Creek	2,450	19,200	27,200	29,100	38,500
Blackfoot River					
At USGS Gage No. 3400	2,290	16,800	22,500	25,000	31,200
Clark Fork					
At downstream Limit of Detailed Study	9,272	49,250	61,000	67,000	86,000
At USGS Gage No. 3530 below Missoula	9,003	47,000	58,000	64,000	82,000
At USGS Gage No. 3405 above Missoula	5,999	27,000	38,200	42,500	56,000
Just upstream of confluence of Blackfoot River	3,668	15,000	22,500	26,000	35,500
Clearwater River					
At downstream Limit of Detailed Study	220	3,040	3,840	4,180	4,860
Just upstream of confluence of Morrell Creek	140	2,340	2,940	3,170	3,650
Grant Creek					
At Interstate Highway 90	25	245	380	465	730
La Valle Creek					
At Mullan Road Crossing	27	448	778	943	1381
Lolo Creek					
At confluence with Bitterroot River	270	2,300	2,900	3,300	3,800
At USGS Gage No. 3520	250	2,100	2,700	3,000	3,500
Miller Creek					
At confluence with Bitterroot River	48	350	550	675	1,150

Table 2 – 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
Moose Can Gully					
At 23rd Avenue in the City of Missoula	2.4	40	60	75	105
Pattee Creek					
At South Higgins Avenue in the City of Missoula, Total Drainage	9.8	105	165	195	265
At confluence with Bitterroot River	16	109	250	348	780
Rattlesnake Creek					
At USGS Gage No. 3410 in the City of Missoula	80	1,905	2,690	3,000	3,750
Rock Creek					
At confluence with Clark Fork	885	6,200	8,300	9,200	11,200
South Drainage East					
At South Higgins Avenue in the City of Missoula, Total Drainage	1.3	45	70	80	105
South Drainage West					
At Miller Creek Road in the City of Missoula, Total Drainage	1.7	25	40	50	65

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 profiles were developed using the USACE HEC-2 step-backwater computer model (Reference 14). Profiles were determined for the 10-, 2-, 1-, and 0.2-percent annual chance events. Cross sections were located using available topographic maps (References 17 and 18) and aerial photographs (References 19 and 20). Hydraulic structures were field measured unless data summaries and/or plans were available to define pertinent elevations and geometry. Below-water cross section data were obtained using field surveys for areas of Bitterroot River, Clark Fork, and Pattee Creek, as well as complete valley cross sections for Blackfoot and Clearwater Rivers (Reference 21). Ground-control surveying for aerial photogrammetry was used to develop overbank cross section data for parts of Bitterroot River and Clark Fork (References 19 and 20). Other cross section data necessary to complete the studies on Bitterroot River, Clark Fork, Lolo Creek, and Rattlesnake Creek were obtained from the USACE, Seattle District, which had done previous studies on parts of these streams (References 5, 6, 22, and 23).

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 was computed (Section 4.2), selected cross section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

Roughness coefficients (Manning's "n") were estimated by field inspection and review of both ground-level and aerial photographs (Reference 19). Roughness value selection was made using one or a combination of the following approaches, depending on the reach 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 various channel types and conditions; comparison with channel hydraulics and associated roughness coefficients; and comparison with work previously completed by other agencies (References 5 and 6). Channel and overbank conditions varied considerably in many instances along the study streams resulting in wide ranges for the "n" values. (See Table 3).

Table 3 – Manning's "n" Values

Flooding Source	Channel	Overbanks
Bitterroot River	0.033-0.043	0.050-0.110
Blackfoot River	0.032-0.042	0.045-0.060
Clark Fork	0.024-0.060	0.032-0.090
Clearwater River	0.033-0.038	0.038-0.095
La Valle Creek	0.045	0.07-0.08
Lolo Creek	0.036-0.047	0.050-0.095
Pattee Creek	0.030-0.031	0.045-0.050
Rattlesnake Creek	0.045-0.080	0.050-0.125
Rock Creek	0.040-0.100	0.045-0.110

The Bitterroot River study began at its confluence with Clark Fork. In order to start the model, the first cross section on Clark Fork below the confluence was used, with the model then stepping to Bitterroot River. Starting water-surface elevations for the Clark Fork section were based on the assumption that flood-event frequencies for the two rivers would not coincide. Based on this assumption, the following associated flood frequencies were used to establish starting water-surface elevations:

Bitterroot River Flood Event	Clark Fork Event for Starting Elevation
10-percent-annual-chance	10-percent-annual-chance
2-percent-annual-chance	4-percent-annual-chance
1-percent-annual-chance	2-percent-annual-chance
0.2-percent-annual-chance	1-percent-annual chance

Starting water-surface elevations for Blackfoot River were based on a procedure similar to that of Bitterroot River. Blackfoot River enters Clark Fork directly above the Montana Power Company Dam at Milltown. As the dam is considered a run-of-the-river structure having no flood-storage capabilities, the HEC-2 model (Reference 14) was used directly to determine the pool elevation for reach frequency event (no flood-routing or stage/frequency determinations). Again, assuming that flood-event frequencies would not coincide, starting water-surface elevations were determined using associated flood frequencies for the two rivers as follows:

Blackfoot River Flood Event	Clark Fork Above Milltown Dam Event for Starting Elevations
10-percent-annual-chance	10-percent-annual-chance
2-percent-annual-chance	4-percent-annual-chance
1-percent-annaul-chance	2-percent-annual-chance
0.2-percent-annual-chance	1-percent-annual-chance

Starting water-surface elevations for Clark Fork were obtained by using the slope-area method. These profiles were computed continuously from Cross Sections A to AN through Cross Sections AO to AU from the original USACE study. Water-surface elevations at this point were verified to within 0.5 foot of the original USACE study. Profiles upstream from these modified cross sections are from the original FIS.

The Clearwater River starting water-surface elevations were determined from a rating curve developed at a cross section that had been field measured at a point 450 feet downstream from the start of the study. The average streambed slope between measured sections was used for Manning's equation. The resulting curve is the best estimate available for starting water-surface elevations.

La Valle Creek starting water-surface elevations were obtained using HEC-RAS 3.1.3 and a normal depth boundary condition (Reference 24).

Lolo Creek starting water-surface elevations were obtained by using the slope-area option of the HEC-2 computer model (Reference 14) for the downstream cross sections. The Lolo Creek Study begins at its confluence with Bitterroot River, but backwater effects from Bitterroot River do not reach the first cross section measured on Lolo Creek. Therefore, the computer model was run upstream from the first cross section, and the profiles were extended downstream to Bitterroot River at elevations determined by the Bitterroot River model. As with other study streams, event frequencies for Lolo Creek and Bitterroot River were assumed not to be coincidental, and a relationship similar to the others previously mentioned was employed as follows:

Lolo Creek Flood Event	Bitterroot River at Mouth of Lolo Creek Event
10-percent-annual chance	10-percent-annual-chance
2-percent-annual-chance	4-percent-annual-chance
1-percent-annual-chance	2-percent-annual-chance
0.2-percent-annual-chance	1-percent-annual-chance

For Miller Creek the starting water-surface elevations were obtained by using the slope-area option of the HEC-2 computer model for the downstream cross section. The Miller Creek study begins at its confluence with the Bitterroot River, but backwater effects from Bitterroot River do not reach the first cross section measured on Miller Creek. Therefore, the computer model was run upstream from the first cross section, and the profiles were extended downstream to Bitterroot River at elevations determined by the Bitterroot River model. Similar relationships of flood events were employed with Miller Creek and the Bitterroot River.

For Rattlesnake Creek, the USACE used the Seattle District Method II backwater program (Reference 23) for their 1-percent annual chance flood profile. Some difficulties were experienced in obtaining result concurrence with the results of this study within acceptable limits. These differences in results were due to the flow regimes involved and the manipulations of the hydraulic model parameters that were required in order to simulate actual field conditions as accurately as possible. More specifically, critical and super-critical flows were found in several areas of the study reach, and the water-surface profile results differed because of the relatively high velocities involved and the different methods that were used to estimate friction losses. A considerable amount of subjective information was involved in the remodeling, which led to a relatively detailed and extensive research effort in order to obtain the desired profile concurrence. In order to develop starting conditions for the various discharge-frequency events, a stage discharge relationship was developed at this section using USACE data and the most reasonable interpretation of channel characteristics in the vicinity of this section. The elevations thus determined were used to complete the plotting. The profiles were extended downstream at a constant slope until they intersected the concurrent event profile for Clark Fork as determined by the previously completed profiles for Clark Fork.

Additional cross section information was obtained in this revised FIS on Rattlesnake Creek to verify/modify the flood profiles contained in the original FIS. Starting water-surface elevations were obtained from the original FIS, and profiles were developed through new cross section data and completed when there was verification with the original FIS.

The HEC-2 computer model for Pattee Creek was started in the City of Missoula at Higgins Avenue. Hydraulic calculations were performed at Higgins Avenue for the 10-, 2-, 1-, and 0.2-percent annual chance events in order to estimate the flow depth and determine the flow distribution at this particular intersection. The flow depth determination provided the starting water-surface elevations for the upstream reach analyses and allowed one to predict flow routing in the downstream channel and street network.

For Grant Creek the starting water-surface elevations were obtained using the slope-area option of the HEC-2 model at the downstream cross sections.

All other areas in the South Hills, particularly the lowlands and sheet-flow areas, were determined to be areas of shallow flooding. Sheet-flow depths were estimated where appropriate. Other flow and/or ponding depths throughout the study area were estimated using the available topographic data (References 11 and 14), hydraulic structure data, flood photographs from May 1980, and preliminary flood-routing techniques. Shallow flooding with an average depth of 1 foot occurs along Rattlesnake Creek at U.S. Highway 90 and the Burlington Northern Railroad.

A small area along Clark Fork is affected by ponding northwest of Missoula. Another area along Clark Fork is subject to ponding southeast of Missoula near a crossing of the Chicago, Milwaukee, St. Paul and Pacific Railroad.

Streams flowing through undeveloped areas were studied by approximate methods. These streams received a cursory field investigation which included geometry estimates and ground-level photodocumentation. Brief hydrologic and hydraulic analyses were performed in the areas of interest. Field-estimated channel geometry was supplemented with available topographic information (References 17 and 18) to develop typical cross sections and perform a stage-discharge analysis.

A small portion of Miller Creek for the proposed Rodeo Ranchettes Subdivision was field surveyed, and cross section geometry was supplemented with topographic information

(Reference 26).

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) 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 4.

Table 4 – Datum Conversion Factors

Stream/Reach	Conversion from NGVD to NAVD (feet)
Bitterroot River	3.5
Blackfoot River	3.5
Clark Fork	3.6
Clearwater River	3.7
Grant Creek	3.6
Lolo Creek	3.6
Miller Creek	3.5
Pattee Creek	3.5
Rattlesnake Creek	3.6
Rock Creek	3.6

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 Flood 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. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 20 and 40 feet (References 17 and 18).

The Clark Fork River, from Cross Sections BJ to EF, the Bitterroot River, from cross sections A to AA, the Blackfoot River from A to J, Grant Creek, from A to R, Miller Creek from A to E, Lolo Creek from A to O, and Rattlesnake Creek from A to BA were all redelineated to two-foot elevation contours in April 2006. The two-foot contours were generated from 1999 LiDAR data in the vicinity of the City of Missoula.

Floodplain boundaries for La Valle Creek were delineated using two-foot contours that were created from LiDAR flown in January of 2006.

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).

Boundaries for areas affected by shallow flooding and ponding were delineated using available topographic maps as referenced previously.

Boundaries for approximate study areas were delineated using topographic maps (References 17, 18, and 26) using elevations and depths as discussed in Section 3.2.

Approximate 1-percent annual chance floodplain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map (Reference 27).

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 5). 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.

In the State of Montana, encroachment in the floodplain is limited to that which will cause an increase in flood heights of 0.5 foot or less. Thus, at the recommendation of the Montana Department of Natural Resources, Floodplain Management Bureau, a floodway having no more than a 0.5 foot surcharge has been delineated in this study.

The floodways for streams studied by detailed methods were computed on the basis of equal conveyance reduction from each side of the floodplain, with the exception of isolated areas along Bitterroot River, Clark Fork, and at the confluence of Lolo Creek with Bitterroot River. At some cross sections along these streams, the computer would not give results within the 0.5 foot limit for encroachment, or would give floodway widths which varied greatly from section to section and did not appear reasonable when compared to aerial photos of past flooding and/or previous floodway delineations done by the USACE (References 6 and 22). In order to resolve these problems, one of two methods was used. The first method simply set a lower limit on the allowable increase in flood heights using the equal conveyance reduction option. The second method established a floodway width based on results from previous trails and forced the computer to use given stations along the cross sections for the floodway boundary.

For Rattlesnake Creek and Pattee Creek, the floodways are coincident with the 1-percent annual chance floodplain due to the high channel velocities.

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.

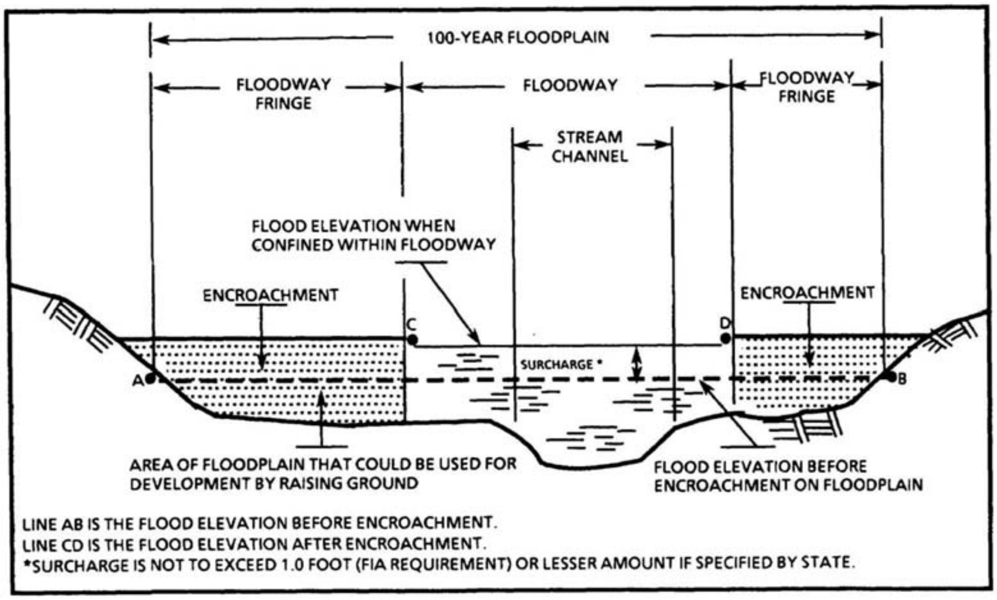

Figure 1 – Floodway Schematic

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)
BITTERROOT RIVER								
A	1,800	410	3,491	9.1	3,111.8	3,111.8	3,111.8	0.0
B	2,850	339	4,101	7.8	3,112.9	3,112.9	3,113.2	0.3
C	2,880	341	4,174	7.6	3,112.9	3,112.9	3,113.4	0.5
D	3,080	545	6,167	5.2	3,113.8	3,113.8	3,114.2	0.4
E	5,105	1,454	9,005	3.5	3,115.4	3,115.4	3,115.7	0.3
F	9,030	1,416	8,399	3.8	3,118.5	3,118.5	3,119.0	0.5
G	13,580	1,199	7,238	4.4	3,122.7	3,122.7	3,123.2	0.5
H	16,805	1,973	12,763	2.5	3,125.2	3,125.2	3,125.7	0.5
I	20,725	2,524	14,544	2.2	3,126.6	3,126.6	3,127.1	0.5
J	24,325	323	3,754	8.5	3,128.7	3,128.7	3,129.1	0.4
K	25,550	322	4,900	6.5	3,130.4	3,130.4	3,130.9	0.5
L	25,625	322	4,919	6.5	3,130.5	3,130.5	3,131.0	0.5
M	25,675	364	4,709	6.8	3,130.5	3,130.5	3,131.0	0.5
N	25,700	364	4,727	6.7	3,130.5	3,130.5	3,131.0	0.5
O	25,850	835	6,471	4.9	3,131.0	3,131.0	3,131.4	0.4
P	29,350	2,801	19,260	1.7	3,132.9	3,132.9	3,133.4	0.5
Q	32,850	580	4,254	7.5	3,134.2	3,134.2	3,134.6	0.4
R	36,250	777	7,593	4.2	3,138.3	3,138.3	3,138.8	0.5
S	38,550	1,894	15,623	2.0	3,139.8	3,139.8	3,140.3	0.5
T	41,300	1,345	8,770	3.5	3,141.0	3,141.0	3,141.5	0.5
U	44,150	1,589	10,585	2.9	3,142.4	3,142.4	3,142.9	0.5
V	46,450	2,246	14,476	2.1	3,143.6	3,143.6	3,144.1	0.5

[1]Feet above confluence with Clark Fork

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

BITTERROOT 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)
BITTERROOT RIVER (cont)								
W	50,450	1,118	7,783	4.0	3,145.9	3,145.9	3,146.4	0.5
X	53,900	2,044	11,973	2.6	3,148.4	3,148.4	3,148.9	0.5
Y	58,000	1,688	10,563	2.9	3,151.2	3,151.2	3,151.7	0.5
Z	62,150	1,209	8,566	3.6	3,154.6	3,154.6	3,155.1	0.5
AA	65,400	1,556	11,101	2.8	3,157.2	3,157.2	3,157.7	0.5
AB	72,690	2,050	13,469	2.2	3,162.5	3,162.5	3,163.0	0.5
AC	76,840	2,944	14,666	2.0	3,165.1	3,165.1	3,165.6	0.5
AD	77,865	2,942	11,817	2.5	3,165.7	3,165.7	3,166.2	0.5
AE	77,890	2,936	11,821	2.5	3,165.7	3,165.7	3,166.2	0.5
AF	78,340	3,147	10,715	2.7	3,166.2	3,166.2	3,166.7	0.5
AG	81,340	4,508	19,688	1.5	3,168.3	3,168.3	3,168.8	0.5
AH	83,380	3,511	11,063	2.6	3,169.9	3,169.9	3,170.4	0.5
AI	87,990	1,542	8,274	3.5	3,175.6	3,175.6	3,176.1	0.5
AJ	92,140	4,956	16,009	1.8	3,178.9	3,178.9	3,179.4	0.5
AK	94,690	4,229	11,103	2.6	3,181.2	3,181.2	3,181.6	0.4
AL	99,215	2,595	10,339	2.8	3,186.0	3,186.0	3,186.5	0.5
AM	102,265	3,338	11,809	2.5	3,188.8	3,188.8	3,189.2	0.4
AN	106,265	2,315/310[2]	12,078	2.4	3,192.1	3,192.1	3,192.6	0.5

[1]Feet above confluence with Clark Fork [2]Left Channel/Right Channel

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

BITTERROOT 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)
BLACKFOOT RIVER								
A	350	218	5,035	5.0	3,268.7	3,268.7	3,268.7	0.0
B	460	219	5,035	5.0	3,268.7	3,268.7	3,268.7	0.0
C	785	228	5,527	4.5	3,268.7	3,268.7	3,268.7	0.0
D	825	228	5,530	4.5	3,268.7	3,268.7	3,268.7	0.0
E	1,115	322	6,297	4.0	3,268.7	3,268.7	3,268.7	0.0
F	1,240	263	5,740	4.4	3,268.7	3,268.7	3,268.7	0.0
G	1,290	263	5,753	4.4	3,268.7	3,268.7	3,268.7	0.0
H	1,470	310	6,058	4.1	3,268.7	3,268.7	3,268.7	0.0
I	1,530	311	6,066	4.1	3,268.7	3,268.7	3,268.7	0.0
J	1,930	289	5,578	4.5	3,268.7	3,268.7	3,268.7	0.0
K	3,090	266	5,250	4.8	3,268.7	3,268.7	3,268.7	0.0
L	4,990	227	3,820	6.5	3,268.7	3,268.7	3,268.7	0.0
M	5,190	228	3,815	6.5	3,268.7	3,268.7	3,268.7	0.0
N	5,210	205	3,149	7.9	3,271.5	3,271.5	3,271.9	0.4
O	5,335	229	3,527	7.1	3,271.8	3,271.8	3,272.1	0.3
P	6,385	143	2,513	9.9	3,272.4	3,272.4	3,272.7	0.3
Q	7,385	312	4,309	5.8	3,274.4	3,274.4	3,274.6	0.2
R	7,465	312	4,411	5.7	3,274.4	3,274.4	3,274.9	0.5
S	8,265	331	3,732	6.7	3,274.9	3,274.9	3,275.3	0.4
T	10,215	233	2,757	9.1	3,277.5	3,277.5	3,277.5	0.0
U	12,715	183	2,815	8.9	3,282.5	3,282.5	3,282.5	0.0
V	15,715	193	2,522	9.9	3,288.3	3,288.3	3,288.6	0.3

[1]Feet above confluence with Clark Fork

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

BLACKFOOT 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)
BLACKFOOT RIVER (Cont)								
W	16,815	250	3,261	7.7	3,291.1	3,291.1	3,291.2	0.1
X	18,015	223	2,917	8.6	3,292.7	3,292.7	3,293.0	0.3
Y	22,170	187	2,006	12.5	3,304.3	3,304.3	3,304.8	0.5

[1]Feet above confluence with Clark Fork

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

BLACKFOOT 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)
CLARK FORK								
A	0	430	7,738	8.7	2,964.2	2,964.2	2,964.2	0.0
B	1,300	431	7,851	8.5	2,965.5	2,965.5	2,965.5	0.0
C	5,300	488	8,307	8.1	2,969.0	2,969.0	2,969.0	0.0
D	10,000	539	8,785	7.6	2,973.0	2,973.0	2,973.0	0.0
E	15,200	344	7,066	9.5	2,977.1	2,977.1	2,977.2	0.1
F	19,630	409	7,371	9.1	2,981.5	2,981.5	2,981.6	0.1
G	21,000	585	11,473	5.8	2,983.4	2,983.4	2,983.5	0.1
H	22,100	681	9,986	6.7	2,984.1	2,984.1	2,984.2	0.1
I	22,870	686	10,682	6.3	2,985.2	2,985.2	2,985.3	0.1
J	26,750	1,198	16,398	4.1	2,987.2	2,987.2	2,987.4	0.2
K	33,600	671	9,548	7.0	2,990.2	2,990.2	2,990.5	0.3
L	38,250	677	8,922	7.5	2,994.2	2,994.2	2,994.3	0.1
M	43,650	664	9,921	6.8	2,998.5	2,998.5	2,998.8	0.3
N	47,600	1,028	13,215	5.1	3,001.1	3,001.1	3,001.5	0.4
O	52,200	2,162	20,669	3.2	3,003.1	3,003.1	3,003.6	0.5
P	55,700	765	10,219	6.6	3,004.8	3,004.8	3,005.2	0.4
Q	57,000	1,667	15,407	4.4	3,006.0	3,006.0	3,006.3	0.3
R	58,400	2,339	15,463	4.3	3,007.1	3,007.1	3,007.3	0.2
S	61,900	2,766	20,884	3.2	3,009.1	3,009.1	3,009.6	0.5
T	65,850	2,087	15,659	4.3	3,011.4	3,011.4	3,011.9	0.5
U	68,400	2,356	13,118	5.1	3,013.6	3,013.6	3,014.0	0.5
V	72,000	3,399	18,024	3.7	3,017.2	3,017.2	3,017.7	0.5
W	76,800	3,707	16,973	4.0	3,021.4	3,021.4	3,021.8	0.4

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLARK FORK (cont)								
X	81,400	6,450	25,546	2.6	3,024.7	3,024.7	3,025.0	0.3
Y	82,460	4,451	20,890	3.2	3,025.3	3,025.3	3,025.8	0.5
Z	83,700	3,884	20,820	3.2	3,026.1	3,026.1	3,026.6	0.5
AA	85,020	3,350	17,349	3.9	3,027.0	3,027.0	3,027.5	0.5
AB	86,040	2,489	10,753	6.2	3,028.0	3,028.0	3,028.5	0.5
AC	87,180	4,061	21,167	3.2	3,030.0	3,030.0	3,030.4	0.4
AD	88,280	2,835	13,369	5.0	3,031.1	3,031.1	3,031.5	0.4
AE	90,190	1,957	14,613	4.6	3,033.7	3,033.7	3,034.2	0.5
AF	91,290	955	9,288	7.2	3,035.4	3,035.4	3,035.8	0.4
AG	92,460	1,568	15,947	4.2	3,036.8	3,036.8	3,037.3	0.5
AH	93,680	2,422	13,957	4.8	3,037.7	3,037.7	3,038.1	0.4
AI	95,330	1,485	11,172	6.0	3,039.7	3,039.7	3,039.8	0.1
AJ	96,910	1,791	18,326	3.7	3,041.4	3,041.4	3,041.8	0.4
AK	97,880	1,368	14,807	4.5	3,041.7	3,041.7	3,042.1	0.4
AL	98,780	1,250	10,847	6.2	3,042.3	3,042.3	3,042.6	0.3
AM	99,870	853	8,175	8.2	3,043.1	3,043.1	3,043.4	0.3
AN	101,000	853	7,646	8.8	3,044.2	3,044.2	3,044.7	0.5
AO	101,840	715	10,334	6.5	3,045.9	3,045.9	3,046.4	0.5
AP	102,140	690	9,680	6.9	3,046.0	3,046.0	3,046.5	0.5
AQ	103,115	905	9,726	6.9	3,046.6	3,046.6	3,047.1	0.5
AR	104,000	760	8,123	8.2	3,047.2	3,047.2	3,047.6	0.4
AS	105,220	565	7,312	9.2	3,048.6	3,048.6	3,048.9	0.3
AT	106,500	553	7,902	8.5	3,050.1	3,050.1	3,050.3	0.2
AU	108,140	528	7,810	11.0	3,051.4	3,051.4	3,051.5	0.1

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLARK FORK (cont)								
AV	109,910	1,523	12,461	5.3	3,053.4	3,053.4	3,053.7	0.3
AW	110,960	1,714	11,844	5.6	3,053.9	3,053.9	3,054.2	0.3
AX	112,760	1,535	7,465	8.9	3,054.9	3,054.9	3,055.3	0.4
AY	114,860	1,449	8,611	7.7	3,057.0	3,057.0	3,057.4	0.4
AZ	116,050	1,883	8,087	8.2	3,058.1	3,058.1	3,058.6	0.5
BA	116,100	1,883	10,432	6.3	3,059.7	3,059.7	3,060.1	0.4
BB	117,185	1,810	11,398	5.8	3,060.6	3,060.6	3,060.9	0.3
BC	118,585	1,880	12,175	5.4	3,061.7	3,061.7	3,061.9	0.2
BD	120,485	1,475	9,279	7.1	3,063.5	3,063.5	3,063.6	0.1
BE	121,535	1,383	10,081	6.5	3,064.8	3,064.8	3,065.2	0.4
BF	122,915	985	7,995	8.2	3,066.1	3,066.1	3,066.5	0.4
BG	125,215	2,597	14,493	4.5	3,069.3	3,069.3	3,069.8	0.5
BH	126,735	2,699	16,566	3.9	3,070.8	3,070.8	3,071.3	0.5
BI	128,485	3,342	20,694	3.2	3,072.5	3,072.5	3,072.9	0.4
BJ	130,985	5,373	11,358	5.8	3,075.1	3,075.1	3,075.5	0.4
BK	132,260	4,549	26,123	2.5	3,077.5	3,077.5	3,077.9	0.4
BL	134,860	1,844	10,346	6.3	3,080.5	3,080.5	3,080.9	0.4
BM	136,680	1,671	13,412	4.9	3,083.2	3,083.2	3,083.7	0.5
BN	138,380	656	7,691	8.5	3,084.9	3,084.9	3,085.3	0.4
BO	139,410	1,256	14,317	4.6	3,086.5	3,086.5	3,087.0	0.5
BP	140,480	1,432	12,569	5.1	3,087.1	3,087.1	3,087.6	0.5
BQ	143,230	1,079	8,469	7.6	3,090.6	3,090.6	3,090.7	0.1
BR	145,380	542	7,403	8.7	3,094.1	3,094.1	3,094.3	0.2

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLARK FORK (cont)								
BS	147,980	1,120	12,054	5.4	3,097.5	3,097.5	3,097.7	0.2
BT	148,980	1,478	12,611	5.1	3,098.3	3,098.3	3,098.4	0.1
BU	150,730	833	9,401	6.8	3,100.1	3,100.1	3,100.4	0.3
BV	151,870	441	6,742	9.5	3,101.5	3,101.5	3,101.7	0.2
BW	153,295	369	6,610	9.7	3,103.4	3,103.4	3,103.6	0.2
BX	155,545	796	11,005	5.8	3,106.4	3,106.4	3,106.7	0.3
BY	157,545	4,909	8,194	7.8	3,108.0	3,108.0	3,108.3	0.3
BZ	158,695	4,790	14,895	4.3	3,111.1	3,111.1	3,111.4	0.3
CA	160,295	2,290	6,687	6.4	3,112.9	3,112.9	3,113.0	0.1
CB	164,100	4,865	18,002	2.4	3,119.5	3,119.5	3,120.0	0.5
CC	166,000	4,451	11,588	3.7	3,121.9	3,121.9	3,122.2	0.3
CD	170,000	3,542	11,383	3.7	3,129.7	3,129.7	3,130.1	0.4
CE	171,600	3,000	10,237	4.2	3,133.5	3,133.5	3,133.9	0.4
CF	173,900	1,381	6,820	6.2	3,137.8	3,137.8	3,138.2	0.4
CG	176,700	2,426	10,090	4.2	3,144.6	3,144.6	3,145.0	0.4
CH	178,670	1,299	6,879	6.2	3,147.8	3,147.8	3,148.1	0.3
CI	178,720	1,306	7,096	6.0	3,147.9	3,147.9	3,148.4	0.5
CJ	180,745	730	4,891	8.7	3,151.8	3,151.8	3,151.8	0.0
CK	183,099	1,480	10,982	3.9	3,156.5	3,156.5	3,156.5	0.0
CL	183,399	1,480	9,953	4.3	3,157.3	3,157.3	3,157.3	0.0
CM	183,934	1,313	7,025	6.1	3,157.5	3,157.5	3,157.5	0.0
CN	186,214	394	3,913	10.9	3,162.7	3,162.7	3,162.8	0.1

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLARK FORK (cont)								
CO	187,817	451	4,541	9.4	3,167.3	3,167.3	3,167.3	0.0
CP	189,167	374	4,478	9.5	3,169.9	3,169.9	3,169.9	0.0
CQ	189,217	399	4,346	9.8	3,169.9	3,169.9	3,170.3	0.4
CR	190,497	393	4,486	9.5	3,172.4	3,172.4	3,172.6	0.2
CS	190,547	393	4,499	9.4	3,172.4	3,172.4	3,172.6	0.2
CT	192,637	367	3,548	12.0	3,175.6	3,175.6	3,175.7	0.1
CU	192,687	371	3,956	10.7	3,176.4	3,176.4	3,176.9	0.5
CV	194,277	380	3,999	10.6	3,179.4	3,179.4	3,179.5	0.1
CW	194,327	384	4,212	10.1	3,179.5	3,179.5	3,180.0	0.5
CX	196,027	416	4,295	9.9	3,182.6	3,182.6	3,182.7	0.1
CY	196,077	447	4,503	9.4	3,182.7	3,182.7	3,183.2	0.5
CZ	196,797	294	3,482	12.2	3,184.0	3,184.0	3,184.3	0.3
DA	198,257	307	4,072	10.4	3,188.6	3,188.6	3,188.6	0.0
DB	198,307	310	4,259	10.0	3,188.7	3,188.7	3,189.2	0.5
DC	199,297	632	5,252	8.1	3,190.9	3,190.9	3,191.2	0.3
DD	199,347	633	5,329	8.0	3,190.9	3,190.9	3,191.4	0.5
DE	201,457	466	5,752	7.4	3,193.9	3,193.9	3,194.2	0.3
DF	202,007	361	4,163	10.2	3,194.7	3,194.7	3,194.9	0.2
DG	204,257	351	4,648	9.1	3,199.0	3,199.0	3,199.0	0.0
DH	206,377	380	5,456	7.8	3,202.0	3,202.0	3,202.0	0.0
DI	208,242	404	5,464	7.8	3,204.6	3,204.6	3,204.6	0.0
DJ	210,267	461	5,651	7.5	3,207.1	3,207.1	3,207.1	0.0
DK	212,697	357	3,636	11.7	3,210.8	3,210.8	3,210.8	0.0

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLARK FORK (cont)								
DL	214,167	335	5,003	8.5	3,214.1	3,214.1	3,214.1	0.0
DM	214,217	339	5,226	8.1	3,214.2	3,214.2	3,214.7	0.5
DN	214,337	323	4,348	9.8	3,214.3	3,214.3	3,214.8	0.5
DO	214,427	324	4,379	9.7	3,214.4	3,214.4	3,214.9	0.5
DP	215,177	286	3,734	11.4	3,215.7	3,215.7	3,216.1	0.4
DQ	217,327	212	3,324	12.8	3,219.6	3,219.6	3,219.7	0.1
DR	217,377	215	3,463	12.3	3,219.9	3,219.9	3,220.4	0.5
DS	219,177	371	5,225	8.1	3,223.6	3,223.6	3,223.8	0.2
DT	221,677	274	4,183	10.2	3,225.9	3,225.9	3,226.1	0.2
DU	224,877	314	3,659	11.6	3,230.8	3,230.8	3,230.9	0.1
DV	226,552	211	2,937	14.5	3,234.4	3,234.4	3,234.4	0.0
DW	226,602	215	3,139	13.5	3,234.8	3,234.8	3,235.3	0.5
DX	228,397	289	4,653	9.1	3,239.2	3,239.2	3,239.4	0.2
DY	230,387	642	7,409	5.7	3,241.6	3,241.6	3,241.7	0.1
DZ	230,437	648	7,693	5.5	3,241.7	3,241.7	3,242.2	0.5
EA	231,177	578	7,263	5.9	3,242.2	3,242.2	3,242.6	0.4
EB	231,437	268	2,459	17.3	3,245.8	3,245.8	3,245.8	0.0
EC	231,487	268	8,506	5.0	3,268.3	3,268.3	3,268.3	0.0
ED	231,677	1,055	17,522	2.4	3,268.8	3,268.8	3,268.8	0.0
EE	233,577	1,901	17,507	1.5	3,268.8	3,268.8	3,268.8	0.0
EF	236,277	624	6,846	3.8	3,268.8	3,268.8	3,268.8	0.0
EG	236,327	625	6,818	3.8	3,268.8	3,268.8	3,268.8	0.0
EH	237,447	2,602	20,636	1.3	3,268.8	3,268.8	3,268.8	0.0

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLARK FORK (cont)								
EI	239,977	3,542	10,711	2.4	3,268.8	3,268.8	3,268.8	0.0
EJ	243,827	2,100	6,089	4.3	3,278.6	3,278.6	3,278.6	0.0
EK	246,217	1,342	3,722	7.0	3,286.8	3,286.8	3,287.1	0.3
EL	249,227	1,564	6,961	3.7	3,296.5	3,296.5	3,296.5	0.0
EM	251,747	1,159	4,081	6.4	3,302.5	3,302.5	3,302.8	0.3
EN	255,277	784	4,009	6.5	3,314.0	3,314.0	3,314.2	0.2
EO	258,077	1,632	5,746	4.5	3,321.4	3,321.4	3,321.4	0.0
EP	260,327	240	1,904	13.7	3,329.0	3,329.0	3,329.0	0.0
EQ	260,377	260	2,236	11.6	3,329.9	3,329.9	3,330.4	0.5
ER	261,857	420	3,354	7.8	3,336.0	3,336.0	3,336.1	0.1
ES	264,497	344	2,469	10.5	3,342.1	3,342.1	3,342.6	0.5
ET	266,757	492	3,374	7.7	3,350.5	3,350.5	3,350.5	0.0
EU	269,777	601	3,356	7.7	3,358.9	3,358.9	3,359.3	0.4
EV	270,817	366	3,494	7.4	3,361.7	3,361.7	3,362.0	0.3
EW	270,867	367	3,600	7.2	3,361.9	3,361.9	3,362.4	0.5
EX	271,827	1,566	2,368	11.0	3,365.2	3,365.2	3,365.2	0.0
EY	275,837	1,624	5,919	4.4	3,382.4	3,382.4	3,382.4	0.0
EZ	278,297	1,191	4,299	6.0	3,387.9	3,387.9	3,388.0	0.1
FA	282,797	768	3,716	7.0	3,403.9	3,403.9	3,404.4	0.5
FB	286,777	1,174	5,474	4.7	3,415.4	3,415.4	3,415.6	0.2
FC	290,317	1,932	3,725	7.0	3,427.5	3,427.5	3,427.5	0.0
FD	294,077	1,039	4,606	5.6	3,441.0	3,441.0	3,441.5	0.5
FE	296,227	830	3,913	6.6	3,446.2	3,446.2	3,446.7	0.5

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLARK FORK (cont**)**								
FF	299,727	597	3,368	7.7	3,457.9	3,457.9	3,458.1	0.2
FG	302,287	1,200	3,825	6.8	3,466.6	3,466.6	3,466.9	0.3
FH	305,047	1,240	5,182	5.0	3,476.2	3,476.2	3,476.3	0.1
FI	305,137	1,250	3,893	6.7	3,476.2	3,476.2	3,476.3	0.1
FJ	305,187	1,300	6,519	4.0	3,477.2	3,477.2	3,477.5	0.3
FK	308,597	788	3,258	8.0	3,486.2	3,486.2	3,486.7	0.5
FL	311,007	900	5,101	5.1	3,494.1	3,494.1	3,494.5	0.4
FM	313,847	757	3,364	7.7	3,502.8	3,502.8	3,503.1	0.3
FN	315,137	874	5,306	4.9	3,507.9	3,507.9	3,508.4	0.5
FO	316,387	869	3,680	7.1	3,511.0	3,511.0	3,511.1	0.1
FP	317,367	900	4,471	5.8	3,514.0	3,514.0	3,514.4	0.4
FQ	318,867	598	3,146	8.3	3,518.3	3,518.3	3,518.5	0.2
FR	320,447	381	2,705	9.6	3,523.8	3,523.8	3,524.3	0.5
FS	322,777	231	2,174	11.0	3,533.8	3,533.8	3,533.9	0.1
FT	323,457	253	2,605	9.2	3,536.3	3,536.3	3,536.7	0.4
FU	325,437	437	3,742	6.4	3,540.8	3,540.8	3,541.2	0.4
FV	325,817	1,034	8,461	2.8	3,542.7	3,542.7	3,543.2	0.5
FW	326,777	996	5,168	4.6	3,543.3	3,543.3	3,543.8	0.5
FX	328,317	344	2,748	8.7	3,548.1	3,548.1	3,548.2	0.1
FY	329,517	360	3,263	7.4	3,550.9	3,550.9	3,551.1	0.2
FZ	330,727	569	3,734	6.4	3,553.8	3,553.8	3,554.0	0.2
GA	331,877	269	1,971	12.2	3,556.0	3,556.0	3,556.4	0.4

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLARK FORK (cont)								
GB	332,317	295	2,665	9.0	3,558.9	3,558.9	3,559.3	0.4
GC	332,867	249	2,221	10.8	3,560.6	3,560.6	3,560.7	0.1
GD	333,937	306	2,653	9.1	3,566.4	3,566.4	3,566.9	0.5
GE	334,917	795	4,434	5.4	3,569.6	3,569.6	3,570.0	0.4
GF	335,917	790	3,930	6.1	3,571.9	3,571.9	3,572.2	0.3
GG	337,517	1,440	5,540	4.3	3,575.7	3,575.7	3,576.0	0.3
GH	338,917	907	4,505	5.3	3,578.2	3,578.2	3,578.6	0.4
GI	339,937	708	2,980	8.1	3,581.7	3,581.7	3,582.2	0.5
GJ	341,117	1,100	5,529	4.3	3,585.5	3,585.5	3,586.0	0.5
GK	342,327	950	3,821	6.3	3,588.3	3,588.3	3,588.4	0.1
GL	343,817	730	4,590	5.2	3,592.8	3,592.8	3,593.0	0.2
GM	344,867	640	3,675	6.5	3,595.4	3,595.4	3,595.6	0.2
GN	346,037	994	4,054	5.9	3,598.9	3,598.9	3,598.9	0.0
GO	346,117	1677	13,116	1.8	3,603.9	3,603.9	3,603.9	0.0
GP	347,547	1908	11,929	2.0	3,604.2	3,604.2	3,604.2	0.0
GQ	351,437	1519	3,271	7.3	3,612.9	3,612.9	3,612.9	0.0
GR	352,667	996	5,303	4.5	3,618.4	3,618.4	3,618.7	0.3
GS	353,627	847	3,333	7.2	3,620.5	3,620.5	3,620.8	0.3
GT	354,187	500	6,063	4.0	3,629.2	3,629.2	3,629.2	0.0
GU	354,557	277	3,255	7.4	3,629.2	3,629.2	3,629.2	0.0
GV	356,007	279	2,889	8.3	3,631.4	3,631.4	3,631.5	0.1
GW	357,397	270	2,654	9.0	3,634.8	3,634.8	3,635.0	0.2
GX	358,867	232	2,438	9.8	3,638.3	3,638.3	3,638.5	0.2

[1]Feet above Missoula County/Mineral County Line

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLARK FORK

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)
CLEARWATER RIVER								
A	-460	193	702	6.0	3,925.5	3,925.5	3,926.0	0.5
B	-25	60	457	9.2	3,927.0	3,927.0	3,927.5	0.5
C	25	60	474	8.9	3,927.3	3,927.3	3,927.8	0.5
D	220	208	1,154	3.6	3,928.8	3,928.8	3,929.1	0.3
E	1,820	510	1,538	2.7	3,930.6	3,930.6	3,931.1	0.5
F	3,030	249	1,005	4.2	3,933.4	3,933.4	3,933.9	0.5
G	4,520	269	1,191	3.5	3,936.3	3,936.3	3,936.8	0.5
H	7,280	202	749	5.6	3,941.6	3,941.6	3,942.0	0.4
I	9,780	480	1,573	2.7	3,948.4	3,948.4	3,948.9	0.5
J	11,400	110	470	6.8	3,952.7	3,952.7	3,952.9	0.2
K	13,420	607	1,982	1.6	3,958.4	3,958.4	3,958.9	0.5
L	15,930	383	977	3.3	3,962.9	3,962.9	3,963.3	0.4
M	18,920	78	395	8.1	3,972.0	3,972.0	3,972.0	0.0
N	19,250	78	431	7.4	3,973.5	3,973.5	3,973.5	0.0
O	19,300	78	443	7.2	3,973.7	3,973.7	3,973.7	0.0
P	19,520	81	471	6.8	3,974.4	3,974.4	3,974.4	0.0
Q	22,420	95	414	7.7	3,985.3	3,985.3	3,985.4	0.1
R	25,000	104	568	5.6	3,993.8	3,993.8	3,994.0	0.2
S	26,560	232	651	4.9	3,998.0	3,998.0	3,998.3	0.3
T	27,350	97	476	6.7	4,000.5	4,000.5	4,000.9	0.4
U	27,400	97	504	6.3	4,000.7	4,000.7	4,001.2	0.5
V	28,230	292	2,304	1.4	4,001.7	4,001.7	4,002.0	0.3

[1]Feet from Placid Lake Road

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLEARWATER 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)
CLEARWATER RIVER (cont)								
W	30,490	744	4,946	0.6	4,001.8	4,001.8	4,002.1	0.3
X	31,895	682	5,585	0.6	4,001.8	4,001.8	4,002.1	0.3
Y	33,820	505	4,156	0.8	4,001.8	4,001.8	4,002.1	0.3
Z	35,830	631	4,858	0.7	4,001.9	4,001.9	4,002.2	0.3
AA	37,030	659	4,675	0.7	4,001.9	4,001.9	4,002.2	0.3

[1]Feet from Placid Lake Road

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CLEARWATER 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)
GRANT CREEK								
A	25	30	111	4.2	3,276.3	3,276.3	3,276.3	0.0
B	200	38	75	6.2	3,279.4	3,279.4	3,279.4	0.0
C	500	29	101	4.6	3,283.7	3,283.7	3,283.7	0.0
D	675	24	85	5.5	3,285.9	3,285.9	3,285.9	0.0
E	1,399	60	103	4.5	3,299.1	3,299.1	3,299.1	0.0
F	2,103	37	106	4.4	3,315.0	3,315.0	3,315.0	0.0
G	3,780	32	88	5.3	3,343.4	3,343.4	3,343.4	0.0
H	4,805	118	176	2.6	3,362.6	3,362.6	3,363.1	0.5
I	6,930	79	155	3.0	3,412.3	3,412.3	3,412.8	0.5
J	8,830	81	95	4.9	3,451.5	3,451.5	3,451.5	0.0
K	10,130	38	101	4.6	3,484.7	3,484.7	3,485.2	0.5
L	12,530	31	96	4.8	3,544.2	3,544.2	3,544.2	0.0
M	13,405	93	116	4.0	3,561.0	3,561.0	3,561.0	0.0
N	14,855	105	193	2.4	3,606.8	3,606.8	3,606.8	0.0
O	17,830	47	131	3.8	3,687.3	3,687.3	3,687.3	0.0
P	19,380	27	94	4.9	3,730.8	3,730.8	3,731.3	0.5
Q	21,080	100	157	3.3	3,779.0	3,779.0	3,779.2	0.2
R	21,305	25	96	4.8	3,785.6	3,785.6	3,785.6	0.0

[1]Feet Above East Bound Exit Ramp I-90

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

GRANT 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)
LAVALLE CREEK								
A	100	525	2,066	0.5	3,074.5	3,074.5	3,074.5	0.0
B	1,061	545	2,467	0.4	3,074.5	3,074.5	3,074.5	0.0
C	1,796	318	1010	0.9	3,074.5	3,074.5	3,074.6	0.1
D	2,535	746	2,356	0.4	3,074.6	3,074.6	3,074.7	0.1
E	2,697	737	1,953	0.5	3,074.6	3,074.6	3,074.7	0.1
F	2,814	733	1,878	0.5	3,074.6	3,074.6	3,074.7	0.1
G	2,905	693	1,496	0.6	3,074.6	3,074.6	3,074.7	0.1
H	3,261	643	1,505	0.6	3,074.6	3,074.6	3,074.7	0.1
I	4,741	876	1,476	0.6	3,074.8	3,074.8	3,075.0	0.2
J	6,209	650	795	1.2	3,075.7	3,075.7	3,075.8	0.1
K	7,835	174	362	2.6	3,078.5	3,078.5	3,078.5	0.0
L	8,917	183	572	1.6	3,079.5	3,079.5	3,079.6	0.1
M	9,725	274	699	1.4	3,079.8	3,079.8	3,080.0	0.2
N	10,442	377	923	1.0	3,080.1	3,080.1	3,080.3	0.2
O	11,290	396	1,165	0.8	3,080.3	3,080.3	3,080.5	0.2
P	11,757	304	961	1.0	3,080.3	3,080.3	3,080.5	0.2
Q	12,128	357	1,046	0.9	3,080.4	3,080.4	3,080.6	0.2
R	12,267	528	1,734	0.5	3,081.4	3,081.4	3,081.5	0.1
S	12,681	735	2,371	0.4	3,081.5	3,081.5	3,081.5	0.0
T	13,326	738	2,442	0.4	3,081.5	3,081.5	3,081.6	0.1
U	13,925	685	1,820	0.5	3,081.5	3,081.5	3,081.6	0.1
V	14,633	386	1,094	0.9	3,081.6	3,081.6	3,081.7	0.1

[1]Feet above Frenchtown Irrigation District Ditch Centerline

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

LAVALLE 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)
LAVALLE CREEK (cont)								
W	15,259	621	1,872	0.3	3,081.6	3,081.6	3,081.7	0.1
X	15,708	598	1,850	0.3	3,081.6	3,081.6	3,081.7	0.1
Y	16,607	978	2,219	0.2	3,081.6	3,081.6	3,081.7	0.1
Z	17,264	1,465	2,061	0.3	3,081.7	3,081.7	3,081.8	0.1
AA	18,447	2,057	1,295	0.4	3,082.1	3,082.1	3,082.1	0.0

[1]Feet above Frenchtown Irrigation District Ditch Centerline

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

LAVALLE 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)
LOLO CREEK								
A	2,700	1,380	771	4.3	3,165.1	3,165.1	3,165.6	0.5
B	4,100	1,000	1,712	1.9	3,169.3	3,169.3	3,169.7	0.4
C	5,190	111	415	7.9	3,174.1	3,174.1	3,174.6	0.5
D	5,240	66	393	8.4	3,174.4	3,174.4	3,174.8	0.4
E	5,270	66	413	8.0	3,174.7	3,174.7	3,175.1	0.4
F	5,870	120	508	6.5	3,178.0	3,178.0	3,178.0	0.0
G	6,370	123	462	7.1	3,180.3	3,180.3	3,180.6	0.3
H	6,450	120	492	6.7	3,180.7	3,180.7	3,181.1	0.4
I	6,480	120	519	6.4	3,180.8	3,180.8	3,181.3	0.5
J	7,900	200	749	4.4	3,186.9	3,186.9	3,187.0	0.1
K	8,300	161	570	5.8	3,188.4	3,188.4	3,188.7	0.3
L	9,080	294	570	5.8	3,194.7	3,194.7	3,194.7	0.0
M	10,520	236	734	4.5	3,202.9	3,202.9	3,203.1	0.2
N	11,940	201	513	6.4	3,211.4	3,211.4	3,211.4	0.0
O	12,515	203	631	5.2	3,215.3	3,215.3	3,215.4	0.1
P	14,170	141	412	8.0	3,225.9	3,225.9	3,225.9	0.0
Q	15,335	159	563	5.9	3,233.6	3,233.6	3,233.8	0.2
R	16,220	246	574	5.8	3,238.1	3,238.1	3,238.5	0.4
S	18,385	340	546	6.0	3,249.6	3,249.6	3,250.1	0.5
T	20,830	314	684	4.8	3,263.9	3,263.9	3,263.9	0.0
U	22,200	250	610	5.4	3,272.7	3,272.7	3,272.9	0.2
V	24,275	75	390	8.5	3,286.2	3,286.2	3,286.3	0.1

[1]Feet above confluence with Bitterroot River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

LOLO 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)
LOLO CREEK (cont)								
W	26,075	99	369	8.1	3,299.5	3,299.5	3,299.5	0.0
X	27,925	78	404	7.4	3,311.7	3,311.7	3,311.7	0.0
Y	27,955	78	448	6.7	3,311.8	3,311.8	3,312.3	0.5
Z	28,050	343	1,173	2.6	3,312.7	3,312.7	3,313.0	0.3
AA	28,375	177	419	7.2	3,313.0	3,313.0	3,313.2	0.2
AB	31,870	532	916	3.3	3,332.5	3,332.5	3,333.0	0.5
AC	35,180	397	619	4.8	3,356.3	3,356.3	3,356.3	0.0
AD	36,550	79	402	7.5	3,365.9	3,365.9	3,365.9	0.0
AE	36,580	79	420	7.1	3,366.1	3,366.1	3,366.1	0.0
AF	36,680	107	548	5.5	3,366.8	3,366.8	3,366.8	0.0
AG	36,940	142	441	6.8	3,367.7	3,367.7	3,367.7	0.0

[1]Feet above confluence with Bitterroot River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

LOLO 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)
MILLER CREEK A through D (No Floodway Computed)								
E	14,800	82	130	5.2	3,364.8	3,364.8	3,365.3	0.5
F	15,286	257	264	2.6	3,371.7	3,371.7	3,372.0	0.3
G	15,500	200	608	1.1	3,372.0	3,372.0	3,372.4	0.4
H	15,800	70	99	6.8	3,375.1	3,375.1	3,375.1	0.0
I	16,350	79	150	4.5	3,382.8	3,382.8	3,383.0	0.2
J	17,475	116	153	4.4	3,403.2	3,403.2	3,403.2	0.0
K	18,000	79	103	6.6	3,413.3	3,413.3	3,413.3	0.0
L	18,550	65	133	5.1	3,421.6	3,421.6	3,421.9	0.3
M	20,850	70	183	3.7	3,470.8	3,470.8	3,470.8	0.0
N	22,400	61	128	5.3	3,487.4	3,487.4	3,487.6	0.2
O	24,000	67	96	7.1	3,518.3	3,518.3	3,518.8	0.5
P	25,400	90	176	3.8	3,544.3	3,544.3	3,544.4	0.1
Q	26,250	20	65	10.4	3,557.6	3,557.6	3,557.6	0.0
R	27,800	145	235	2.9	3,581.1	3,581.1	3,581.6	0.5
S	30,250	99	190	3.6	3,608.8	3,608.8	3,609.2	0.4
T	31,350	55	91	7.4	3,626.5	3,626.5	3,626.5	0.0
U	32,900	212	180	3.7	3,652.4	3,652.4	3,652.4	0.0
V	34,250	155	124	5.4	3,666.6	3,666.6	3,666.6	0.0
W	36,400	194	149	4.5	3,703.1	3,703.1	3,603.6	0.5

[1]Feet above confluence with Bitterroot River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

MILLER 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)
PATTEE CREEK								
A	315	26	46	4.2	3,233.7	3,233.7	3,233.7	0.0
B	1,375	47	52	3.8	3,262.6	3,262.6	3,262.6	0.0
C	1,550	116	117	1.7	3,268.7	3,268.7	3,268.7	0.0
D	1,815	40	36	5.4	3,275.7	3,275.7	3,275.7	0.0
E	1,885	41	36	5.4	3,279.6	3,279.6	3,279.6	0.0
F	2,655	23	30	6.5	3,300.7	3,300.7	3,300.7	0.0
G	2,855	222	629	0.3	3,311.2	3,311.2	3,311.2	0.0
H	3,055	33	34	5.7	3,316.5	3,316.5	3,316.5	0.0
I	3,555	31	33	5.9	3,334.5	3,334.5	3,334.5	0.0
J	4,085	46	38	5.2	3,355.6	3,355.6	3,355.6	0.0

[1]Feet above South Higgins Avenue in the City of Missoula

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

PATTEE 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)
RATTLESNAKE CREEK								
A	220	150	289	12.1	3,189.9	3,182.1[2]	3,182.1[2]	0.0
B	500	230	652	4.6	3,189.9	3,188.3[2]	3,188.3[2]	0.0
C	750	63	354	8.5	3,191.6	3,191.6	3,191.6	0.0
D	940	210	270	11.1	3,195.6	3,195.6	3,195.6	0.0
E	1,030	230	638	4.7	3,197.5	3,197.5	3,197.5	0.0
F	1,540	64	323	9.3	3,202.4	3,202.4	3,202.4	0.0
G	1,570	66	345	8.7	3,202.7	3,202.7	3,202.7	0.0
H	1,680	85	322	9.3	3,204.2	3,204.2	3,204.2	0.0
I	2,110	74	423	7.1	3,211.7	3,211.7	3,211.7	0.0
J	2,145	73	436	6.9	3,211.9	3,211.9	3,211.9	0.0
K	3,025	270	378	7.9	3,222.5	3,222.5	3,222.5	0.0
L	4,205	380	440	6.8	3,240.9	3,240.9	3,240.9	0.0
M	5,205	390	609	4.9	3,256.4	3,256.4	3,256.4	0.0
N	5,585	42	226	13.3	3,263.5	3,263.5	3,263.5	0.0
O	5,885	354	861	5.7	3,269.4	3,269.4	3,269.4	0.0
P	6,065	154	336	10.3	3,271.2	3,271.2	3,271.2	0.0
Q	6,875	475	822	4.3	3,285.0	3,285.0	3,285.0	0.0
R	7,870	74	272	11.0	3,302.8	3,302.8	3,302.8	0.0
S	8,370	102	415	8.5	3,313.1	3,313.1	3,313.1	0.0
T	9,000	288	472	9.1	3,321.6	3,321.6	3,321.6	0.0
U	9,750	570	606	6.3	3,334.0	3,334.0	3,334.0	0.0
V	10,330	295	391	9.4	3,342.8	3,342.8	3,342.8	0.0

[1]Feet above confluence with Clark Fork [2]Elevations Computed Without Consideration of Backwater Effects From Clark Fork

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

RATTLESNAKE 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)
RATTLESNAKE CREEK (cont)								
W	10,800	360	1,760	1.5	3,354.4	3,354.4	3,354.4	0.0
X	10,850	370	685	4.4	3,354.4	3,354.4	3,354.4	0.0
Y	11,900	500	338	9.9	3,370.6	3,370.6	3,370.6	0.0
Z	12,350	450	930	2.7	3,377.6	3,377.6	3,377.6	0.0
AA	12,600	494	1,250	2.9	3,379.0	3,379.0	3,379.0	0.0
AB	13,425	436	667	9.7	3,393.2	3,393.2	3,393.2	0.0
AC	14,530	490	556	8.5	3,409.0	3,409.0	3,409.0	0.0
AD	15,340	470	1,601	7.3	3,421.2	3,421.2	3,421.2	0.0
AE	16,170	460	450	6.7	3,434.6	3,434.6	3,434.6	0.0
AF	17,145	390	526	7.1	3,450.0	3,450.0	3,450.0	0.0
AG	18,250	230	421	9.9	3,467.6	3,467.6	3,467.6	0.0
AH	19,340	410	528	7.6	3,484.3	3,484.3	3,484.3	0.0
AI	19,790	210	256	11.7	3,490.6	3,490.6	3,490.6	0.0
AJ	20,400	100	398	7.9	3,500.0	3,500.0	3,500.0	0.0
AK	20,500	65	426	7.0	3,501.2	3,501.2	3,501.2	0.0
AL	20,550	368	5,009	0.6	3,514.1	3,514.1	3,514.1	0.0
AM	21,140	180	592	6.0	3,514.2	3,514.2	3,514.2	0.0
AN	21,340	130	350	8.6	3,516.0	3,516.0	3,516.0	0.0
AO	21,700	150	347	8.8	3,520.9	3,520.9	3,520.9	0.0
AP	22,220	140	408	8.6	3,530.1	3,530.1	3,530.1	0.0
AQ	22,860	110	325	9.5	3,542.5	3,542.5	3,542.5	0.0
AR	23,920	120	565	6.4	3,557.6	3,557.6	3,557.6	0.0
AS	23,960	52	253	11.9	3,557.6	3,557.6	3,557.6	0.0

[1]Feet above confluence with Clark Fork

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

RATTLESNAKE 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)
RATTLESNAKE CREEK (cont)								
AT	23,980	52	344	8.7	3,559.4	3,559.4	3,559.4	0.0
AU	24,500	340	433	8.5	3,565.8	3,565.8	3,565.8	0.0
AV	25,450	410	541	8.0	3,582.3	3,582.3	3,582.3	0.0
AW	26,225	110	553	6.8	3,594.4	3,594.4	3,594.4	0.0
AX	27,260	170	470	8.6	3,607.2	3,607.2	3,607.2	0.0
AY	27,900	160	375	8.6	3,617.1	3,617.1	3,617.1	0.0
AZ	28,400	190	416	9.3	3,626.6	3,626.6	3,626.6	0.0
BA	29,400	200	742	5.6	3,641.3	3,641.3	3,641.3	0.0

[1]Feet above confluence with Clark Fork

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

RATTLESNAKE 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)
ROCK CREEK								
A	0.10	710	2,069	4.5	3,527.1	3,525.8[2]	3,526.3[2]	0.5
B	0.30	460	2,097	4.4	3,533.1	3,533.1	3,533.6	0.5
C	0.32	500	1,640	5.6	3,533.2	3,533.2	3,533.7	0.5
D	0.60	1,170	3,973	2.3	3,540.0	3,540.0	3,540.2	0.2
E	0.87	600	1,724	5.3	3,547.7	3,547.7	3,548.1	0.4
F	1.21	585	2,238	4.1	3,559.9	3,559.9	3,560.2	0.3
G	1.45	725	2,284	4.0	3,565.6	3,565.6	3,565.9	0.3
H	1.67	675	1,859	5.0	3,571.0	3,571.0	3,571.0	0.0
I	1.92	750	2,392	3.9	3,576.4	3,576.4	3,576.9	0.5
J	2.13	930	2,599	3.5	3,581.6	3,581.6	3,581.9	0.3
K	2.29	805	2,893	3.2	3,584.6	3,584.6	3,585.0	0.4
L	2.44	655	2,225	4.1	3,587.6	3,587.6	3,588.1	0.5
M	2.57	380	1,598	5.8	3,591.4	3,591.4	3,591.4	0.0
N	2.73	580	1,647	5.6	3,595.5	3,595.5	3,596.0	0.5
O	2.76	885	6,219	1.5	3,600.3	3,600.3	3,600.8	0.5
P	2.90	830[3]	3,080	3.0	3,600.7	3,600.7	3,601.2	0.5
Q	4.03	715[3]	2,227	4.1	3,631.7	3,631.7	3,632.2	0.5
R	4.32	1130	3,018	3.1	3,640.1	3,640.1	3,640.5	0.4
S	4.54	650	1,785	5.2	3,647.6	3,647.6	3,647.6	0.0
T	4.85	750	2,473	3.7	3,658.4	3,658.4	3,658.5	0.1
U	5.09	385	1,084	8.5	3,666.0	3,666.0	3,666.4	0.4
V	5.34	475	1,592	5.8	3,676.4	3,676.4	3,676.8	0.4
W	5.57	641	2,177	4.2	3,684.4	3,684.4	3,684.7	0.3

[1]Miles above confluence with Clark Fork [2]Elevation Computed Without Consideration of Backwater Effects from Clark Fork
[3]Floodway Lies Entirely Outside County Corporate Limits

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

ROCK CREEK

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 Missoula 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 6.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDAY MAP REVISION DATE	INITIAL FIRM EFFECTIVE DATE	FIRM REVISION DATE
Missoula, City of	March 8, 1974	--	January 6, 1983	August 16, 1988
Missoula County (Unincorporated Areas)	August 30, 1974	--	August 15, 1983	June 5, 1985 August 16, 1988

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA COUNTY, MT
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

A number of hydrologic and/or hydraulic studies have been performed on various portions of Clark Fork and the South Hills area.

The USACE published hydrologic and hydraulic results for reaches of Clark Fork, Bitterroot River, and Lolo Creek (References 5, 6, and 22). One report covers the area of Clark Fork below the confluence of Bitterroot River (Reference 5). The USACE hydrology was based on the gage below Missoula (Gage No. 3530), and the results at comparable frequencies had reasonable concurrence. Adjustments for changing drainage areas were also made at intervals along the study reach. A second report by the USACE covers Clark Fork from the confluence of Bitterroot River upstream to Hellgate Canyon, east of the City of Missoula (Reference 6). The gaging station above Missoula (Gage No. 3405) was used as the basis for determining the intermediate regional 1-percent annual chance flood. The value published by the USACE was nearly identical to that determined for this study; hence, the USACE figure was accepted as representative and used where applicable in this study reach. In general, the data from these reports were compatible with those in the study, and concurrence was found in most instances. Some differences in floodway delineation were found, but these differences are due to the use of different encroachment limits and methods, as discussed previously in Section. 4.2.

The Geology Department of the University of Montana has published a report (Reference 28) that includes reaches of Clark Fork covered in this study. This report provided useful information about watershed characteristics and historical flooding.

The reach of Clark Fork east from Hellgate Canyon to the Missoula-Granite County limits was included in the report published by the Geology Department of the University of Montana (Reference 28). This reach includes the gage site above Missoula (Gage No. 3405), and values for the 2- and 1-percent annual chance frequency events are given and are used on analysis of the gage data by USGS methods (Reference 7). The figures for the gage data listed in the report were significantly lower than those determined for this study for the same gage. These differences apparently result from the use in the University of Montana report of geographical and analytical methods that have since been updated and/or modified by the USGS. Hence, the results determined for this study by the USACE, as mentioned previously, were considered more representative and were used throughout the reach to the confluence of Blackfoot River at Milltown.

The USGS performed log-Pearson Type III analyses of data from gages on Clark Fork. The results were published in 1976 (Reference 5); however, because subsequent measurements have been taken, these previously published results are considered to be of little value.

A private consulting firm completed a detailed hydraulic study along approximately 2 miles of the Clark Fork including the Reserve Street Bridge in 2004 (Reference 25) for Missoula County. The study includes replacement of the Reserve St Bridge and gravel mining along the south bank of the river. The study ties into the effective study of the Clark Fork and includes new lower BFEs and updated floodplain delineation. This study was revised and accepted by FEMA and is included in this FIS.

The SCS published a report on the hydrology of Bitterroot River drainage (Reference 29) based mainly on snow survey data and precipitation records. The report provided some useful precipitation information that was incorporated into this study. Discrepancies in peak-flow determination by the USGS have since been updated.

The USGS has published discharge-frequency data for Blackfoot River (Reference 7), and a report by the University of Montana Geology Department (Reference 28) also lists 2- and 1-percent annual chance flows. Comparison of results showed values for this study to be slightly higher than those of both reports. The USGS used a log-Pearson Type III distribution analysis based on the gage records from the station near Bonner. The study was done in 1973 and did not include 1974 and 1975 peak flows, which were above normal and included in this study. The University of Montana report also used USGS methods, some of which have been updated. Because of the methods used in the older studies, their differences with the values in this study are probably the result of using an expanded data base and more current methodologies; and the results thus obtained are the most representative.

The USGS performed log-Pearson Type III analyses of data from gages on Blackfoot River, Clark Fork, and Lolo Creek. The results were published in 1976 (Reference 7). However, because subsequent measurements have been taken, these previously published results are considered to be of limited value.

The USACE completed a report on Lolo Creek in June 1975 in which they published 2- and 1-percent annual chance peak discharges (Reference 22). A comparison of those values with the ones in this study showed reasonable concurrence; thus, the 1975 values were accepted as representative and were used where applicable. The 10- and 0.2-percent annual chance discharges were taken from the final tabulations used for this study. The gage above Sleeman Creek is near the upper limit of the study reach; therefore, adjustments for the increased drainage area at the mouth (beginning of detailed study) were made by the transfer technique suggested by the USGS (Reference 7).

The USACE completed a report on Rattlesnake Creek in 1976 which determined a suggested 1-percent annual chance floodplain and coincident floodway (Reference 23). Concurrence with this study was within acceptable limits: therefore, the data collected by the USACE for their report formed the basis of information used for this FIS.

A private consulting firm developed a Storm Drainage Management Plan for South Hills Area, Missoula, Montana (Reference 30) and another developed the South Hills Drainage Project, Missoula County (Reference 15). Their reports for the Missoula County Commissioners evaluated the existing and potential stormwater drainage problems within the South Hills and made recommendations for stormwater management plans. Much of the field investigation and historical-flood problem information was included in this study.

A private consulting firm completed a detailed hydrologic and hydraulic study for portions of Butler and La Valle Creek in 2006 (Reference 13 and 24) for Missoula County. Their report included the preparation of new hydrologic data for Butler and La Valle Creeks, updated detailed flooding for La Valle Creek from Valley French Ditch to upstream of the confluence of Butler and La Valle Creeks, Butler Creek from the confluence with La Valle to the

Frenchtown Irrigation District Ditch, and Upper La Valle from the confluence to the Frenchtown Irrigation District Ditch, as well as a floodway analysis on La Valle Creek from the Frenchtown Irrigation District Ditch upstream for a total of 18,447 feet. This study is included in this FIS.

Flood Insurance Studies have been prepared for Missoula County, the City of Missoula, and adjacent Flathead County, Montana, and are in agreement with this study (References 31, 32, and 33).

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

Table 7 – Summary of LOMCs

Type of LOMC	Case Number	Effective Date	Project Identifier
LOMR	89-08-13P	May 12, 1989	Bitterroot River to Reserve Street
LOMR	89-08-33P	August 15, 1989	N/A
LOMR	91-08-36P	October 21, 1991	N/A
LOMR	92-08-055P	December 15, 1992	N/A
LOMR	99-08-240P	April 26, 2000	Tract D-2, C.O.S. NO. 4754, Parcel 1 & Tract D, C.O.S. NO. 2976, Parcel 2
LOMR	00-08-199P	June 14, 2000	Grant Creek Center Phases I & II
LOMR	04-08-371P	July 23, 2004	South Hills Storm Drainage Project

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.

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