Clark Fork of the Columbia River

Floodplain Delineation

Prepared for

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FLOOD INSURANCE STUDY
SANDERS COUNTY, MONTANA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in Sanders County, Montana, and aides 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 County that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Montana has floodplain management criteria and regulations that are more restrictive than the minimum Federal requirements. The more restrictive criteria regarding floodway encroachment is used in this study.

1.2 Authority and Acknowledgements

The hydrologic and hydraulic analyses for this study were performed by HKM Engineering Inc. for Sanders County. This work was completed in August 2000.

The source of the base map is Horizons, Inc. in Rapid City, South Dakota. The base map was prepared from aerial photographs taken by Horizons, Inc. on November 2, 1999. The base map has a contour interval of 5 feet and a scale of 1 inch equals 1000 feet. Coordinates are State Plane, NAD83-1992, MT Zone 2500. The map projection is Lambert Conformal Conic. The datum is the North American Vertical Datum of 1988. Benchmark data is presented in Appendix A.

1.3 Coordination

The initial coordination meeting was held prior to beginning the study and was attended by representatives from the Sanders County, The Montana Department of Natural Resources and Conservation (DNRC), county residents, and the study contractor.

Coordination with county officials and residents, and Federal, State and regional agencies produced information pertaining to floodplain regulations, community maps, flood history, and other hydrologic data.

The U.S. Geological Survey (USGS) was contacted for hydrologic data. Vertical and horizontal control data used to establish survey control and the network of elevation reference marks was provided by the U.S. Coastal and Geodetic Survey (USC&GS).

An intermediate meeting was held in Thompson Falls and Plains on June 13, 2000, and attended by Sanders County, county residents, and the study contractor. The purpose of these meetings was to present preliminary results of the study to the County.

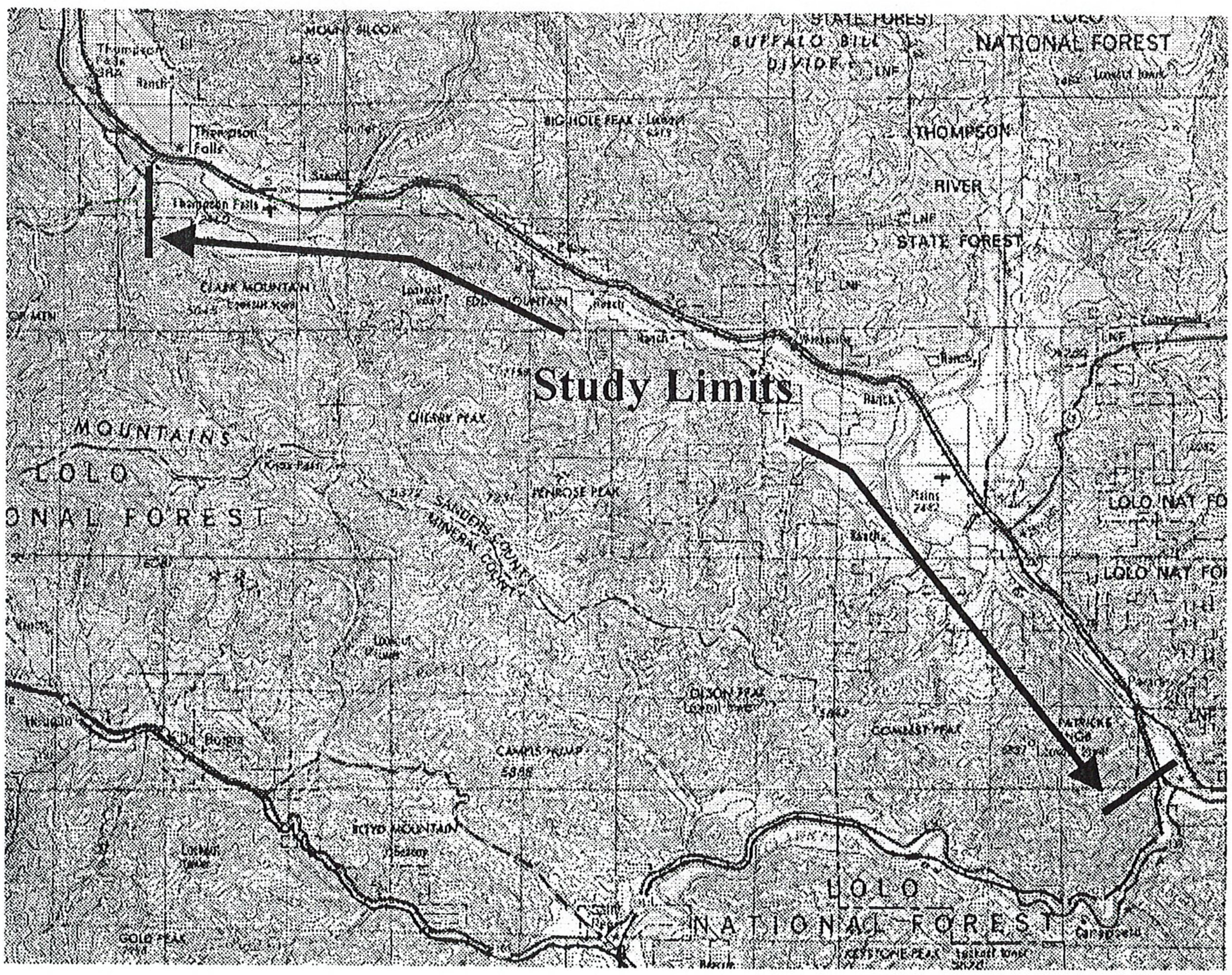
2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study is contained within Sanders County, Montana. The area of study is shown on the vicinity map (Figure 1). Riverine flooding on the Clark Fork River from Thompson Falls Reservoir upstream to the confluence with the Flathead River was studied by detailed methods. The scope and methods of the study were proposed to, and agreed upon by, DNRC and the County.

Figure 1

Vicinity Map



2.2 Community Description

Sanders County is located in northwestern Montana. Thompson Falls is the largest city in Sanders County.

Sanders County is bounded by Mineral County on the south, Lake County on the east, Lincoln County on the north, and Idaho on the west.

The largest nearby cities are Kalispell to the northeast and Missoula to the southeast.

The Clark Fork River flows from southeast to northwest through Sanders County. Residential development along the Clark Fork is increasing rapidly. Because of the steep valley walls, development generally occurs in the valley bottom which may be prone to flooding.

The climate west of the Continental Divide is termed a modified north Pacific coast type. Rivers carry floating ice during the late winter or early spring. Generally, nearly half of the annual long-term average precipitation total falls in the months of May, June and July. The western portion of the State is the wettest. Most snow falls during the months of November through March. The majority of Montana's river flows occur during the spring and early summer months with the melting of the winter snowpack. Heavy rains during the spring thaw increase the flood threat. Ice jams usually occur in March during the spring breakup. Annual normal temperature and precipitation for Thompson Falls are 47.6°F and 20.80 inches, respectively (U.S. Department of Commerce, 1974).

2.3 Principal Flooding Problems

There are two USGS gages in the study reach:

12389000 Clark Fork near Plains, Montana	1910-current year
12390000 Thompson Falls Reservoir	1930-current year

Maximum discharges for the Clark Fork gage have occurred in May or June in all years except 1916 (July 2) and 1994 (April 26).

Major floods occurred in 1948, 1964, 1975, 1996, and 1997. Only the flood of 1996 resulted from ice jamming. Since this is the only significant documented ice jam flood, no recurrence intervals for ice jam floods have been developed. See Table 1.

TABLE 1 HISTORIC FLOODS		
Date	Discharge (cfs)	Recurrence Interval (years)
June 5, 1948	134,000	45
June 11, 1964	128,000	25
June 22, 1975	107,000	6
February 9-14, 1996	51,300	NA
May 19, 1997	110,000	7

The U.S. Army of Corps of Engineers reported the following information regarding the 1964, 1948, and 1975 flood events (U.S. Army Corps of Engineers, 1981):

"One of the most damaging floods in northwestern Montana of recent history was the June 1964 flood. An unusually cold spring delayed melting of a record snowpack in the Rocky Mountains. Snow surveys indicated that the snowpack was generally 150 to 200 percent of normal. On 8 June, temperatures in the mountains rose to the high 40's and 50's. A day earlier, on 7 June, heavy rains started around noon and continued until the evening of the 8th – a total of about 30 hours. An unusual aspect of this storm was an intrusion of warm, moist air from the Gulf of Mexico instead of the usual Pacific frontal system. Since the heaviest rains fell in the Flathead River Basin and the Clark Fork Basin was only in the fringe of the storm system, the flows on the Clark Fork near Plains were not as great in magnitude as experienced in the Flathead Basin. A maximum discharge of 128,000 cubic feet per second (c.f.s.) was recorded on 11 June 1964 at the gaging station near Plains.

The flood of June 1948 was also the result of heavy snow runoff augmented by rain. Above normal precipitation for two successive months and cool temperatures into mid-May increased the water content of the above normal snowpack and delayed its melting. Temperatures began increasing on 15 May and reached the mid-70's at Missoula on the 16th and 17th. Rain began falling on the 19th and continued intermittently through the 23rd. Flows in some stream west of the Continental Divide were the highest in over 40 years. At the streamgaging station near Plains, the Clark Fork reached a maximum discharge of 134,000 c.f.s., which was the highest ever recorded.

In June 1975, a late spring caused an unusually heavy snowpack to be carried over into May. From the 10th through 16th of June, temperatures ranged up to 13°F above normal. Heavy rains fell along the Continental Divide in the Flathead Basin, similar to the June 1964 flood; however, the storm was not as intense, and flooding on the Clark Fork was primarily from snowmelt. On 22 June 1975, the Clark Fork reached a maximum discharge of 107,000 c.f.s. at the streamgage near Plains."

On the night of February 9, 1996, an ice jam 12 miles in length formed above Thompson Falls. Ice jams occurred at two locations. One was at the bedrock channel constriction one mile upstream of the dam, and the second was at the island filled area, 8 miles upstream of Thompson Falls. Upstream of the island area, the jam flooded farms and a four-mile stretch of Route 200 in the Eddy Flats area. Above Eddy Flats, the river washed away 500 feet of railroad track causing the derailment of two freight trains. At the island area, 60 plus acres of ice remained, covering the islands and many of the connecting channels. The ice size ranged from slush ice to broken sheets that were 10 to20 feet wide and up to a foot thick. On Saturday the 10th, the toe of the jam shifted and moved several yards downstream past the island area. On Wednesday the 14th, the jam broke and ice began to move as one. Operators at the Thompson Falls Dam opened a central gate to its maximum, in an effort to pass as much of the ice and debris as possible so it wouldn't cause any damage to the hydroelectric station to the right of the dam. A debris boom designed to funnel ice to the centrally located gate failed and was swept against a steel bridge. Beaver Creek Road was completely washed out and Blue Slide Road was closed due to the uncertainty of the ground beneath the road.

On Saturday, May17, 1997, the Clark Fork surpassed its 16-foot flood stage. The river crested at 17.12 feet on Monday the 19th.

2.4 Flood Protection Measures

The highway between Thompson Falls and Plains has been raised to reduce flood damage.

3.0 ENGINEERING METHODS

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 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 100-year flood (1-percent chance of annual exceedence) 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 peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

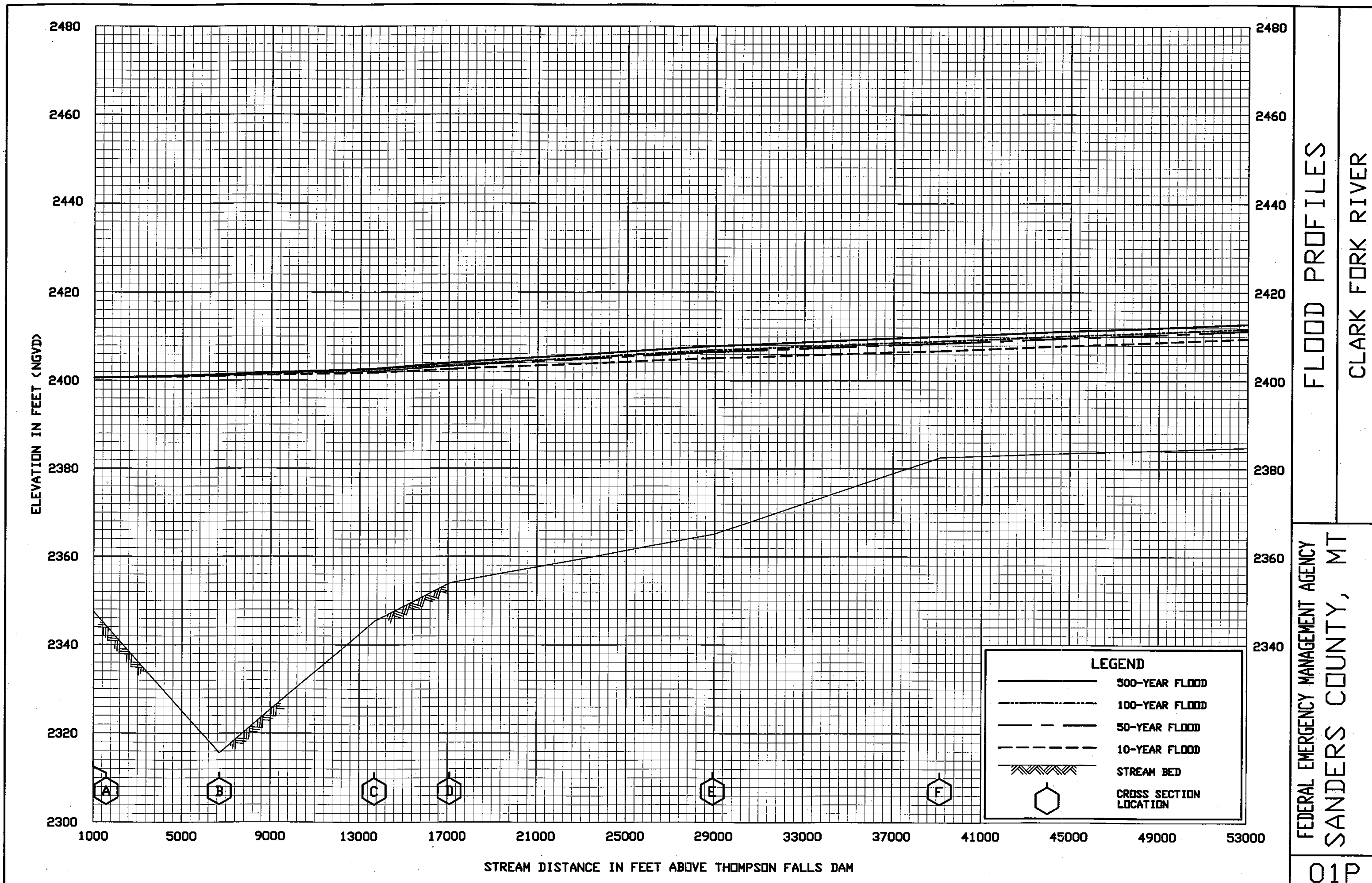
FEMA indicates flood flow frequency curves for gaged sites on unregulated streams shall be obtained from the local district office of the USGS, Water Resources Division. The USGS indicates the flow at the gage Clark Fork near Plains, Montana (12389000) is partly regulated by Hungry Horse Reservoir (12362000) and by Flathead Lake (Kerr Dam) (12371500). Hungry Horse Dam and Kerr Dam are located on the Flathead River, a tributary of the Clark Fork River. Key drainage areas are provided in Table 2.

TABLE 2 GAGE STATIONS		
Station Number	**Station Name**	**Drainage Area (sm)**
12390000	Thompson Falls Reservoir	20,968
12389000	Clark Fork near Plains, MT	19,958
12371550	Flathead Lake at Polson, MT	7,086
12362000	Hungry Horse Reservoir near Hungry Horse, MT	1,654

Hungry Horse Reservoir and Flathead Lake regulate 8% and 36% of the drainage upstream of the Clark Fork gage, respectively. The USGS (2000) developed peak discharge-frequency relationships for the entire period of record from 1910 to 1999 and for the period after construction of Kerr Dam and Hungry Horse Dam, 1953 to 1999, to determine the impact of storage on peak discharge estimates. Peak discharge estimates were prepared for both the Clark Fork near Plains (12389000) and the Clark Fork at St. Regis, MT (12354500). The Clark Fork at St. Regis is unregulated by reservoir storage. By comparing the peak discharge estimates of the Plains gage, regulated by Hungry Horse and Kerr Dams, with the St. Regis peak discharge estimates, one can determine the impact of flood storage in the lake and reservoir. The results are presented in Table 3.

TABLE 3 100 YEAR PEAK DISCHARGES AT PLAINS AND ST. REGIS		
Period	**Clark Fork near Plains 12389000**	**Clark Fork at St. Regis 12354500**
1910-99	142,000 cfs	83,100 cfs
1953-99	137,000 cfs	78,400 cfs

Table 3 shows that for the Clark Fork near Plains, the estimated 100-year peak discharge dropped from 142,000 cfs for the period 1910-99 which contains both unregulated and regulated data, to 137,000 cfs during the period of 1953-99, which is regulated by both Hungry Horse and Kerr Dams. However, while there was a 4 percent drop at the regulated Plains gage, there was a 6 percent drop at the unregulated St. Regis gage. Therefore, it appears that the decrease at the Plains gage is attributable to natural hydrologic patterns and the impact of upstream storage at Plains during severe flood conditions is minimal. As a result, the peak discharge estimates


2480
2460
2440
2420
2400
2380
2360
2340
2320
2300
ELEVATION IN FEET (NGVD)
1000
5000
9000
13000
17000
21000
25000
29000
33000
37000
41000
45000
49000
53000
STREAM DISTANCE IN FEET ABOVE THOMPSON FALLS DAM
A
B
C
D
E
F
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
CLARK FORK RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
SANDERS COUNTY, MT
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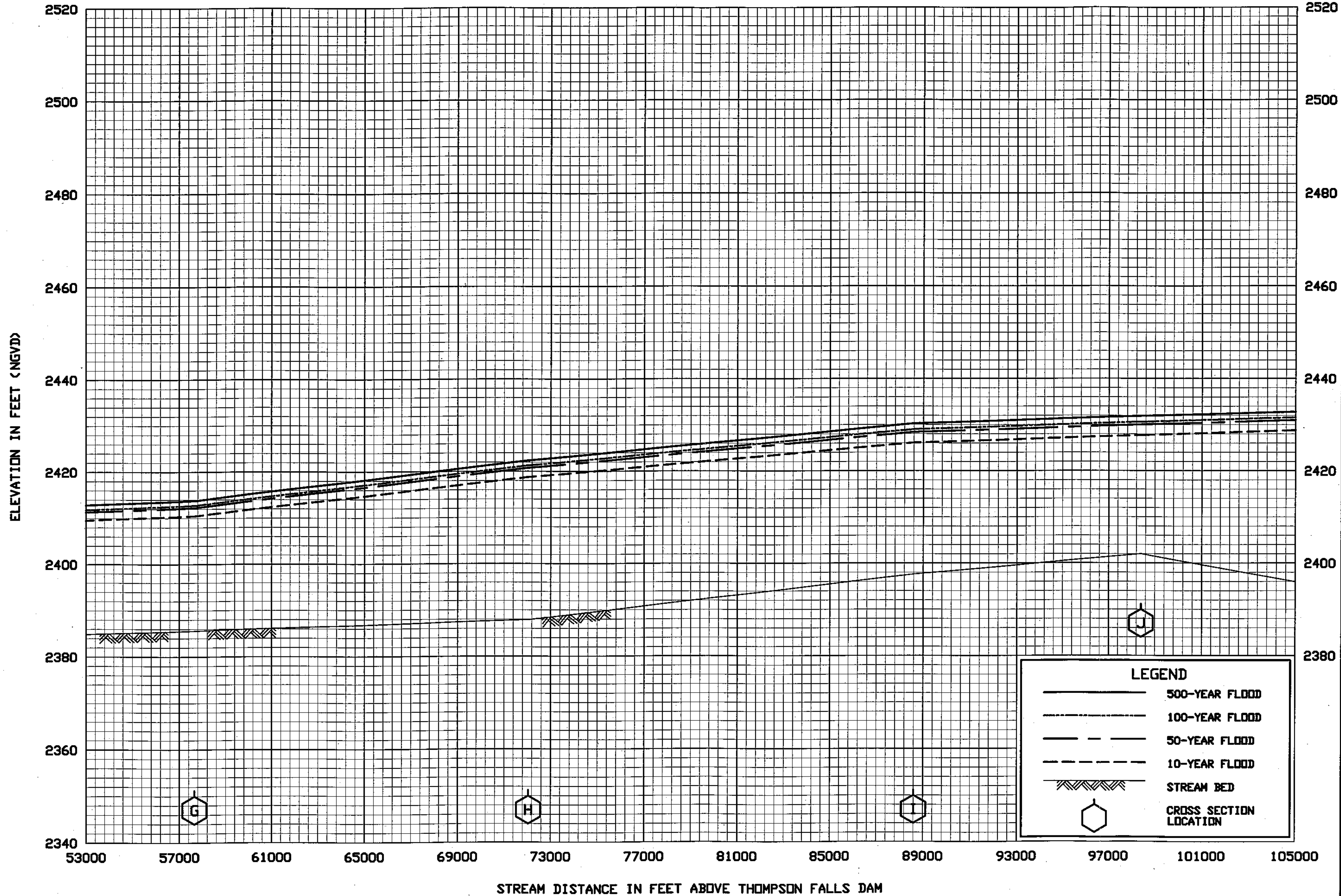

FLOOD PROFILES

CLARK FORK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SANDERS COUNTY, MT

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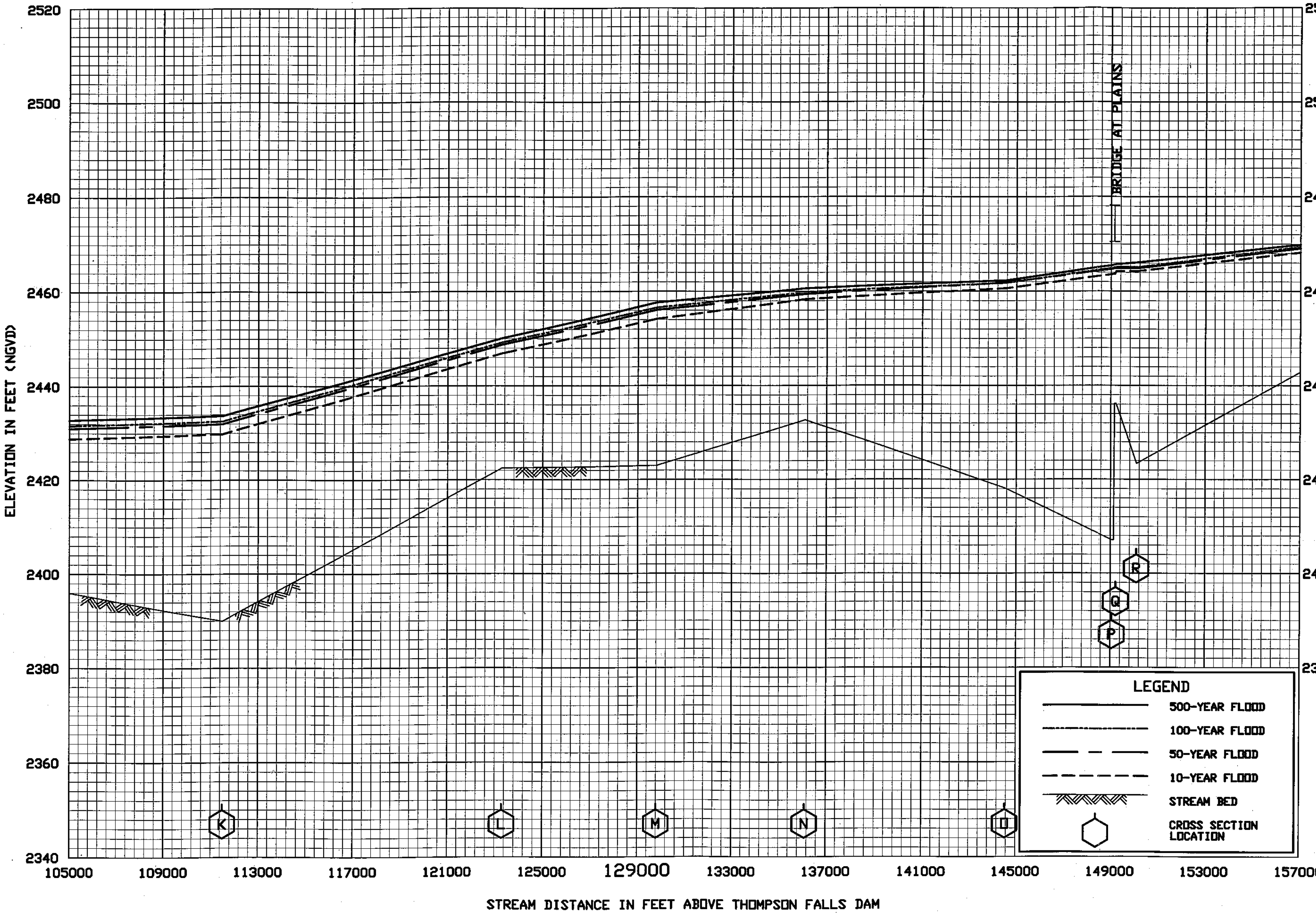

FLOOD PROFILES

CLARK FORK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SANDERS COUNTY, MT

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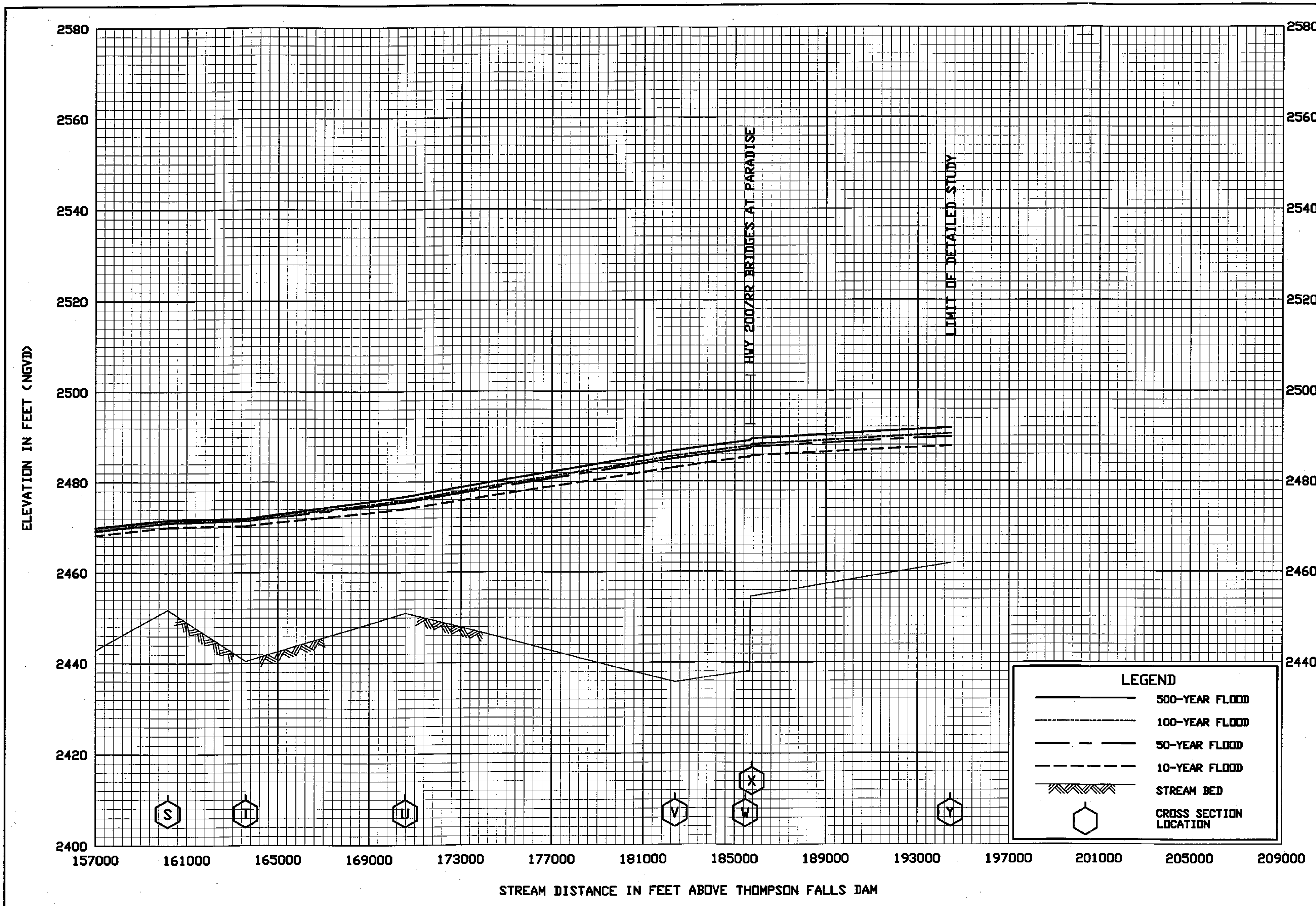

FLOOD PROFILES

CLARK FORK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SANDERS COUNTY, MT

04P

developed for the Plains gage for the entire period of record, 1910-99, will be used for this study. Records for the Plains gage are "good", which means about 95 percent of the daily discharges are within 10 percent of their true values. Therefore, it may be concluded that the 6 percent difference in 100-year peak discharge estimates for 1910-99 and 1953-99 may be within the accuracy of gage measurements without regard to the different periods of record.

Since there is only one significant documented ice jam flood (February 9-14, 1996), a separate ice jam hydrologic analysis was not performed.

Peak discharge – frequency relationships for the Clark Fork River are shown in Table 4.

TABLE 4
SUMMARY OF DISCHARGES

Flooding Source And Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second)			
		10-Year	50-Year	100-Year	500-Year
Clark Fork near Plains, MT	19,958	115,000	136,000	142,000	155,000

The U.S. Army Corps of Engineers (COE) performed a flood study of the Clark Fork in the vicinity of Plains in 1981 and determined the 100-year discharge to be 143,000 cfs (U.S. Army Corps of Engineers, 1981). The difference in 100-year discharge estimates partially results from approximately 19 years of additional streamflow data.

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.

Cross sections for the backwater analyses were obtained from topographic maps compiled from aerial photographs (Horizons, Inc., 1999). For each section located on the topographic maps, coordinates were assigned at the rivers edge that could be located in the field with global positioning system (GPS) equipment. Field surveyors located these bank points in the field and using a boat, GPS, and a depth sounder, surveyed an underwater profile between the points. The underwater profile at the gage Clark Fork near Plains, Montana (12389000) was provided by the U.S. Geological Survey. All bridges were surveyed to obtain elevation data and structural geometry.

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).

Water surface elevations for floods of the selected recurrence intervals were computed through use of the COE HEC-RAS step-backwater computer program (U.S. Army Corps of Engineers, 2000). Starting water-surface elevations for the Clark Fork River were determined based on historic records for Thompson Falls Reservoir (12390000). A review of records for Thompson Falls Reservoir (12389000) indicates annual peak stages do not vary significantly. Three streamflow events were used for calibration: 11,600 cfs; 118,000 cfs; and 134,000 cfs. The starting water surface for the streamflow of 11,600 cfs was surveyed to be 2395.45 feet NAVD88. The flood peak of 118,000 cfs occurred on May 19, 1997 and the peak stage in Thompson Falls Reservoir was 2400.65 feet NAVD88 on May 12, 1997. A reservoir stage of 2400.65 feet NAVD88 was used as a starting elevation for this event. Only end of month (EOM) storage data is available for maximum streamflow of record of 134,000 cfs on June 5, 1948. The storage at the end of May 1948 was 11,390 AF. This was close to usable capacity of 14,970 AF at the spillway crest elevation of 2399.70 feet NAVD88. Therefore, it is assumed that the reservoir stage reached the spillway crest by the time of the peak streamflow on June 5, 1948. Therefore, a starting water surface elevation of 2399.70 feet NAVD88 was used for this event. The maximum reservoir stage of record (2400.65 feet NAVD88) was used for the starting water surface elevation for the 10, 50, 100, and 500-year flood events. One half foot was added to this elevation for floodway computations.

Preliminary channel and overbank roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgement and were based on field observations of the stream and floodplain areas (Chow, 1959). Preliminary roughness factors were adjusted to calibrate the HEC-RAS model to the water surface profile for the streamflow of 11,600 cfs at the time of the survey. The calibrated model matches the surveyed water surface profile within 0.5 feet. The calibrated model was checked with the floods of 1948 (134,000 cfs) and 1997 (118,000 cfs). Roughness values calibrated for a flow of 11,600 cfs were multiplied by a factor of 0.65 to reflect the reduction in roughness occurring as streamflow depths increase. Applying this factor resulted in matching the flood elevations at the gage "Clark Fork near Plains, Montana" (12389000).within 0.1 foot and 1 foot for flows of 118,000 cfs and 134,000 cfs, respectively. These reduced roughness factors were used in modeling the 10, 50, 100, and 500-year floods. The channel "n" values for the Clark Fork River ranged from 0.020 to 0.160, and the overbank “n” values ranged from 0.030 to 0.100, before application of the 0.65 factor. The channel “n” value of 0.160 reflects abandoned bridge piers downstream of the bridge at Plains.

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

All elevations are referenced to the North American Vertical Datum of 1988 (NAVD88). Elevations based on the National Geodetic Vertical Datum of 1929 (NGVD29) were adjusted to NAVD88 by adding 3.7 feet. Elevation reference marks used in the study are shown on the maps.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 100- and 500-year 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 1:1000 with a contour interval of 5 feet (Horizons, Inc., 1999).

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, V, and VE); and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year 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.

4.2 Floodways

Encroachment on floodplains, such as structures and fills, 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 100-year 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 encroaching so that the 100-year 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 State of Montana limits such increases to 0.5 foot, which was used for this study.

The floodway presented in this study was computed 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 have been tabulated for selected cross sections (Table 4). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year 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 100-year flood more than 0.5 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

Figure 2

Floodway Schematic

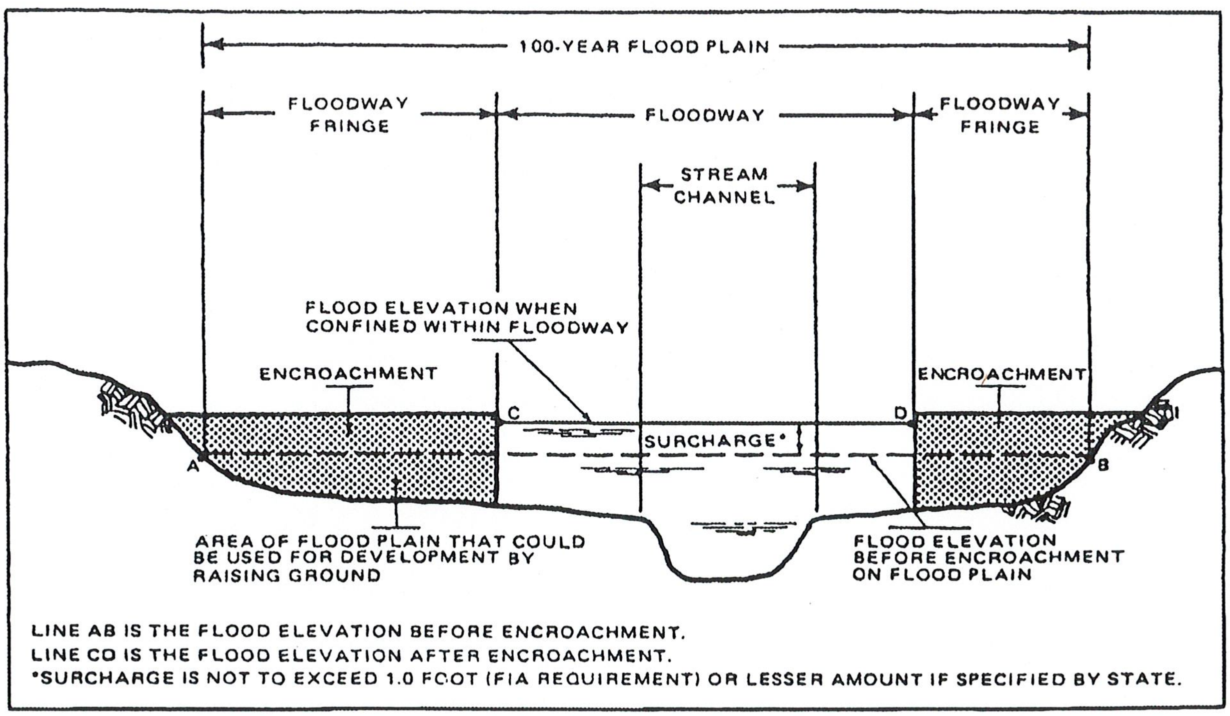

TABLE 5
FLOODWAY DATA, CLARK FORK RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY, SANDERS COUNTY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
Cross Section	Distance[1]	Width (feet)	Section Area (sq. ft)	Mean Velocity (ft per sec.)	Regulatory	Without Floodway	With Floodway	Increase
					(FEET NAVD88)			
A	1,000	819.88	28319.23	5.01	2400.65	2400.65	2401.15	0.50
B	6,700	627.27	23819.84	5.96	2401.24	2401.24	2401.72	0.47
C	13,700	529.32	17337.40	8.19	2402.40	2402.40	2402.82	0.43
D	17,100	510.30	17409.22	8.16	2403.50	2403.50	2403.89	0.39
E	28,950	585.25	19993.37	7.10	2406.94	2406.94	2407.24	0.31
F	39,150	1793.90	34646.42	4.10	2409.00	2409.00	2409.26	0.26
G	57,650	884.33	18107.86	7.84	2412.72	2412.72	2412.86	0.14
H	72,050	756.00	18943.38	7.50	2421.29	2421.29	2421.47	0.17
I	88,600	651.10	16951.34	8.38	2429.01	2429.01	2429.14	0.13
J	98,400	575.46	12369.01	11.48	2430.63	2430.63	2430.73	0.10
K	111,500	423.00	8950.94	15.86	2432.54	2432.54	2432.62	0.08
L	123,300	643.19	12926.99	12.32	2449.23	2449.23	2449.23	0.00
M	129,800	2696.00	28334.20	5.01	2456.58	2456.58	2456.61	0.03
N	136,100	4707.00	39400.32	3.60	2459.84	2459.84	2459.90	0.07
O	144,550	2919.19	35127.93	4.04	2461.78	2461.78	2461.84	0.07
P	149,050	3295.79	33601.20	4.23	2464.93	2464.93	2465.08	0.15
Q	149,215	3338.80	26117.04	5.49	2465.14	2465.14	2465.30	0.16
R	150,085	647.48	17846.39	10.74	2465.05	2465.05	2465.20	0.15
S	160,185	1245.35	17920.44	7.92	2471.37	2471.37	2471.76	0.39
T	163,585	1279.19	17210.02	8.25	2471.64	2471.64	2472.13	0.50
U	170,585	811.88	14667.72	9.68	2475.94	2475.94	2476.14	0.20
V	182,385	746.19	19947.97	7.12	2485.66	2485.66	2486.14	0.48
W	185,485	669.08	20057.56	7.08	2487.74	2487.74	2488.19	0.45
X	185,760	819.71	22338.03	6.36	2488.21	2488.21	2488.65	0.43
Y	194,460	834.20	17157.01	8.28	2490.52	2490.52	2490.67	0.15

[1]Feet Above Thompson Falls Dam

5.0 INSURANCE APPLICATION

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 rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

ZONE AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

ZONE V

Zone V is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown at selected intervals within this zone.

ZONE VE

Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

ZONE X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

ZONE D

Zone D is the flood insurance rate zone that corresponds to undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations 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 100- and 500-year floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

Flood Insurance Study for the Town of Plains has been published (U.S. Army Corps of Engineers, 1981). The U.S. Army Corps of Engineers (COE) modeled 14 cross sections. This study has cross sections comparable to COE cross sections 1+00, 4+00, 9+00, 13+00 and 14+00. The COE study used a 100-year flood discharge of 143,000 cfs compared to 142,000 cfs for this study. The computed 100-year water surface elevations for this study are within 0.7 foot of the COE elevations for sections 9+0, 13+00 and 14+00. The COE elevations at sections 1+00 and 4+00 exceed those of this study by 7.0 and 2.7 feet, respectively. The COE states:

> "The starting elevation for the backwater computations at the most downstream section is not a known value and must be approximated by hydraulic calculations; therefore, the accuracy of the computed water surface elevations is diminished through the most downstream 3/4-mile reach of the study area."

The COE does not specify what hydraulic calculations were used to approximate the 100-year flood starting elevation. Despite the fact that the COE mathematical model was calibrated to the observed October 1, 1980 water surface profile which had a discharge of 16,000 cfs, the approximated 100-year flood starting elevation appears too high. This appears to be confirmed by the fact that the COE elevations and those for this study converge at upstream sections.

8.0 LOCATION OF DATA

Data for this study is located in the office of the county commissioners in Thompson Falls, Montana.

9.0 BIBLIOGRAPHY AND REFERENCES

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APPENDIX A

ELEVATION BENCHMARKS

ELEVATION[1]	DESCRIPTION	NORTHING[2]	EASTING[2]
HKM VERIFIED			
2471.89	USCGS BM PLAINS	1216755	638269
2448.73	USCGS BM W472	1236127	617927
2463.25	USCGS BM Y472	1228813	630927
2460.21	USCGS BM L520	1224134	633745
2462.74	USCGS BM WW472	1240782	612849
2503.87	USCGS BM F520	1174388	660916
2497.84	USCGS BM Y373	1173960	665446
2477.16	USCGS BM G520	1198272	650478
2421.67	USCGS BM P472	1257459	577536
2440.19	USCGS BM S520	1277068	522468
2473.71	USCGS BM 21RHM	1266871	554693
2398.28	USCGS BM Z520	1302643	513989
2497.81	USCGS BM O15	1186012	657152
2450.86	USCGS BM V472	1241979	609072
2425.44	USCGS BM R472	1251263	586079
2444.35	USCGS BM XX472	1241295	611987
2435.41	USCGS BM P473	1273083	527992
2443.40	USCGS BM G472	1267808	539416
2432.82	USCGS BM UU472	1245799	597921
2465.62	USCGS BM Z472	1219605	636418
2493.19	USCGS BM E473	---	---
MDT VERIFIED			
2416.43	USCGS BM H520	---	---
2417.85	USCGS BM K472	---	---
2407.59	USCGS BM Q520	---	---
2436.92	USCGS BM Q472	---	---
2414.10[3]	USCGS BM L472	---	---
UNVERIFIED			
2451.71	USCGS BM R520	---	---
2455.72	USCGS BM F101	---	---
2479.03	USCGS BM A473	---	---
2472.20	USCGS BM B473	---	---
2485.21	USCGS BM D473	---	---

Notes:
1. The datum is the North American Vertical Datum of 1988.
2. Coordinates are State Plane, NAD83-1992, MT Zone 2500.
3. Published Elevation Void.