US Army Corps
of Engineers
Walla Walla District

Feasibility Report

Big Lost River Basin, Idaho

Upper Snake River and Tributaries

September 1991

BIG LOST RIVER BASIN, IDAHO
UPPER SNAKE RIVER AND TRIBUTARIES
FEASIBILITY REPORT

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EXECUTIVE SUMMARY

This feasibility study of flood damage reduction along the Big Lost River was conducted under the Upper Snake River and Tributaries Study authority. The purpose of this study was to determine the technical, economic, and environmental feasibility of constructing a project in the Big Lost River Basin to reduce flood damages.

The following alternatives were considered: enlarge Mackay Reservoir; enlarge emergency spillway of Mackay Dam; regulate Mackay Reservoir for flood control; build a dam on Antelope Creek; divert flood flows into Chilly Sinks or Barton Flat areas; and divert flood flows into the Old Utah Construction Canal (also called Blaine Canal) and extend this canal to the desert.

Preliminary studies showed that the storage alternatives are not economically feasible. Detailed studies of the Chilly-Barton Flats diversion alternative revealed that percolation rates would be much less than those assumed in the preliminary studies. Therefore, it concluded that none of the alternatives are economically justified at this time.

CHILLY CANAL DIVERSION DAM AND HEADWORKS
BARTON FLATS FLOOD DIVERSION
BIG LOST RIVER, IDAHO

PERTINENT DATA

GENERAL

Drainage Area, square miles	450
Discharge in cubic feet per second:	
Maximum of record, natural	3,820
Minimum of record, natural	31
Mean annual flow	331
100 year flood	4,820
50 year flood	4,420
Suspended sediment concentration:	
Maximum, mg/L	610
Minimum, mg/L	109
Streambed elevawion, feet mean sea level:	
Thalweg	6389.0
Spillway forebay	6393.0
Tailwater elevation, feet mean sea level:	
100 year flood	6396.6
50 year flood	6396.5

DAM

Length of Dam, feet	860
Structure elevations, feet mean sea level:	
Top of concrete structures	6403
Top of embankment	6405
Maximum water surface, feet mean sea level	6401
Project Lands, Acres	63.1

SPILLWAY

Spillway design flood	4,800
Natural tailwater elevation, feet mean sea level	
100 year flood	6396.9
50 year flood	6396.7

PERTINENT DATA (Continued)

SPILLWAY (Continued)

Crest length, feet	175.0
Crest elevation, feet mean sea level	6497.0
Stilling basin length, feet	16.0
Stilling basin elevation, feet mean sea level	6391.0

ABUTMENT EMBANKMENT

Embankment height above stream bed, feet	12
Embankment volume, cubic yards	6260
Embankment top width, feet	16
Material	Gravel Fill
Slopes, upstream and downstream	1V - 2H

IRRIGATION OUTLET

Chilly Canal:	
Flood Capacity, miners inches	3500
Gate type	Slide Gate
Manual operator	

FLOOD DIVERSION HEADWORKS

Capacity, cubic feet per second	500
Gate type	Radial
Number of gates	1
Gate height, feet	9
Gate width, feet	14

FLOOD DIVERSION CANALS

Main Canal:	
Total length, miles	1.3
Capacity, cubic feet per second	500
Invert slope, feet per foot	0.0003
Depth of Water, feet	6.5
Maximum velocity, feet per second	2.2
Bottom width, feet	10
Side slopes	4H : 1V
Freeboard, feet	4

Sediment accumulation:	
Maximum, cubic yards per year	529
Minimum, cubic yards per year	Negligible
Project Lands, Acres	38.1

CANAL DROP STRUCTURES

Baffled apron drops
no upstream control

INFILTRATION BASIN

	500 cfs Project
Embankment volume	
Compacted fill, cubic yards	60,720
Spoil from excavation, cubic yards	847,400
Embankment top width, feet	16
Material	Earth
Slopes, upstream	1V - 2H
downstream	1V - 4H
Interior bottom dimensions:	
Length, feet	1150
Width, feet	1200
Area, acres	31.7
Maximum water depth, feet	10
Freeboard, feet	4
Maximum containment volume, Acre-feet	
Project Lands, Acres	35.1

BIG LOST RIVER BASIN, IDAHO
UPPER SNAKE RIVER AND TRIBUTARIES
FEASIBILITY REPORT

SECTION 1 - INTRODUCTION

1.01. Study Authority.

This is an interim study conducted under the authority of a March 1954 resolution of the Senate Committee on Public Works as follows:

> "Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the report of the Chief of Engineers on Columbia River and Tributaries, Northwestern United States, submitted in House Document Numbered 531, Eighty-First Congress, Second Session, with a view to determining whether any modification of the recommendations contained therein is advisable at this time, with particular reference to the Upper Snake River basin above Weiser, Idaho."

The interim study was undertaken in response to a request from the Idaho Department of Water Resources. Local groups supporting a flood control project include: Soil Conservation Service, Butte Soil and Water Conservation District, Butte County Commissioners, Custer County Commissioners, and Big Lost River Irrigation District. Idaho National Engineering Laboratory (INEL) is also interested in reducing potential flooding of the Big Lost River.

1.02. Study Purpose and Scope.

a. General.

This report presents results of an investigation of the feasibility of reducing flood damages on the Big Lost River in Idaho. Frequent flooding occurs in the 28-mile reach between Mackay Dam and Arco, Idaho. Major flooding could cause considerable damage to Mackay, Arco, and INEL facilities.

b. Study Area.

The study area is totally within the State of Idaho in Custer and Butte Counties. Project location is shown on plate 1.

The geographic scope of damage and benefits is the Big Lost River basin from approximately 11 miles upstream of Mackay Reservoir (diversion to Chilly Canal) to downstream where the river disappears below Arco in an area called Big Lost River Sinks.

1.03. <u>Environmental Setting and Natural Resources</u>.

a. <u>Existing Basin Conditions</u>.

This is an arid region, characterized by generally flat topography with a few rocky buttes and mountain ranges. The soils are porous and vegetation is sparse on the native range land.

The population in the basin is mainly located in the Big Lost River Valley on ranches and in a few small towns. Principle towns in upstream order are: Arco, population 1,198; Moore, 215; and Mackay, 582.

b. <u>Basin Hydrology</u>.

The drainage area of the basin is about 1,800 square miles, including the northeastern slopes of the Pioneer Mountains and southwestern slopes of the Lost River Range. The southwestern exposure of the Lost River Range is a barren expanse of wasteland with bare, rocky mountains rising steeply 5,000 to 6,000 feet above the valley floor. From this range the tributary streams drop to the edge of the valley floor and disappear into sinks.

The Big Lost River basin contains about 50,000 acres of irrigated land, of which 40,000 acres are below Mackay Dam. The upper area is used primarily for livestock, while the area below Mackay Dam is used for crop production (such as potatoes, grain, hay and pasture).

A large part of the annual precipitation falls in the form of snow during December, January, and February in the lower areas and from November to April at the higher altitudes.

Appendix A contains a more complete description of the basin hydrology.

c. <u>Basin Stream Flows</u>.

Normally, active streams from the eastern part of the drainage basin do not enter the Big Lost River. Flood flows from the western side of the basin reach the river but only a few of these tributaries normally contribute surface flows in the summer months. Stream flows are described further in appendix A.

In the reach of the Big Lost River valley, known as the Chilly Sinks downstream of Chilly, considerable surface runoff is normally lost to groundwater flow. Above Chilly, the river channel is relatively stable and there is little seepage loss. Stream gauge records of the Mackay Reservoir discharge show a gain in water supply between the streamflow above Chilly Sinks at the Howell Ranch gauge and the reservoir discharge. Below Mackay Dam, large quantities of water are lost from the river in areas known as the Darlington and Moore Sinks. Overbank flooding occurs in the valley between Mackay and Arco at discharges ranging from 500 cfs near Arco to 1,500 cfs near Mackay.

Further downstream below Arco, the river flows onto the Snake River Plain. Southeast of Arco, it enters Box Canyon, a narrow canyon approximately 7 miles long, with an average depth of 70 feet and a width of 130 feet. Fractured basalt in this reach contributes to a significant loss of flow to ground water. At the exit of Box Canyon a diversion structure and channel with a capacity of 9,300 cfs is used to spread water to four areas which have a total capacity of 18,200 acre-feet at elevation 5,040 feet mean sea level (msl) and 58,000 acre-feet at elevation 5,050 feet msl. Flows not diverted at the structure pass northward across the INEL in a shallow gravel-filled channel. The flow gradually disappears into the ground in an area referred to as the Big Lost River Sinks. There is no direct surface discharge from the Big Lost River into the Snake River.

d. Barton Flats Geology.

The stratiform of Barton Flats consists of alternating layers of contrasting permeabilities and is assumed to be the result of alternating basal moraine and outwash. This stratiform is typical of that found in glaciated areas. According to Ross (1947) who performed much of the original geologic mapping in southeast Idaho, glacial deposits are abundant in the vicinity of Chilly Buttes.

The stratiform is over 100 feet deep consisting of stratified and unstratified alluvium overlying bedrock. Three test holes drilled 50 feet into the alluvium did not reach groundwater or bedrock. A fourth drill hole, to 126 feet, encountered water at the alluvium-rock contact at 103 feet. After water was encountered the water level in the casing rose to 86 feet. The rise in water level implies that the aquifer is confined by an overlying impermeable layer of alluvium.

Appendix B contains a more complete geologic description of the basin.

1.04. Existing Water Resource Projects.

a. Mackay Dam and Reservoir.

Mackay Reservoir, the only storage on the Big Lost River, is formed by an earth and rockfill dam, which was constructed in 1918. Original construction was stopped after the dam reached 70 feet in height because of leakage through the embankment. Original plans were to build the dam to a height of 120 feet. Reservoir capacity was 38,400 acre-feet until 1956 when the spillway crest was raised 5 feet to elevation 6,066.5 feet msl. Reservoir storage at the spillway crest is recorded as 44,368 acre-feet. Active storage is estimated to be about 43,500 acre-feet. The reservoir is a single purpose project, filled and drafted to meet irrigation demands.

Average seepage from the toe of Mackay Dam is directly related to reservoir water surface elevation and is recorded by the irrigation district. At maximum reservoir water surface elevation 6066.5, seepage is about 24 cfs. At elevation 6027 the average seepage is recorded at about 3 cfs. Additional seepage (not recorded at the toe of the dam) from the reservoir returns to the Big Lost River between Mackay Dam and the U.S. Geological Survey (USGS) stream gauge downstream.

Although Mackay Dam and Reservoir is operated specifically for irrigation, it can provide incidental flood protection; that is, its very existence provides some storage capacity for floodwaters if the reservoir is below the spillway crest. However, inspection of hydrologic data indicates damaging floods typically occur when Mackay Reservoir is near full. Therefore, floodwaters are spilled without control.

b. Irrigation Canals.

Numerous irrigation canals operate throughout the Big Lost River basin and are located above and below Mackay Dam. Canals above Mackay Reservoir include the Neilson Ditch, Davidson Ditch, Chilly Canal, and approximately 17 other lesser irrigation canals. Below Mackay Dam, irrigation canals include the Sharp, Darlington, Burnett, Moore, West Side, East Side, and Island canals.

During extreme flood conditions irrigators, under the control and direction of the local watermaster, are willing to divert water into irrigation canals and accept damage to reduce flood damages downstream. This operation is not a cure to the overall flood problems in the basin but does moderate damages.

Floodwater diverted to the canals recharges subsurface moisture and groundwater via local sinks.

SECTION 2 - PLAN FORMULATION

2.01. Problems and Opportunities.

Problems and opportunities of the Big Lost River, as discussed in this report, relate primarily to the incidence of flood damage suffered by the residents living along the river, in the communities of Mackay, Moore, Arco, and the INEL.

There is frequent minor flooding and intermittent major flooding along the Big Lost River between Mackay Reservoir and Arco. Minor flood control is achieved individually and cooperatively by local residents, under the direction of the local watermaster, by diverting floodwater into existing irrigation canals.

Flood damages occur frequently when flows exceed channel capacity in the 28-mile reach between Mackay Dam and Arco. The flood of May-June 1967 was the largest to date and inundated some 7,000 acres and caused $800,000 in damages (1967 price level). Smaller, frequent floods damage agricultural lands, bridges, roads, and INEL property downstream of Arco. Twelve major floods have occurred since 1943. In 1986 and several other years, losses have exceeded $1 million.

In addition to possibly increasing the flood storage capacity of Mackay Reservoir, there are opportunities for storage on Antelope Creek and above Mackay Reservoir. There are also possibilities for diverting floodwater into sink areas in the Chilly Sinks/Barton Flat area and southwest of Arco at the end of the Utah Construction (Blaine) Canal.

2.02. Planning Constraints.

The most critical water resource need in the Big Lost River basin is for flood damage reduction on the Big Lost River between Mackay Dam and Arco, Idaho. Although other needs are less critical and should be satisfied if feasible, plan formulation primarily involved exploring alternative means of solving the flood problem while considering the environmental effects of projects.

2.03. Alternative Solutions Considered.

a. General.

Two alternative modifications to Mackay Dam were investigated. The first alternative would raise the dam to provide 13,000 acre-feet of surcharge storage above the existing spillway crest and increase spillway capacity. The second alternative provides for flow over the dam in a

1,400-foot section to provide emergency spillway capacity. Other alternatives considered included regulation of the existing Mackay Reservoir for flood control, construction of Antelope Dam, diversion of flows into sink areas, and nonstructural alternatives.

b. Enlarge Mackay Reservoir Capacity by Raising Dam and Adding a Spillway.

Three alternatives include:

(1) Raise the embankment by 13 feet, construct left abutment side channel spillway, and install a toe drainage system. Estimated construction cost is $2,400,000.

(2) Raise the embankment by 13 feet, construct left abutment side channel spillway, and install a grout curtain. Estimated construction cost is $4,700,000.

(3) Raise the embankment by 13 feet, construct left abutment side channel spillway, and install a concrete diaphragm wall. Estimated construction cost is $14,000,000.

This alternative would increase surcharge storage by 13,000 acre-feet and increase spillway capacity. Flood control benefits would be negligible and there are safety concerns if the dam is raised without controlling high seepage rates through the dam. Adding a grout curtain or a concrete diaphragm wall are not economical. These alternatives were not studied in detail.

c. Enlarge Mackay Reservoir and Provide Overtopping Protection.

Three alternatives were also evaluated to protect the embankment from overtopping, including:

(1) Reshape the embankment crest and downstream slope with a roller-compacted concrete cap and install a toe drainage system. Estimated construction cost is $4,400,000.

(2) Reshape the embankment crest and downstream slope with a roller-compacted concrete cap and install embankment and foundation grouting. Estimated construction cost is $6,700,000.

(3) Reshape the embankment crest and downstream slope with a roller-compacted concrete cap and install a concrete cutoff wall to bedrock. Estimated construction cost is $15,900,000.

This alternative would increase surcharge storage by 13,000 acre-feet. Flood control benefits would be negligible. Grouting or installing a concrete cutoff wall are not economical. These alternatives were not studied in detail.

d. Regulate Existing Dam for Flood Control.

Management of Mackay Reservoir for flood control, in conjunction with the primary purpose of irrigation storage, is difficult due to the small capacity of the reservoir. Seasonal runoff varies from two to six times the storage capacity. A minimum of 50-cfs release (including seepage) must be maintained for downstream fishery and water rights. If releases exceed 1,500 cfs flooding occurs downstream. The Soil Conservation Service is presently preparing a reservoir operation guide for the management of the reservoir for the Big Lost River Irrigation District. A study by the Idaho Department of Water Resources (August 1976) explored the possibility of managing the reservoir for flood control. The study indicated that there was potential for increased flood control management.

Regulating Mackay Reservoir for flood control could improve flood control but relies on precise operation of the reservoir in connection with runoff forecasts. The Soil Conservation Service is presently preparing an operation guide for the Big Lost River Irrigation District in which flood control will be one objective of reservoir operation. However, since irrigation is the primary purpose, there may be conflicts in trying to include flood control in the operation. Since the reservoir is relatively small in comparison to runoff volume, it is doubtful that this alternative by itself could provide the needed protection unless it were operated only for flood control. Since this is not feasible under current conditions, this alternative cannot be considered as a solution. However, in conjunction with upstream diversion, it could enhance the flood control program.

e. Antelope Creek Dam.

A dam site on Antelope Creek in Section 30, T. 5 N., R. 25 E. was evaluated for flood storage, hydropower, and irrigation storage. Capacity of the reservoir would be 10,000 acre-feet with 7,500 acre-feet of active storage. The dam would have a height of 95 feet and a crest length of 1,200 feet. Construction cost of the dam is estimated at $20 million, including $0.8 million for constructing hydropower facilities.

Antelope Creek Dam is not an economically viable solution. Even with the most optimistic consideration of benefits for flood control, hydropower, and irrigation, costs far exceed benefits resulting in a benefit-to-cost ratio far below unity. Therefore, this alternative was not considered further.

f. Diversion of Flows into Sink Areas.

(1) The Barton Flats Flood Diversion would divert a maximum 500 cfs from the Big Lost River and infiltrate it into groundwater. Facilities would include a diversion structure to control the diversion of floodwater from the Big Lost River. The structure would consist of a spillway, headworks for the existing Chilly Canal, diversion canal headworks and canal, and an infiltration basin.

The canal and infiltration basin would be operated during periods of high flow above 1,500 cfs to reduce flooding along the Big Lost River. Floodwaters would be diverted an average of 16 days per year. Diverted flow would be at capacity (500 cfs) about 50 percent of the time the canal is in use.

Preliminary studies indicated a potentially feasible flood control project consisting of a diversion structure to divert floodwaters into a canal out on to Barton Flats. Floodwater would percolate into the soil through the bottom of the canal and remaining water would flow out the end of the canal onto the surface of Barton Flats. Waters not percolating into the soil would return to the Big Lost River.

(2) The Old Utah Construction Canal (Blaine Canal) was constructed in the early 1900's, but was never used for water distribution as planned. The canal starts in Section 14, T. 16 N., R. 25 E. and follows the west side of the valley for about 22 miles. The design capacity was 1,250 cfs and the canal had six large drop structures which would need to be replaced. A new canal would have a capacity of 2,000 cfs, follow the existing canal, and be extended about 3 miles into the lava beds across Highways 20 and 26. Estimated construction costs range from $12,700,000 to $13,800,000, depending on materials used.

Developing the Old Utah Construction Canal (Blaine Canal) as a flood diversion facility is not economically justified. Therefore, it was not considered further.

g. Nonstructural Alternatives.

Nonstructural alternatives would include floodplain management, flood proofing of individual structures, and permanent evacuation of floodplain areas.

The Federal Emergency Management Agency maintains up-to-date flood insurance studies in the basin that are used to establish flood insurance rates and to assist communities in efforts to promote sound floodplain management. Each Flood Insurance Study provides flood elevations and boundaries to assist communities in developing floodplain management measures. Floodplain management is well established in the basin and therefore not considered further as a nonstructural alternative.

A number of existing homes and structures subject to flooding are located on high ground (fill) or have been constructed on raised foundations to prevent flood damage. As a result, there is no local interest in an extensive flood proofing program in the basin.

Permanent evacuation of the floodplain would involve removing and relocating buildings and structures along the riverbanks. The greatest concentration of structures along riverbanks is immediately below MacKay Dam. This reach of the river is a prime recreation area and there is no local interest in relocation.

2.04. <u>Alternative Plan Summary</u>.

Storage alternatives, re-regulation of Mackay Dam, and development of the Old Utah Construction Canal were eliminated from detailed studies as discussed above.

The possibility of local protection in eight areas where damage appears concentrated was examined. In five of these areas, the cost of protection would exceed the value of the property to be protected so there was no point in computing damages and respective benefit. Two locations would require ring levees, making protection impractical and of doubtful feasibility. Protection at the final location, on one side of the river, would induce damage and erosion on the other side of the river and benefit one or two property owners, and therefore lacks a Federal interest.

Preliminary studies indicated a potentially feasible flood control project consisting of facilities to divert floodwaters from the Big Lost River on to Barton Flats. Therefore, alternative methods of constructing a flood diversion were investigated.

2.05. <u>Flood Diversion Alternatives Eliminated from Detailed Study</u>.

Preliminary investigations of a diverting floodwater to Barton Flats included several canal alignments, and infiltration basins.

One alternative included a system consisting of a main feeder canal and lateral canals. Total length of the feeder canal would be about 6 miles. Ten canal drop structures would be needed on this feeder canal. Total length of lateral canals would be about 10 miles. Each lateral would pond water to percolate into the subsoil. Analysis of this plan showed a higher cost than other plans. Therefore, this system of feeder and lateral canals was eliminated from detailed study.

Another alternative included a canal to carry water from the diversion, and an infiltration basin. The canal alignment would follow the 6,400 elevation contour to the toe of the ridge along the west side of Barton Flats. The canal would parallel the toe of the ridge then turn and carry water to the infiltration basin. It would cross an existing irrigation canal several times, adding to relocation and construction costs. Because the ground rises sharply from the toe of the ridge, following the 6,400 elevation contour would be prohibitive. This alignment would require the same number of concrete drop structures as a canal alignment across Barton Flats. Also, geological data indicate little or no infiltration potential for most of the canal length thereby increasing the design capacity (overall dimensions) and cost of an infiltration basin. This alignment with an infiltration basin was not considered further because of high relocation and construction costs.

2.06. Geotechnical Considerations.

Preliminary studies did not specifically identify an infiltration rate. However, preliminary studies indicated that further studies would be necessary to determine an infiltration rate and the optimum canal alignment for optimum infiltration.

The infiltration rates used for design of canals and infiltration basin are based on field tests conducted in the project area, flow losses measured in the Neilson irrigation canal, and a review of infiltration testing conducted by the Soil Conservation Service in a geologically similar area. The infiltration rate curve used in the design of the infiltration basin was conservatively selected as described in appendix B, Geotechnical Considerations.

Infiltration was found to vary depending on the hydrostatic head and would require stripping to remove surface fines.

To infiltrate the design discharge of 1,000 cfs, a canal having a bottom width of 30 feet and a water depth of 5 feet would have to be 23.7 miles long (assuming all infiltration is through the bottom of the canal).

Assuming the surface of Barton Flats could be flooded to a depth of 1 foot (without stripping topsoil and surface soil to be totally uniform) the estimated area required to infiltrate 1,000 cfs would be almost 2,000 acres (3 square miles). Although the computed area is not excessively large and Barton Flats is relatively flat, it cannot be assumed water would sheet flow over the area. Barton Flats is bisected by many old canals and water would find its way through these canals with extensive uncontrolled erosion. Therefore, all diverted water should be confined within canals or a basin and not allowed to discharge freely to the surface of Barton Flats.

To achieve the desired infiltration through the canal bottom, the alignment must be located on Barton Flats. The ground surface of Barton Flats has a relatively uniform slope of about 0.006 feet per foot. A number of canal drop structures would be needed.

2.07. Diversion Structure.

Each diversion plan would have a diversion structure to control the diversion of floodwater from the Big Lost River. Hydraulic analysis and design of the diversion structure is shown in appendix C, Hydraulic Design of Spillway and Canal Headworks.

The structure would be designed to pass the 50-year flow of 4,420 cfs over the spillway, control floodwater diversion to Barton Flats, and provide adequate head to supply the existing Chilly Canal water right.

Fish screening and bypass facilities may be needed at this structure. Environmental studies were not completed and the need and scope of fish facilities was not determined.

2.08. Alternative Diversion Plans Considered in Detail.

a. 1,000 cfs Flood Diversion.

This alternative would be designed to infiltrate a maximum diversion of 1,000 cfs from the Big Lost River. Features would include the diversion structure described above, a 1,000 cfs capacity canal, and an infiltration basin.

Canal alignment for this alternative would be located across Barton Flats and not follow a particular contour. A bridge would be needed where the canal crosses Bartlett Point Road and four drop structures would be needed.

About 150 cfs would percolate into the soil through the bottom of the canal and the remaining 850 cfs would infiltrate through the basin.

The infiltration basin would be rectangular with a level bottom, a design ponding depth of 10 feet, 4 feet of freeboard, and would cover approximately 70 acres. The basin wouod be excavated at the upstream corner and the material excavated would be used to construct an engineered embankment on the downstream sides. Excess material would be placed on the downstream side of the embankment.

The proposed canal and infiltration basin would be operated during periods of high flow, above 1,500 cfs, to reduce flooding along the Big Lost River. River flow in excess of 1,500 cfs would be diverted into the canal until the canal reaches the maximum design flow of 1,000 cfs. The canal discharge would be held constant at the maximum level during any further increase in the river discharge.

Floodwaters would be diverted an average of 16 days per year. Flood diversions would be less than capacity (1,000 cfs) more than 80 percent of the time the canal is in use.

b. <u>500 cfs Flood Diversion</u>.

This alternative would be designed to infiltrate a maximum diversion of 500 cfs from the Big Lost River. Features would include the diversion structure described above, a 500 cfs capacity canal, and an infiltration basin.

Canal alignment for this alternative would be located across Barton Flats and not follow a particular contour. A bridge would be needed where the canal crosses Bartlett Point Road and four drop structures would be needed for this canal alignment.

About 50 cfs would percolate into the soil through the bottom of the canal and the remaining 450 cfs would infiltrate through the basin.

The infiltration basin would be rectangular with a level bottom, with a design ponding depth of 10 feet, 4 feet of freeboard, and cover approximately 40 acres. The basin would be excavated at the upstream corner and the material excavated would be used to construct an engineered embankment on the downstream sides. Excess material would be placed on the downstream side of the embankment.

The proposed canal and infiltration basin would be operated during periods of high flow above 1,500 cfs to reduce flooding along the Big Lost River. River flow in excess of 1,500 cfs would be diverted into the canal until the canal reaches the maximum design flow of 500 cfs. The canal discharge would be held constant at the maximum level during any further increase in the river discharge.

Floodwaters would be diverted an average of 16 days per year. Diverted flow would be at capacity (500 cfs) about 50 percent of the time the canal is in use.

c. <u>250 cfs Flood Diversion</u>.

This alternative would be designed to infiltrate a maximum diversion of 250 cfs from the Big Lost River. Features would include the diversion structure described above, a 250 cfs capacity canal, and an infiltration basin.

Canal alignment, associated facilities and operation of this alternative would be the same as described for the 1,000 and 500 cfs alternatives but reduced appropriately in capacity and size.

2.09. Selection of a Final Plan.

a. Rational for Selection.

Each alternative plan should be sound, practicable, technically feasible, economically justified, and environmentally acceptable. Each alternative plan must not increase downstream flood damages.

Both, the 1,000 and 500 cfs flood diversion alternatives are technically feasible and would decrease flood damages. However, the 500 cfs diversion would be operated near and at design capacity more often than a 1,000 cfs facility. The 250 cfs plan would operate at capacity a higher percentage of time during the average 16 days per year but is far less effective in reducing flood damages. The 500 cfs diversion plan is considered the optimal plan and is presented in this report.

b. Risk and Uncertainty.

The infiltration rate was the basis for sizing canals and infiltration basins. Actual infiltration rate depends on the soil types that would be intersected by the canal and exposed in the infiltration basin. There is a risk of constructing a canal or infiltration basin over one or several sinks that may consistently take a significant flow. If this occurred, canal reaches downstream from such sinks or the basin may never fill to its design capacity. This implies that canal and basin capacities should be designed and adapted to actual field conditions. Determining specific field conditions and optimizing alignment and locations to soil conditions is beyond the scope of this feasibility study.

Environmental studies were not completed, and therefore, the environmental impacts were not completely identified. The need for fish bypass and screening facilities is uncertain. The cost of adding those facilities, if they should be required, is presented on table 1. Furthermore, possible fish and wildlife mitigation measures associated with riparian and grassland habitat losses were not identified because of the abbreviated environmental studies.

SECTION 3 - FINAL PLAN

3.01. Plan Location.

The final plan, 500 cfs diversion, would provide a level of flood protection between the Chilly Canal diversion and Mackay Reservoir, and through the towns of; Mackay, Leslie, Moore, Arco, and INEL. The flood damage analysis is described in appendix D. Five river reaches, where hydraulic cross sections were available, were analyzed in detail and the resulting information assisted in damage estimates for intervening areas.

3.02. Plan Description.

a. General.

The diversion site is located in the Big Lost River basin of Custer County, Idaho, approximately 20 miles northwest of the town of Mackay. The diversion structure is within the $S^1/_2$, sec. 1, T. 8 N., R. 21 E. just south of Chilly Buttes. The infiltration basin is within the $N^1/_2$, sec. 7, T. 8 N., R. 22 E. south of Bartlett Point Road at the upper end of Barton Flats. A canal connects the two as shown on plate 2, Project Layout.

b. Existing Irrigation Diversion.

There is an existing concrete structure on the Big Lost River for the purpose of diverting irrigation water into the Chilly Canal. The top of the concrete structure (vertical concrete walls) is about 15 feet above the floor on the downstream side and is about 7 feet above the upstream river channel bottom. Wood boards and plastic sheeting are used to block the 20-foot-wide spillway crest for diverting water to the Chilly Canal.

Construction of a flood diversion at this site would necessitate removal of the existing concrete structure and installation of new irrigation canal headworks for the Chilly Canal.

c. Real Estate.

Five private landowners would be impacted by this project. Approximately 7 acres would be required to construct, operate, and maintain the diversion structure and appurtenant facilities. About 30 acres of flowage easement would also be necessary behind the dam to accommodate the maximum designed impoundment, plus a 4-foot free-board.

Below the dam, a canal easement would be acquired for the diversion canal, which crosses private ownership. A short length of canal and all of the proposed infiltration basin are situated on U.S. Government land, which is under jurisdiction of the Bureau of Land Managemenv. Real estate requirements are described in appendix E.

d. Diversion and Care of Water.

A temporary irrigation diversion would be installed upstream to maintain the existing Chilly Canal during construction. A cofferdam would be installed upstream of the concrete structure site and a dewatering system installed for foundation work. The river would flow around the south end of the structure site. Upon completion of the concrete structures, the river would be allowed to flow through the diversion headworks or over the spillway during construction of the embankment tie.

e. Embankment Tie.

The proposed embankment section is described in appendix B. The embankment includes a downstream seepage berm to ensure against heave and piping of the downstream toe. The embankment and foundation are both gravel material and have similar permeabilities. The required thickness of the seepage berm to resist heaving is minimal.

The upstream slopes of the embankment would be armored with riprap to prevent erosion. River velocities against the embankment are assumed to be minimal and not a factor in the design. The ponding area behind the diversion structure is relatively well protected from wind and a minimal layer thickness of 24 inches of riprap is considered to be appropriate. The riprap toe would be placed to a depth of 5 feet below the thalweg.

Embankment tie from the canal headworks to the right abutment at elevation 6405 is shown on plate 3, Headworks and Diversion Dam Plan.

f. Diversion Structure.

The structure would consist of three components: a 175-foot-wide spillway and stilling basin, flood diversion headworks (500 cfs capacity), and irrigation headworks to supply a maximum of 70 cfs to the Chilly Canal. A general layout of these structures is illustrated in plate 3, Headworks and Diversion Dam Plan. Features of a 1,000 cfs diversion structure are described in appendix C (a 500 cfs facility would have one less gate).

(1) Spillway.

The spillway would be uncontrolled and sized to pass a design flow of 4,420 cfs. Spillway capacity is independent of the flood diversion capacity. Miscellaneous trash and river debris would be allowed to pass over the spillway.

(2) Flood Diversion Headworks.

One 14-foot-by 9-foot radial gate would be installed to control water flow into the canal. At full gate opening the discharge would be 500 cfs.

A small settling basin just upstream of the canal intake will be required to capture bedload material. Periodic cleaning would be required.

A log boom will be required to keep large floating debris out of the diversion canal.

(3) Chilly Canal Headworks.

The intake of this canal will be controlled with a 3-foot-by 5-foot vertical slide gate with a hand wheel operator.

g. Flood Diversion Canal.

The canal would have a design capacity of 500 cfs. The length of canal would be about 1.3 miles. The canal section would be a trapezoidal section with a bottom width of 10 feet, side slopes of 1V on 4H, and a normal depth of about 6.5 feet. Design velocity would be about 2.2 feet per second. Freeboard would be 4 feet.

Two concrete baffled apron drop structures would be located along the canal and one at the end of the canal dropping into the infiltration basin. These drops would be 10, 10, and 12 feet respectively.

Typical sections and plan of the canal and baffled apron drop structures are shown on plate 4, Typical Sections.

h. Infiltration Basin.

The infiltration basin would be rectangular with a level bottom, with a design ponding depth of 10 feet, 4 feet of freeboard, and cover approximately 40 acres. The basin would be excavated at the upstream corner where flow would enter through a concrete drop structure. Excavated material would be used to construct an engineered embankment on the downstream sides. The embankment on the downstream end of the infiltration basin was not analyzed for stability or seepage conditions, but would be conservatively designed to preclude any problems with stability and piping. Excess material from required excavation, which would consist of gravelly sands or sandy gravels, would be placed on the outside toe of the slope to buttress the embankment and lengthen the seepage path. A cross section through the basin is shown on plate 4, Typical Sections.

3.03. Operation.

River flow readings from the existing Howell gauge station above the diversion would be used to set the gates and flow into the flood diversion facilities. The flood diversion will not be utilized until flows upstream of the structure reach 1,500 cfs. At this point, the canal gates may be opened. When river flows reach 2,500 cfs, flow over the spillway can no longer be controlled by the flood diversion.

During the normal irrigation season the flood diversion gates would be closed, ponding water behind the structure to supply the Chilly Canal.

3.04. Maintenance.

Routine maintenance of gates and manual operators would be required. Periodically, sediment build-up in the canal and infiltration basin would have to be removed to maintain infiltration capacity. A sedimentation analysis is contained in appendix F.

SECTION 4 - ENVIRONMENTAL INVESTIGATIONS

4.01. Environmental Setting.

The project area consists of high, steep mountains sloping to a broad flat valley with a few buttes. The climate is semiarid with cold winters and warm, dry summers. Mean annual precipitation ranges from about 8 to 10 inches, with much of that falling as snow December through March. Runoff from the mountains typically peaks in late June. The river channel has eroded; and, the bed load accumulation is enough to cause frequent overbank flooding. This periodic flooding contributes to a wide band of riparian vegetation and wetlands adjacent to the river. Other vegetation types in the project area range from conifer forest in the mountains to sagebrush-grassland in the valley interspersed with agricultural crops. Grazing has reduced the abundance of the native plants in the area and contributed to soil erosion and river channel instability.

Wildlife species of the area include big game animals such as pronghorn antelope and mule deer; upland game such as sage grouse and rabbits, waterfowo (mallard, teal, Canada goose), raptors (bald eagle, red-tailed hawk, peregrine falcon), songbirds; nongame mammals (coyote, skunk, beaver, voles, ground squirrels); and several reptiles and amphibians. Many of these species depend upon the riparian area for at least part of their life cycle. Fish species of the Big Lost River and its tributaries include rainbow trout, brook trout, mountain whitefish, kokanee salmon, and shorthead sculpin. The river has been stocked with kokanee salmon and hatchery rainbow trout.

4.02. Environmental Impacts.

The proposed project would have several environmental impacts that would need to be mitigated. The canal would divert flood flows, thereby reducing the amount of overbank flooding that now occurs along the river. This would probably result in a decline of the quality and quantity of riparian and wetland vegetation adjacent to the river. Riparian habitat would also be lost because of construction in the dam and canal areas. Loss of riparian habitat would result in a decrease in the numbers of fish and wildlife in the area.

The dam and canals would potentially have an adverse effect on fish in the river. The dam would block movement of fish up and down the river unless a fish ladder is installed. Fish may be diverted into the canal and flushed onto Barton Flat unless fish screens are installed.

The canal structure itself and the water discharged at the end of the canal would cause a loss of sagebrush-grassland habitat. This would result in a loss of important sage grouse nesting habitat, mule deer and pronghorn winter range, and pronghorn fawning habitat. The canal may also interfere with sage grouse and pronghorn migration patterns and may destroy or interfere with sage grouse leks.

4.03. Environmental Review Requirements.

a. General.

The following laws and regulations apply to this proposed project. A summary of compliance progress to date and anticipated future compliance needs are also described.

b. Cultural Environment.

Reservoir Salvage Act; National Historic Preservation Act; Executive Order 11593, Protection and Enhancement of the Cultural Environment.

A reconnaissance level survey was conducted to assess the cultural resource potential of the project area. The survey included both a literature search and limited field investigations. A report of findings was prepared and submitted to the Idaho State Historic Preservation Office (SHPO) for review. The Idaho SHPO provided comments on those sites identified during the survey and recommended "that an archaeological inspection should be conducted of all areas to be impacted if the project is implemented."

c. Clean Water Act.

The Corps would need to prepare a Section 404(b)(1) evaluation for construction of the dam and canal headworks. The Corps would also need to obtain water quality certification from the Idaho Department of Health and Welfare.

d. Endangered Species Act of 1973.

Two endangered species, the bald eagle and the peregrine falcon, occur in the project area. The Corps would need to prepare a biological evaluation to determine if the project would have an adverse effect on these species.

e. Fish and Wildlife Coordination Act.

This project has been coordinated with the U.S. Fish and Wildlife Service and the Idaho Department of Fish and Game. A summary of the coordination activities and the Planning Aid Report, dated September 1987, are included in appendix G. A Coordination Act Report was not completed.

f. National Environmentao Policy Act (NEPA).

The Corps would need to prepare NEPA documentation should this project move forward.

g. Clean Air Act.

This project would be in compliance with this act. A copy of the NEPA documentation would be sent to the Environmental Protection Agency, as required.

h. Executive Order 11988, Floodplain Management.

Because of the nature of the project, work within the floodplain cannot be avoided. The project could adversely affect floodplain resources through the potential reduction in riparian habitat. The project may also encourage further development within the floodplain by reducing the threat of flooding below the proposed dam. The Corps will need to investigate ways to minimize these impacts should the project go forward.

i. Executive Order 11990, Protection of Wetlands.

Some wetlands may be adversely affected by this project. The Corps would need to investigate ways to minimize this impact and develop a no-net loss plan should the project go forward. Potential loss of wetlands would be addressed as part of an impact assessment performed through Fish and Wildlife Coordination Act activities.

j. Agricultural Lands.

Counsel of Environmental Quality Memorandum, 11 August 1980, Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA.

The Corps would need to coordinate with the Soil Conservation Service to determine if prime or unique farmlands would be affected by this project.

SECTION 5 - ECONOMICS OF THE FINAL PLAN

5.01. Real Estate Cost Estimate.

Land value estimates are based upon data provided by the Custer County Assessor and recent sales that have taken place in the vicinity of the project.

It is intended that the construction contractor would be responsible for providing all borrow materials for this project. Hence, no additional acquisition requirements for a quarry site are envisioned. Moreover, no additional sites would be required for spoil disposal. All excess excavated materials would be disposed of within the limits of the project by incorporating it into the canal and infiltration berms.

Real estate requirements are detailed in appendix E.

5.02. Construction Cost Estimates.

Construction cost estimates are at October 1990 price levels and are detailed in appendix H. Estimates are based on construction experience and similar construction. Contingencies are included for each line item to reflect the uncertainty of the estimate. The construction cost estimate for the 500 cfs plan, including contingencies, is $6,118,000.

Estimates for fish bypass facilities are based on cost experience at irrigation diversions of similar flow capacities. Mitigation features were not determined. Therefore, the cost of mitigation features is not included in the cost estimate.

5.03. Planning, Engineering, and Construction Management.

Planning, engineering, and construction management costs were estimated based on experience curves relating government costs to direct construction costs.

5.04. Investment Cost.

Investment cost was estimated based on compound interest during construction at 8 7/8-percent discount interest rate for the 1990 price levels. Interest during construction is $331,000. Investment cost for the 500 cfs plan is $7,950,000.

5.05. Annual Costs.

The annual investment cost is based on a life-cycle cost analysis using 8 7/8-percent discount interest rate over an economic life of 50 years. Annual interest and amortization is estimated at $716,000.

Operation and maintenance costs include the annual cost to operate and inspect the diversion structure and facilities, scarifying the bottom of canal and basin on a 3-year frequency to maintain infiltration, and removal of built up sediment every 6 years. Annual operation, maintenance, and replacement costs for the 500 cfs plan are estimated to be $16,000.

Replacement costs include; replacement of gates and operators at 25 and 20 year frequencies, respectively.

The total annual cost for the selected plan, without fish facilities, is estimated to be $732,000. Annual costs with fish bypass and screen facilities is estimated at about $1,000,000. The cost estimate would be higher if further environmental studies showed additional fish and wildlife mitigation measures are necessary.

5.06. Damage Estimates and Benefits.

a. Damage Estimates.

Detailed damage estimates were made for five reaches where cross sections were available and damages are concentrated (see appendix D). Structure and content damages from detailed reaches were used to estimate average damage per structure for each flood event. The damage per structure estimate for each flood event was multiplied by the number of structures within the respective floodplain to estimate total structure and content damages for the 10-, 50-, 100-, and 500-year floods.

Agriculture damage estimates were based on crops grown in the Big Lost Valley. Crop estimates include: about 10 percent seed potatoes, 30-percent alfalfa/grain, and 60-percent hay. Duration of all floods is estimated to be between 2 and 3 days. Based on this information, crop losses are estimated to be 75 percent, with a loss of revenue of 75 percent, and 75 percent less cost incurred after a flood. Crop acreage was estimated from aerial photos; and, costs and receipts for crops were taken from 1989-1990 Crop Budgets prepared by the University of Idaho.

Emergency expenses include evacuation, protection of life, property, health, and temporary housing. The per house emergency costs were estimated to be $660, plus $75 per day for 3 days temporary housing.

Damages to roads and bridges were estimated by updating damages reported by the Soil Conservation Service to those features for the 1965 flood to current cost level.

Average annual damage and remaining damage with alternative plans were calculated by the damage-frequency integration method. Total average annual damage, under natural conditions without a project, is estimated to be $636,000 (see appendix D for the breakdown of total damage).

b. Average Annual Benefit.

The average annual benefit for the final plan, 500 cfs diversion, is estimated to be $281,000.

5.07. Economic Feasibility.

Economic data is summarized on table 1 for the 1,000, 500, and 250 cfs flood diversion plans. All plans, not including fish bypass facilities or mitigation costs, have benefit-to-cost ratios far below unity between 0.21 and 0.38 to 1.

Table 1 also shows the sensitivity of additional costs for fish bypass facilities. Project benefit-to-cost ratios are further reduced as a result of these costs.

SECTION 6 - PUBLIC INVOLVEMENT AND COORDINATION

6.01. Public and Sponsor Coordination.

In a 10 April 1989 letter, the Butte Soil and Water Conservation Board agreed to act as an interim sponsor for the Big Lost River basin, Idaho project, until the formation of a Watershed Improvement District could be completed.

An informational meeting was held in September 1989 with local sponsors and local ranchers to discuss project sponsorship and feasibility field test activities.

Multiple water issues in the basin created strong local controversy. Formation of a Watershed Improvement District (WID) was opposed by the local irrigation district and the referendum to organize a WID was voted down by a wide margin on 5 October 1989.

On 8 January 1990, Butte County signed a letter of intent to enter into a Local Cooperation Agreement (LCA) assuming a favorable and acceptable project.

A series of public meetings were held on 16 through 17 January 1990 to reconsider formation of a WID to sponsor the potential Corps flood control project and other water resource projects of local interest. The objective and status of feasibility study activities were presented at these meetings. There was no further progress in formulating the WID.

Results of this feasibility study were presented and discussed on 17 January 1991, with Mr. Dan Holden, Soil Conservation Service, and later reviewed by the Butte Soil and Water Conservation District board. Because of the negative results no further coordination was considered by the board.

Pertinent correspondence and letters of support are shown in appendix I.

6.02. Public Notice.

A public notice will formally announce the termination of this feasibility study.

SECTION 7 - DISCUSSION AND RECOMMENDATION

7.01. Discussion.

None of the local protection, storage, or diversion alternatives are economically justified at this time. When it became evident that there was no economically feasible project, the environmental evaluations was terminated. Project costs could be higher than shown in this report if further environmental studies show the need for additional fish and wildlife mitigation measures.

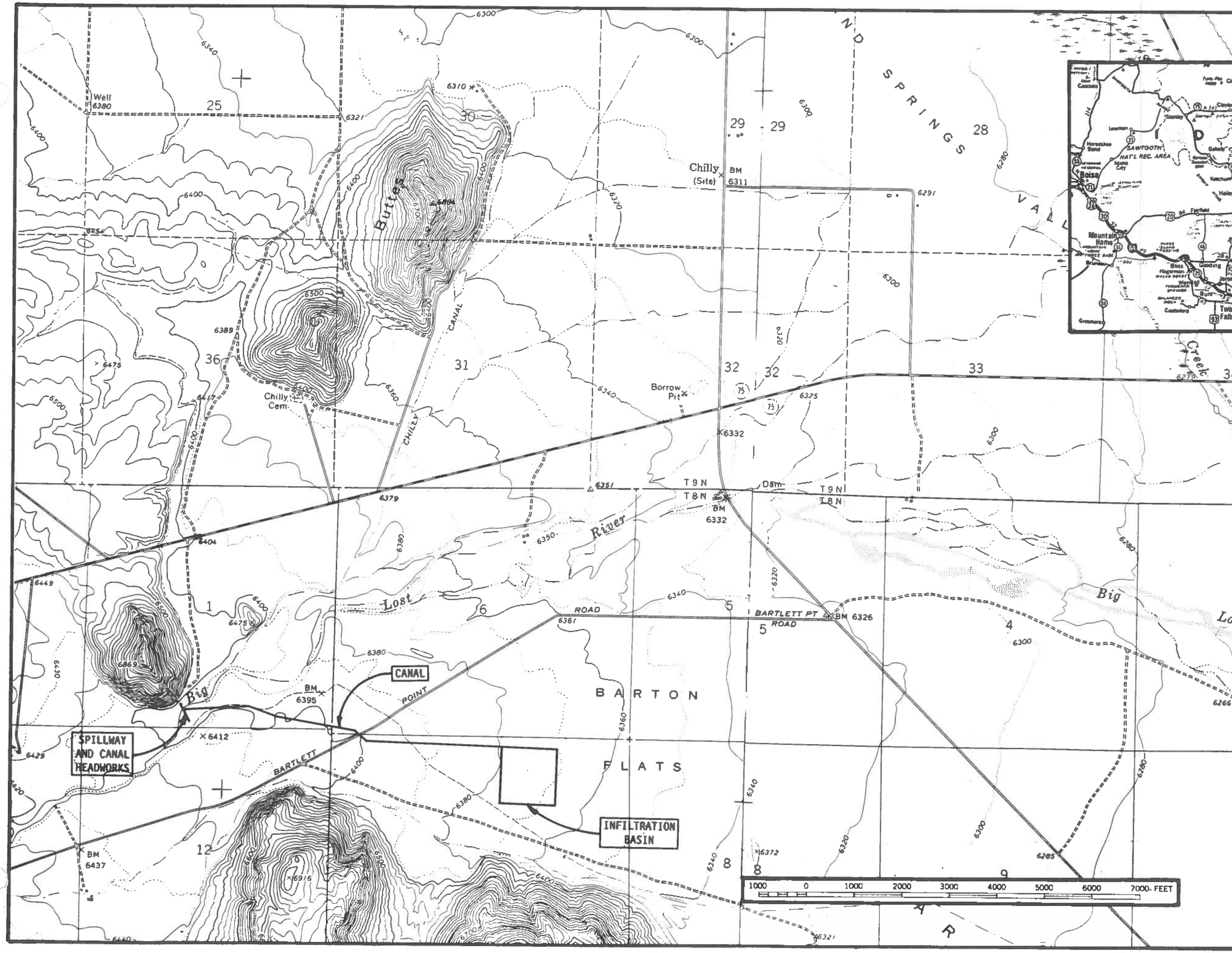
7.02. Recommendations.

It is recommended that Corps of Engineers planning studies for the Big Lost River basin under the authority cited in section 1 be concluded with this report with no further Corps of Engineers action anticipated at this time.

TABLE 1
BIG LOST RIVER BASIN, FLOOD DIVERSION TO BARTON FLATS
Project Economic Data ($1,000) 1_/

	ITEM		1000 cfs Flood Diversion AMOUNT		500 cfs Flood Diversion AMOUNT		250 cfs Flood Diversion AMOUNT	
01	Lands and Damages		30,300		30,300		30,300	
15	Mobilization, Demob & Prep Work		136,000		136,000			
15	Care & Diversion of Water		224,600		224,600			
15	Overflow Structures		1,269,500		1,191,400			
15	Earthwork, Embankment Tie-in & Canal		1,602,000		326,500			
	(Canal)				1,105,000			
15	Bartlett Point Road Bridge		199,600		167,100		(Estimated construction cost)	
15	Baffled Apron Drop Structures		341,700		204,500			
15	Earthwork, Infiltration Basin		5,804,700		2,732,600		3,900,000	
	Subtotal		$9,608,400		6,118,000		$3,930,300	
	Contingencies	0%	(Included)		(Included)		(Included)	
	Construction Cost		$9,608,400		$6,118,000		$3,930,300	
30	Planning, Engineering and Design		1,277,100	Estimated costs with fish fac-ilites	919,300	Estimated costs with fish fac-ilites	629,800	Estimated costs with fish fac-ilites
31	Construction Management		902,600		582,200		373,900	
	Total Project Cost		$11,788,100		$7,619,500		$4,934,000	
06	Fish Mitigation Features (Screens & Ladder) (Includes Contingencies, Plng Engr and Const Mgmt)			$2,300,000		$1,600,000		$1,600,000
				$14,088,100		$9,219,500		$6,534,000
	Interest During Construction 0 yr const, compound interest at:	8.875%	512,000	611,900	331,000	400,500	214,000	284,000
	TOTAL INVESTMENT COST		$12,300,000	$14,700,000	$7,950,000	$9,620,000	$5,148,000	$6,818,000
	ANNUAL COSTS							
	Interest and Amortization							
	Service Life @ % 50	8.875%	1,107,000	1,323,000	716,000	866,000	463,000	614,000
	Operation, Maintenance and Replacements		20,000	215,000	16,000	150,100	13,000	107,600
	TOTAL ANNUAL COSTS		$1,127,000	$1,538,000	$732,000	$1,016,100	$476,000	$721,600
	AVERAGE ANNUAL BENEFIT		$426,000	$426,000	$281,000	$281,000	$154,000	$154,000
	Benefit to Cost Ratio		0.38	0.28	0.38	0.28	0.32	0.21
	Net Benefits		($701,000)	($1,112,000)	($451,000)	($735,100)	($322,000)	($567,600)

1_/ Costs for wildlife mitigation and riparian habitat along the Big Lost River are not included.



BIG LOST RIVER BASIN
BARTON FLATS TO BELOW ARCO, IDAHO
INTERIM FEASIBILITY STUDY

LOCATION AND VICINITY MAP

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH
G. CLAUSEN DECEMBER 1990

PLATE 1

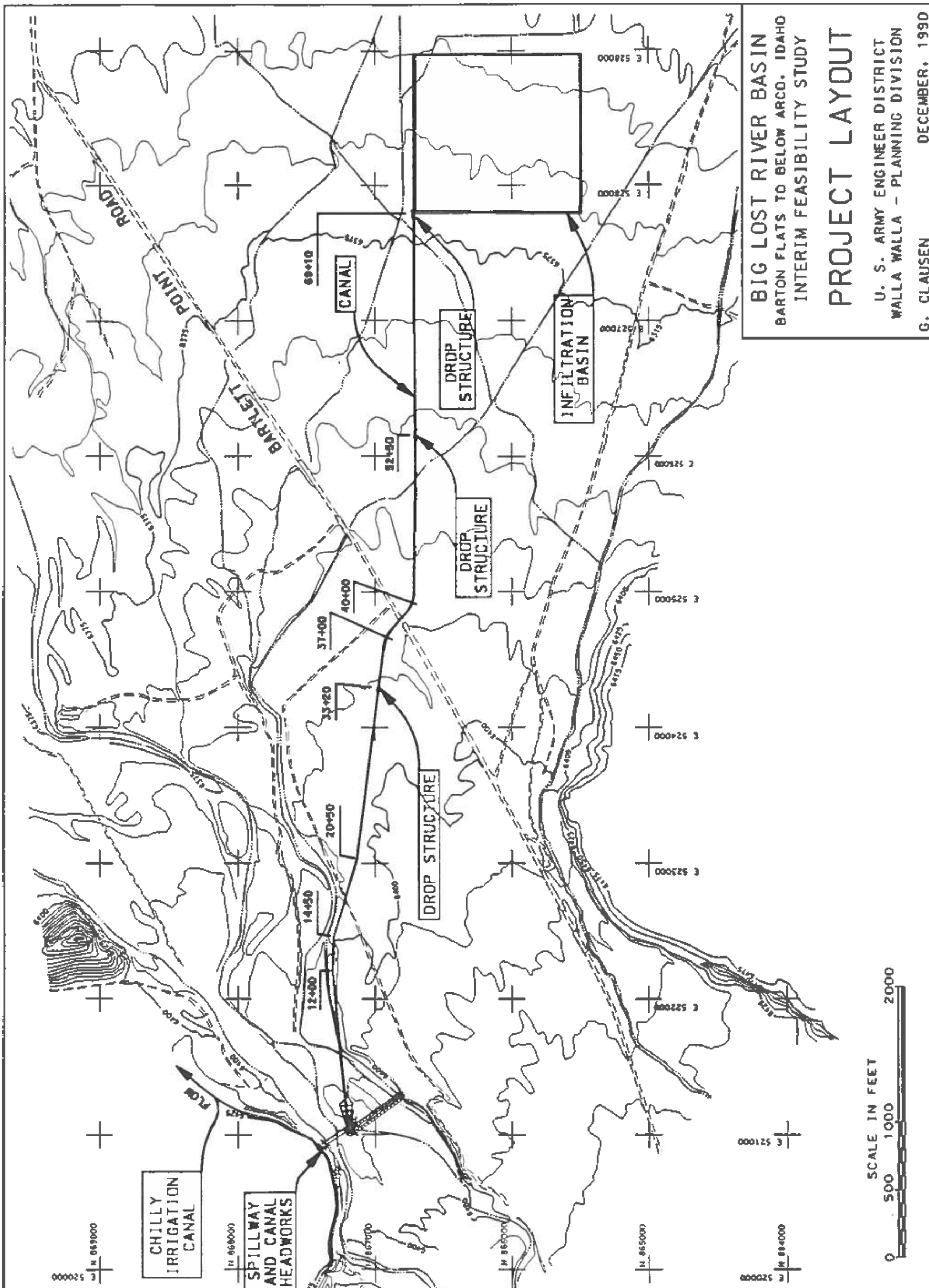
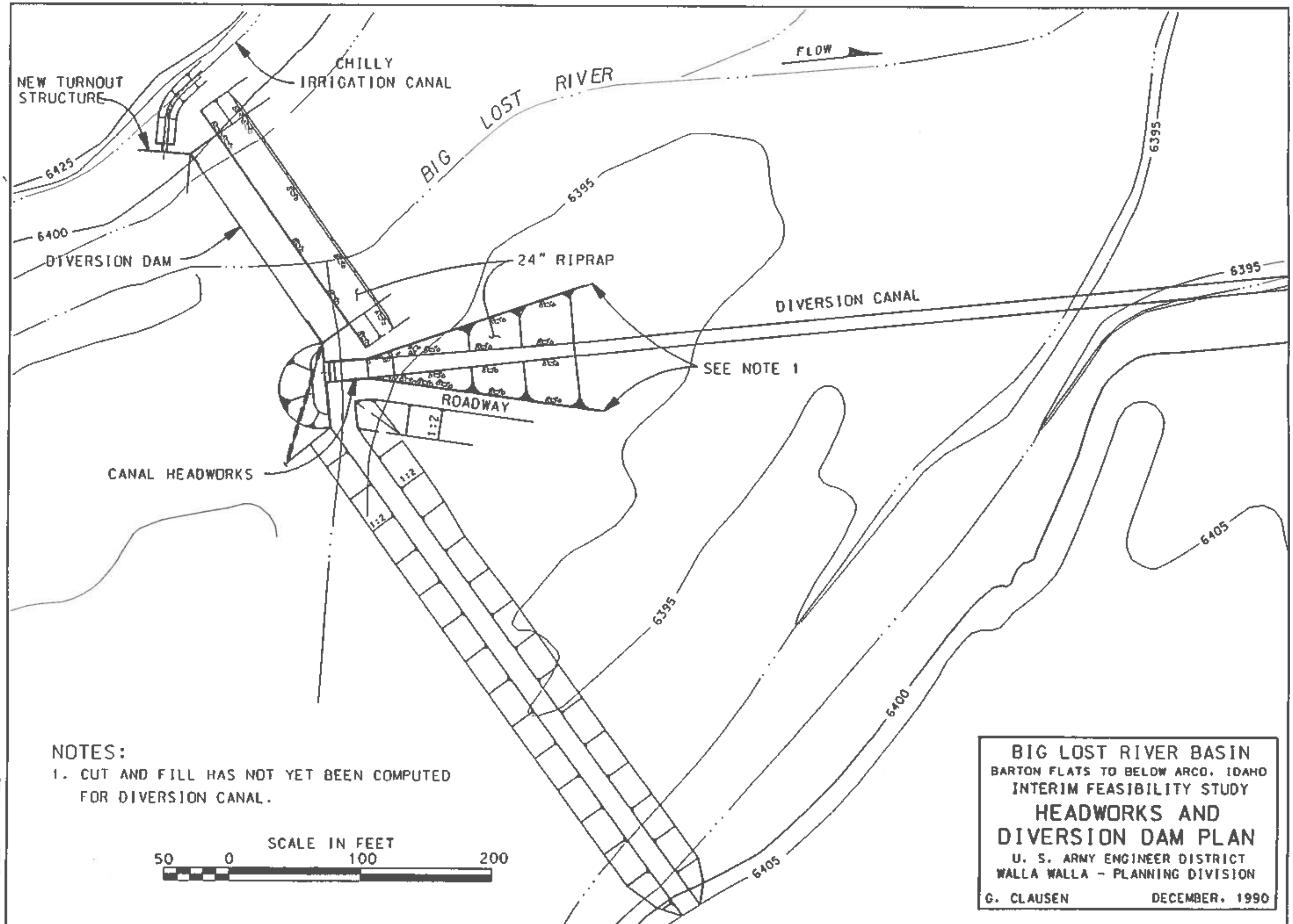

BIG LOST RIVER BASIN
BARTON FLATS TO BELOW ARCO, IDAHO
INTERIM FEASIBILITY STUDY
PROJECT LAYOUT
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - PLANNING DIVISION
G. CLAUSEN
DECEMBER, 1990
BARTLETT POINT ROAD
CANAL
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
DROP STRUCTURE
INFILTRATION BASIN
CHILLY IRRIGATION CANAL
SPILLWAY AND CANAL HEADWORKS
FLOW
12+00
14+50
20+50
33+20
37+00
40+00
52+50
68+10
SCALE IN FEET
0
500
1000
2000

PLATE 2



NOTES:
1. CUT AND FILL HAS NOT YET BEEN COMPUTED FOR DIVERSION CANAL.

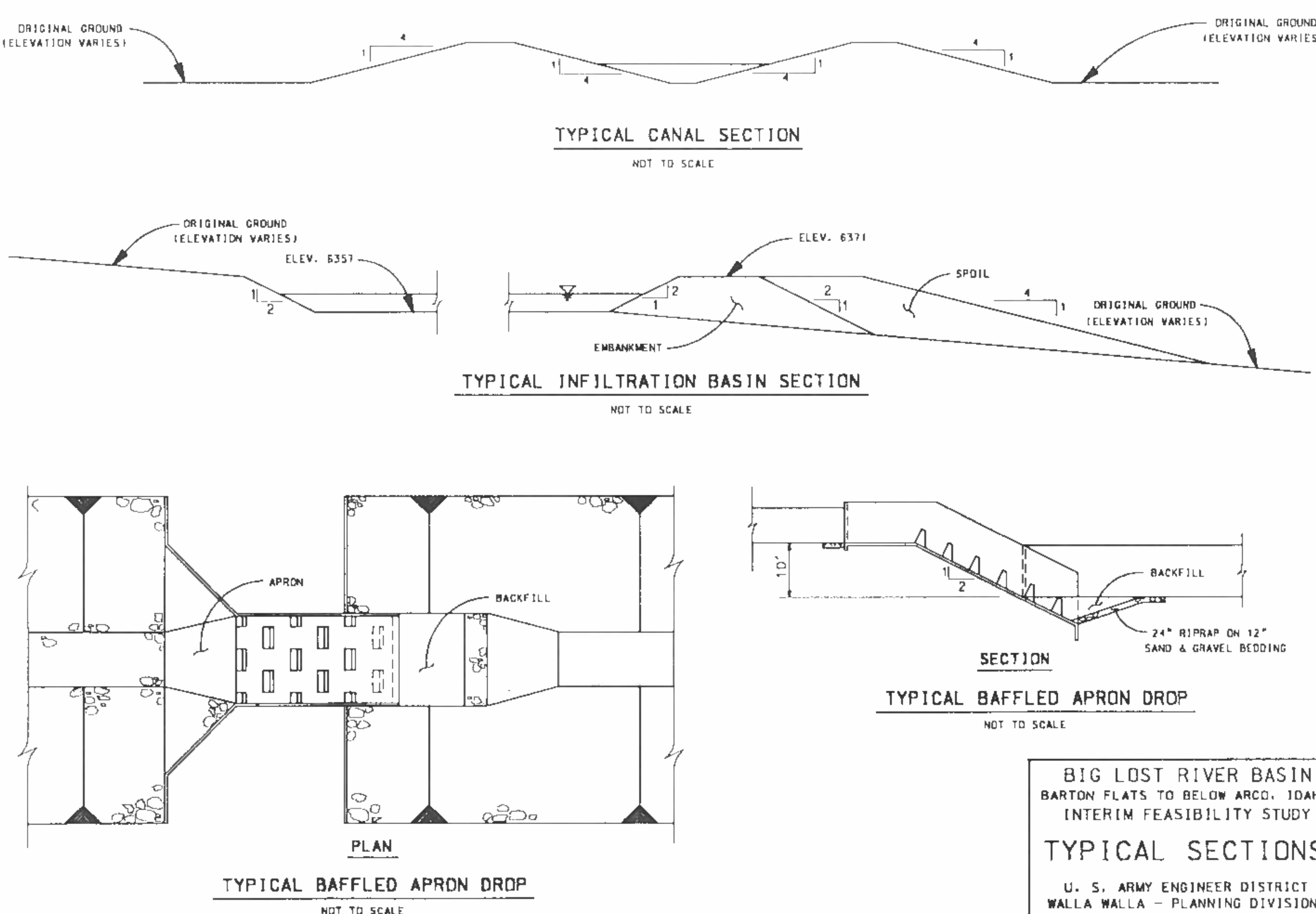
BIG LOST RIVER BASIN
BARTON FLATS TO BELOW ARCO, IDAHO
INTERIM FEASIBILITY STUDY

HEADWORKS AND DIVERSION DAM PLAN

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - PLANNING DIVISION

G. CLAUSEN DECEMBER, 1990

PLATE 3



BIG LOST RIVER BASIN
BARTON FLATS TO BELOW ARCO, IDAHO
INTERIM FEASIBILITY STUDY

TYPICAL SECTIONS

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - PLANNING DIVISION

G. CLAUSEN — DECEMBER, 1990

PLATE 4

APPENDIX A

Hydrology

APPENDIX A

HYDROLOGY

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CHARTS

TABLE OF CONTENTS (CONTINUED)

CHARTS (CONTINUED)

PLATES

APPENDIX A

HYDROLOGY

1. INTRODUCTION.

The purpose of this appendix is to present the Big Lost River Basin hydrology as part of a interim feasibility report on flood control in the Basin.

2. BASIN DESCRIPTION.

The Big Lost River Basin is located in eastern Idaho, north of the Snake River Plain, as shown on plate 1. Drainage area of the Basin is 1,800 square miles, including the northeastern slopes of the Pioneer Mountains and southwestern slopes of the Lost River Range. The southwestern exposure of the Lost River Range is a barren expanse of wasteland with bare, rocky mountains rising steeply 5,000 to 6,000 feet above the valley floor. From this range the tributary streams drop to the edge of the valley floor and disappear.

The Big Lost River Basin contains about 50,000 acres of irrigated land, of which 40,000 acres are below Mackay Dam. The upper area is used primarily for livestock, while the area below Mackay Dam is used for crop production (such as potatoes, grain, hay, and pasture).

The population in the Basin is mainly located in the Big Lost River Valley on ranches and in a few small towns. Principle towns in upstream order are: Arco, population 1,198; Moore, population 215; and Mackay, population 582.

3. CLIMATE.

The climate of the Lost River Basin is characterized by warm dry summers and cold winters. A large part of the annual precipitation falls in the form of snow during December, January, and February in the lower areas and from November to April at the higher altitudes. Table 1 summarizes the maximum, mean, and minimum annual precipitation and temperature extremes at Mackay and Arco, Idaho.

a. Temperature.

In the summer, the days are hot and the nights are cool. During the winter, the temperature frequently falls below zero. At the entrances to some of the tributary valleys the temperature has dropped to 40 degrees Fahrenheit (F) below zero, but during ordinary winters the minimum temperature recorded in the valley is from 10 degrees to 20 degrees F below zero. In the summer, a temperature of 100 degrees F or more for a few days is not uncommon. The maximum recorded temperature in the Lost River Basin is 104 degrees F.

b. Precipitation.

Precipitation in the Lost River Basin ranges from an annual average of less than 9 inches on the Snake River Plain to a annual average of over 20 inches at high altitudes. The normal annual precipitation for the Basin above the U.S. Geological Survey (USGS) stream gauge "Big Lost River near Arco, Idaho" is 17.7 inches. The following data table shows climatic data for the climatological stations at Mackay and Arco.

TABLE 1

ANNUAL PRECIPITATION AND TEMPERATURE EXTREMES

Station	Elev. in Feet	Precipitation in inches Annual Mean	Max.	Min.	Temperature Extremes in degrees F Max.	Min.
Mackay	5,897	9.3	15.0	3.6	104	-29
Arco	5,300	10.3	16.6	4.9	102	-46

4. STREAMFLOWS.

Normally, active streams from the eastern part of the drainage basin do not enter the Big Lost River. Flood flows from the western side of the basin reach the river but only a few of these tributaries normally contribute surface flows in the summer months.

In the reach of the Big Lost River Valley known as the Chilly Sinks, downstream of Chilly, considerable surface runoff is normally lost to groundwater flow. Above Chilly the river channel is relatively stable and there is little seepage loss. Stream gauge records of the outflow from Mackay Reservoir show a gain in water supply between the streamflow above Chilly Sinks at the Howell Ranch gauge and the outflow from the reservoir. Below Mackay Dam, large quantities of water are lost from the river in areas known as the Darlington and Moore Sinks. Overbank flooding occurs in the valley between Mackay and Arco at discharges ranging from 500 cfs near Arco to 1,500 cfs near Mackay.

Further downstream below Arco, the river flows onto the Snake River Plain. Southeast of Arco, it enters Box Canyon, a narrow canyon approximately 7 miles long, with an average depth of 70 feet and a width of 130 feet. Fractured basalt in this reach contributes to a significant loss of flow to groundwater. At the exit of Box Canyon a diversion structure and channel with a capacity of 9,300 cubic feet per second (cfs) is used to spread water to four areas which have a total capacity of 18,200 acre-feet at elevation 5,040 feet mean sea level (msl) and 58,000 acre-feet at elevation 5,050 feet msl. Flows not diverted at the structure pass northward across the Idaho National Engineering Laboratory in a shallow gravel-filled channel. The flow gradually disappears into the ground in an area referred to as the Big Lost River Sinks. There is no direct surface discharge from the Big Lost River into the Snake River.

a. Gauging Stations.

The USGS has maintained several stream gauging stations and one reservoir contents gauging station in the Big Lost River Basin. The following table shows the ones that were used in this study.

Station	USGS Gauge #	Drainage Area Square Miles
Big Lost R. (east channel) above Mackay Reservoir	13123500[1]	766[5]
Big Lost R. (west channel) above Mackay Reservoir	13124000[1]	766[5]
Big Lost R. below Mackay Reservoir near Mackay, ID	13127000[2]	813
Big Lost R. near Arco, ID	13132500[3]	1,410
Big Lost R. at Howell Ranch	13120500[4]	450

[1] Period of record: 1919-59
[2] Period of record: 1904-06, 1912-15, and 1919-88
[3] Period of record: 1947-60 and 1966-88
[4] Period of record: 1904-14 and 1920-88
[5] Channels are interconnected above gauge sites. Total drainage area above gauges is 766 square miles. The total discharge of these four gauges is approximately the total surface inflow to Mackay Reservoir.

b. Hydrographs.

The Big Lost River and its tributaries have a generally uniform pattern of streamflows because most of their water supplies originate from seasonal moisture mostly stored as snow and released during the spring months as the snow melts. In general, natural streamflows are high during the months of April through July and low in the months of August through March. The summary hydrographs on chart 10 and water year 1967 runoff on chart 11 show the seasonal trends for the Big Lost River.

c. Flow Duration.

Flow duration curves were developed for the Big Lost River at Howell near Chilly, Idaho. Both annual and partial flow duration curves were developed. The partial duration curve is for the period 1 May through 31 July. The mean discharge for this period is 930 cfs. The mean discharge for the annual flow duration curve is 331 cfs. These curves are shown on charts 7 and 8.

5. EFFECTS OF CURRENT REGULATION.

Effects of diverting flows at the proposed diversion site on flows into and downstream of the Mackay Reservoir were considered. Attempts were made to relate mean daily discharge values for the Big Lost River at Howell to the total inflow to Mackay Reservoir. The period considered was 1919 to 1959 since inflow to the reservoir from the Big Lost River was only recorded during this period.

Big Lost inflow to the Mackay Reservoir is generally less than the flows recorded at the Howell gauge. Since the drainage area for the river near the reservoir is larger than the drainage area at Howell the difference in flow must equal the losses plus the diversions minus local inflow.

Flows between the Howell gauge and the reservoir are diverted for the purposes of irrigation and flood control. While irrigation records exist, flood control diversions have not been recorded. Since diversions were made at both high and low flows for the entire period of record and since accurate records of these diversions were not made, it is not possible to separate diversion flows from other losses.

Hydrographs at both locations were compared for various discharges during high and low flow periods. Flood diversion operations seem to be inconsistent for the same given flows during high discharge periods. Diversion operations during high flows are apparently based on observations of the flows at the Howell gauge. If flows are increasing at the Howell gauge the amount of diversion is increased. Note that during past flood events, up to 2,200 cfs has been diverted from the channel between the Howell gauge and the reservoir.

Inspection of hydrographs for low flow years shows that flows due to snowmelt in the lower basin occur at approximately the same time as snowmelt in the upper basin.

The Mackay Reservoir is operated for irrigation only. During large floods which occurred during high water years, especially 1967 (reference chart 11), the reservoir was near full before the flood peak occurred.

Flows should be reduced in downstream reaches by the amount of flow diverted. MacKay Reservoir must be assumed full or near full since large floods have occurred at a time of year when the reservoir was near full. Losses other than diversion losses are considered to be insignificant. It is important to note that current diversions be operated as they are now and not reduced because of the diversion operation at the Chilly Canal diversion.

6. FREQUENCY ANALYSIS.

The frequency analysis for the Big Lost River Basin consists of observed annual peak discharge frequency analysis and regulated annual peak discharge frequency analysis for two reaches of the river, one from the diversion site to Mackay Dam, the other from Mackay Dam to just downstream of Arco, Idaho. These were used in developing specific frequency floodplains for economic analysis. The following paragraphs describe the methodology used in developing the observed annual peak discharge and the regulated annual peak discharge frequency curves.

a. Annual Peak Discharge Analysis.

(1) Reach Above Mackay Dam.

(a) Discharge Records.

The period of record used for the analysis was 1904-14 and 1920-88 for the Big Lost River at Howell Ranch, Idaho, USGS gauge number 13120500.

(b) Frequency Computations.

The annual peak discharge frequency curve for Big Lost River at Howell Ranch was computed using the computer program "Flood Flow Frequency Analysis" and a period of record 1909-14 and 1919-88. The program, developed by the Hydrologic Engineering Center (HEC), uses the methods outlined in the Water Resources Council (WRC), "Guidelines for Determining Flood Flow Frequencies," Bulletin 17b, revised September 1981. A generalized skew of -0.3 was used as suggested by plate 1 of the WRC guidelines. The following table lists selected specific frequency flood events and the annual peak discharge frequency curve is shown on chart 3.

Annual Peak Discharges
Big Lost River at Howell Ranch

Recurrence Interval (years)	Expected Probability	Discharges (cfs) USGS Gauge # 13120500
10	0.10	3,480
50	0.02	4,440
100	0.01	4,800
500	0.002	5,550

The regulated annual peak discharge frequency curve was computed using a regulation objective of 1,500 cfs (bank full) with a maximum diversion of 1,000 cfs. Any diversion at the proposed diversion site will reduce peak discharges at the diversion location by the amount diverted. The regulated annual peak discharge frequency curve is shown on chart 6. The following table lists selected specific frequency flood events which are representative below the proposed diversion.

Regulated Annual Peak Discharges
at Proposed Chilly Canal Diversion

Recurrence Interval (years)	Expected Probability	Discharges (cfs) USGS Gauge # 13120500
10	0.10	2,480
50	0.02	3,440
100	0.01	3,800
500	0.002	4,550

(2) Reach Between Mackay Dam and Arco.

(a) Discharge Records.

Regulated discharge frequency curves were developed for the following two gauges on the Big Lost River downstream of Mackay Reservoir.

USGS Gauge #	Drainage Description	Available Area (sq. mi)	Period of Record
13127000	Big Lost River below Mackay Reservoir, near Mackay, Idaho	813	1904-06, 1912-15 & 1919-86
13132500	Big Lost River near Arco, Idaho	1,410	1947-60 & 1966-86

Both gauges are downstream of Mackay Reservoir, which began storing water early in 1919. Therefore, all available records are regulated except for the years 1904-15 from the gauge near Mackay. This data was removed from the set, leaving a regulated period of record of 1919-86, which was used to generate the frequency curve for observed flows at the gauge. In addition to regulation by Mackay Reservoir, both gauges are affected by irrigation diversions upstream of the gauge sites.

Effects of diverting flows at the proposed diversion site on peak discharges downstream of the Mackay Reservoir were considered. The period of record considered for this analysis is 1919-59, since inflow to the reservoir from the Big Lost River was only recorded during this period.

(b) Frequency Computations.

1. Observed.

The data set for each gauge was input into the HEC's "Flood Flow Frequency Analysis" program, PC version dated 12 December 1983, along with a generalized skew of -0.30 as suggested by plate 1 of the WRC "Guidelines for Determining Flood Flow Frequency," Bulletin 17b, revised September 1981. The program computed median plotting positions, frequency statistics, and the frequency curves included as charts 1 and 2. The following table lists the regulated annual peak discharges for various recurrence intervals for both gauges.

Annual Peak Discharges

Recurrence Interval (years)	Expected Probability	Regulated Discharges (cfs) USGS Gauge # 13127000	USGS Gauge # 13132500
2	0.50	1,470	404
5	0.20	2,080	1,070
10	0.10	2,470	1,690
50	0.02	3,280	3,520
100	0.01	3,620	4,480
500	0.002	4,380	7,070

2. Regulated by Proposed Diversion.

The Mackay Reservoir is operated for irrigation only. During large floods which occurred during high water years, especially 1967 (reference chart 11), the reservoir was nearly full before the time of the flood peak.

Flows should be reduced in downstream reaches by the amount of flow diverted. MacKay Reservoir must be assumed full or near full since large floods have occurred at a time of year when the reservoir was near full. Losses other than diversion losses are considered to be insignificant. It is important to note that current diversions be operated as they are now and not reduced because of the diversion operation at the Chilly Canal diversion. The following table lists selected regulated discharges for selected recurrence intervals. The regulated annual peak discharge frequency curves are shown on charts 4 and 5.

Regulated Annual Peak Discharges

Recurrence Interval (years)	Expected Probability	Regulated Discharges (cfs) USGS Gauge # 13127000	USGS Gauge # 13132500
2	0.50	1,470	404
5	0.20	1,080	500
10	0.10	1,470	690
50	0.02	2,280	2,520
100	0.01	2,620	3,480
500	0.002	3,380	6,070

7. HYDRAULIC ANALYSIS.

This section will present the methodology, data and results of the hydraulic study for the Big Lost River. The floodplains were used for damage estimates. The hydraulic analysis is divided into approximate and detailed study reaches.

There are five detailed reaches--Arco, Moore, Leslie, Mackay, and Chilly. The site of the proposed diversion structure was modeled to develop a tailwater rating curve. The tailwater rating curve is shown on chart 38.

a. Channel Capacities.

Maximum channel capacities were determined using the HEC program HEC-2, "Water Surface Profiles," and range from 500 cfs near Arco to 1,500 cfs near and above Mackay.

b. Model and Model Calibration.

(1) Detailed Reaches.

The hydraulic study for detailed reaches was done using field surveyed cross sections and the HEC program HEC-2, "Water Surface Profiles," at the locations shown on plates 2 through 10.

(2) Approximate Reaches.

The hydraulic study for approximate reaches was done by inspection of USGS's 7.5-minute quadrangle sheets and 1986 aerial photographs. No water surface profiles were computed for these reaches.

c. Cross-Section Development.

All cross-section data was field surveyed. Where necessary, cross sections were extended in overbank areas using USGS's 7.5-minute quadrangle sheets.

d. Computational Procedures.

Water surface profiles were computed for both existing conditions and for a 1,000 cfs diversion for the recurrence intervals of 10-, 50-, 100-, and 500-year and are shown on charts 12 through 37.

Starting water-surface elevations were obtained by computations using the slope area method in HEC-2 for all reaches except the Arco Reach.

A USGS rating curve for the Arco gauge near Arco, Idaho was used for starting water surface elevations for the Arco Reach.

Roughness coefficients (Manning's "n") used in the hydraulic computations for the channel were determined by calibration at the Arco gauge and use of the USGS water-supply paper 1849, titled "Roughness Characteristics of Natural Channels." Overbank roughness coefficients were determined by engineering judgment. Channel and overbank roughness coefficients used are 0.038 and 0.050, respectively.

All elevations are referenced to the National Geodetic Vertical Datum of 1929.

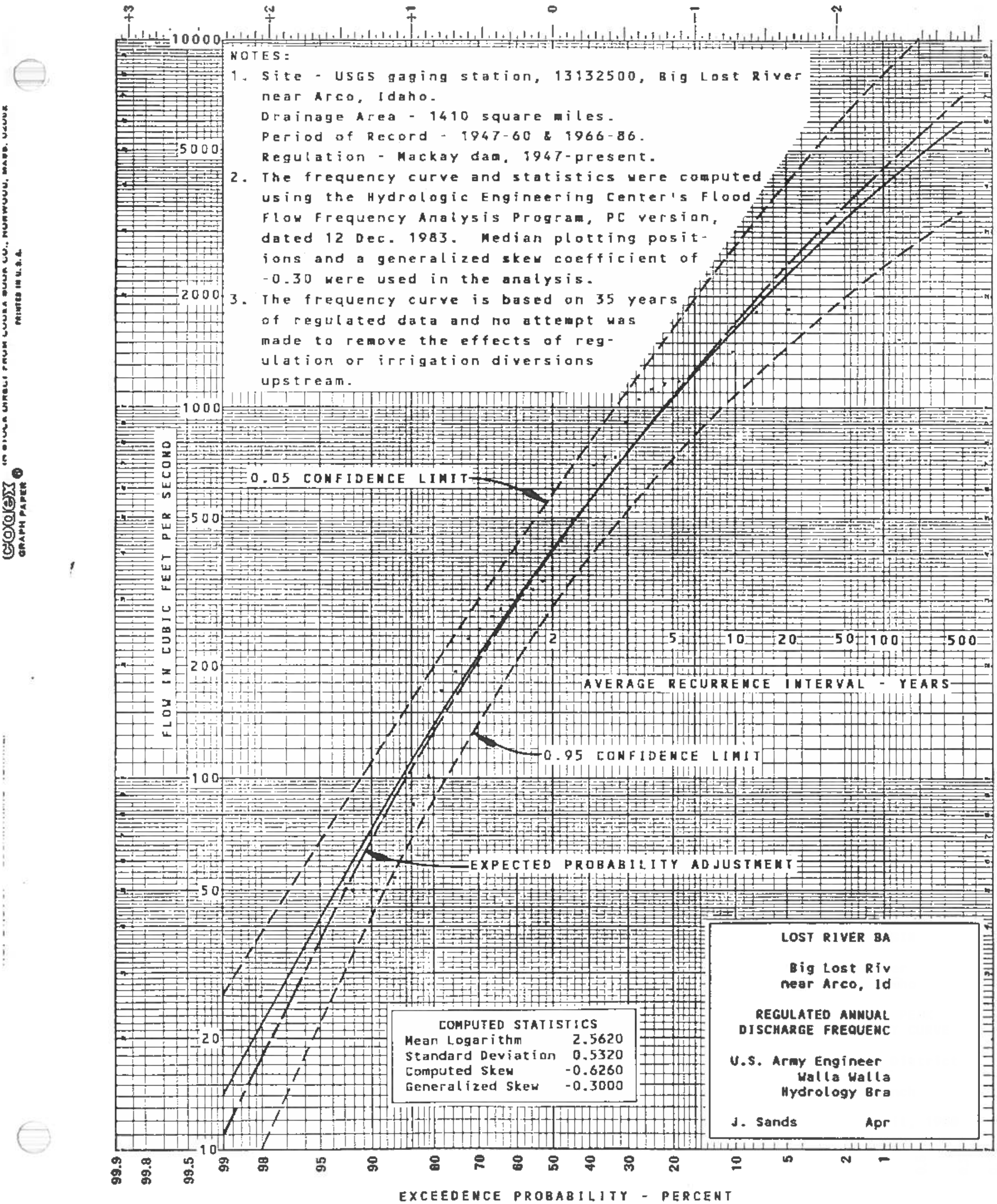
e. Flood Plains.

(1) Detailed Reaches.

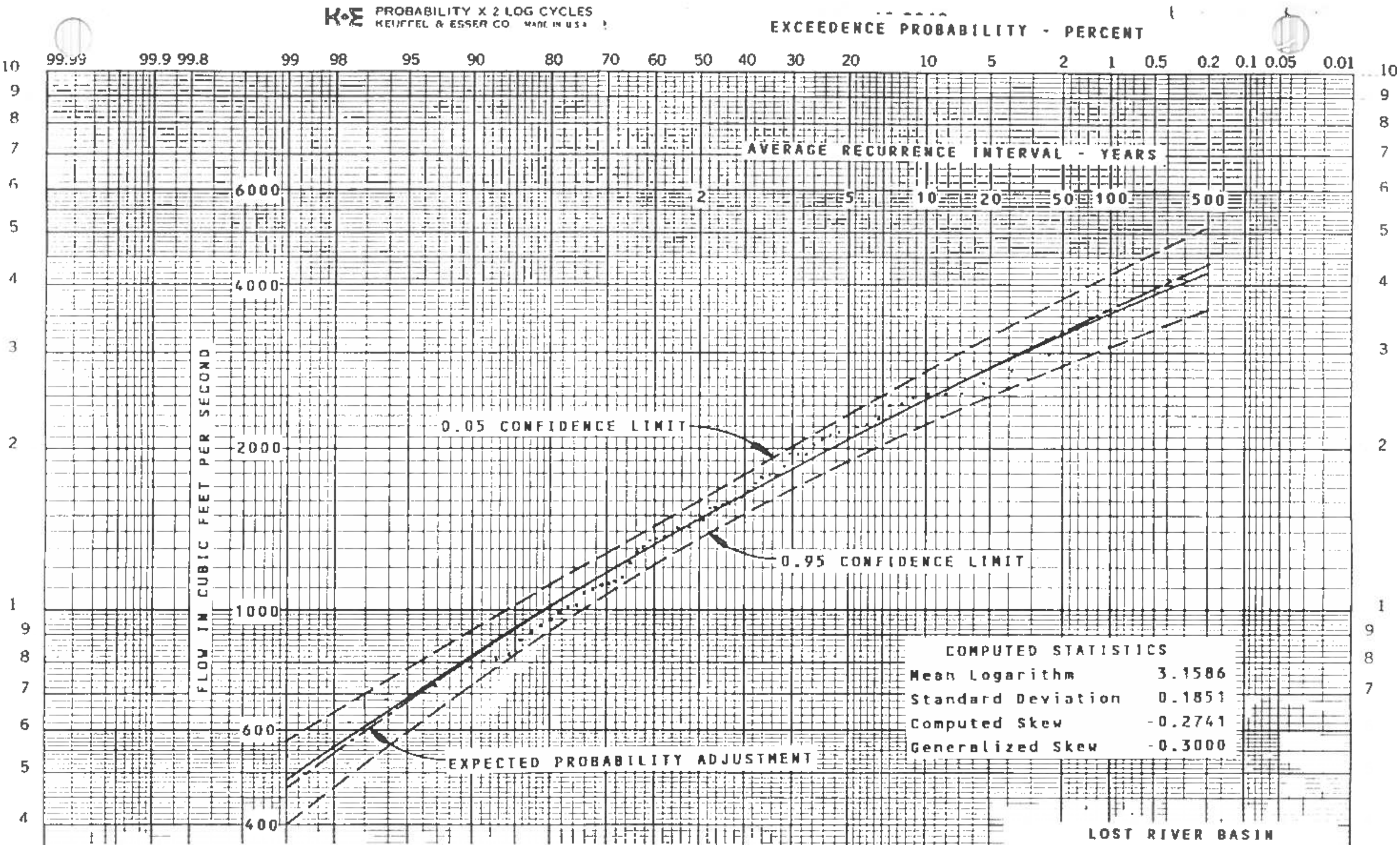
The 10-, 50-, 100-, and 500-year floodplains were defined for each of the five reaches and are shown on plates 2 through 10. The extent of the floodplains is the same for both regulated and existing conditions because of the relatively wide and level floodplain and the comparatively small amount of diverted flow. The 50-year floodplain was compared to the floodplain limits of the 1967 flood, which had a recurrence interval of approximately 22 years. These floodplain boundaries compare well with few minor differences because the channel conveyance is comparatively small and overbank areas are generally wide, relatively flat, and have clearly defined limits.

(2) Approximate Reaches.

Floodplains for approximate reaches were determined using 1986 aerial photos and USGS's 7.5-minute quadrangle sheets. Depths of flooding used were average depths taken from the nearest detailed reach.


NOTES:
1. Site - USGS gaging station, 13132500, Big Lost River near Arco, Idaho.
Drainage Area - 1410 square miles.
Period of Record - 1947-60 & 1966-86.
Regulation - Mackay dam, 1947-present.
2. The frequency curve and statistics were computed using the Hydrologic Engineering Center's Flood Flow Frequency Analysis Program, PC version, dated 12 Dec. 1983. Median plotting positions and a generalized skew coefficient of -0.30 were used in the analysis.
3. The frequency curve is based on 35 years of regulated data and no attempt was made to remove the effects of regulation or irrigation diversions upstream.
0.05 CONFIDENCE LIMIT
0.95 CONFIDENCE LIMIT
EXPECTED PROBABILITY ADJUSTMENT
FLOW IN CUBIC FEET PER SECOND
AVERAGE RECURRENCE INTERVAL - YEARS
EXCEEDENCE PROBABILITY - PERCENT
COMPUTED STATISTICS
Mean Logarithm 2.5620
Standard Deviation 0.5320
Computed Skew -0.6260
Generalized Skew -0.3000
LOST RIVER BA
Big Lost Riv
near Arco, Id
REGULATED ANNUAL
DISCHARGE FREQUENC
U.S. Army Engineer
Walla Walla
Hydrology Bra
J. Sands Apr

APPENDIX A



COMPUTED STATISTICS	
Mean Logarithm	3.1586
Standard Deviation	0.1851
Computed Skew	-0.2741
Generalized Skew	-0.3000

NOTES:

1. Site - USGS gaging station, 13127000, Big Lost River below Mackay Reservoir, near Mackay, Idaho.
   Drainage Area - 813 square miles.
   Period of Record - 1919-1986.
   Regulation - Mackay dam, 1919-present.

2. The frequency curve and statistics were computed using the Hydrologic Engineering Center's Flood Flow Frequency Analysis program, PC version, dated 12 December, 1983. Median plotting positions and a generalized skew coefficient of -0.30 were used in the analysis.

3. The frequency curve is based on 68 years of regulated data and no attempt was made to remove the effects of regulation.

LOST RIVER BASIN

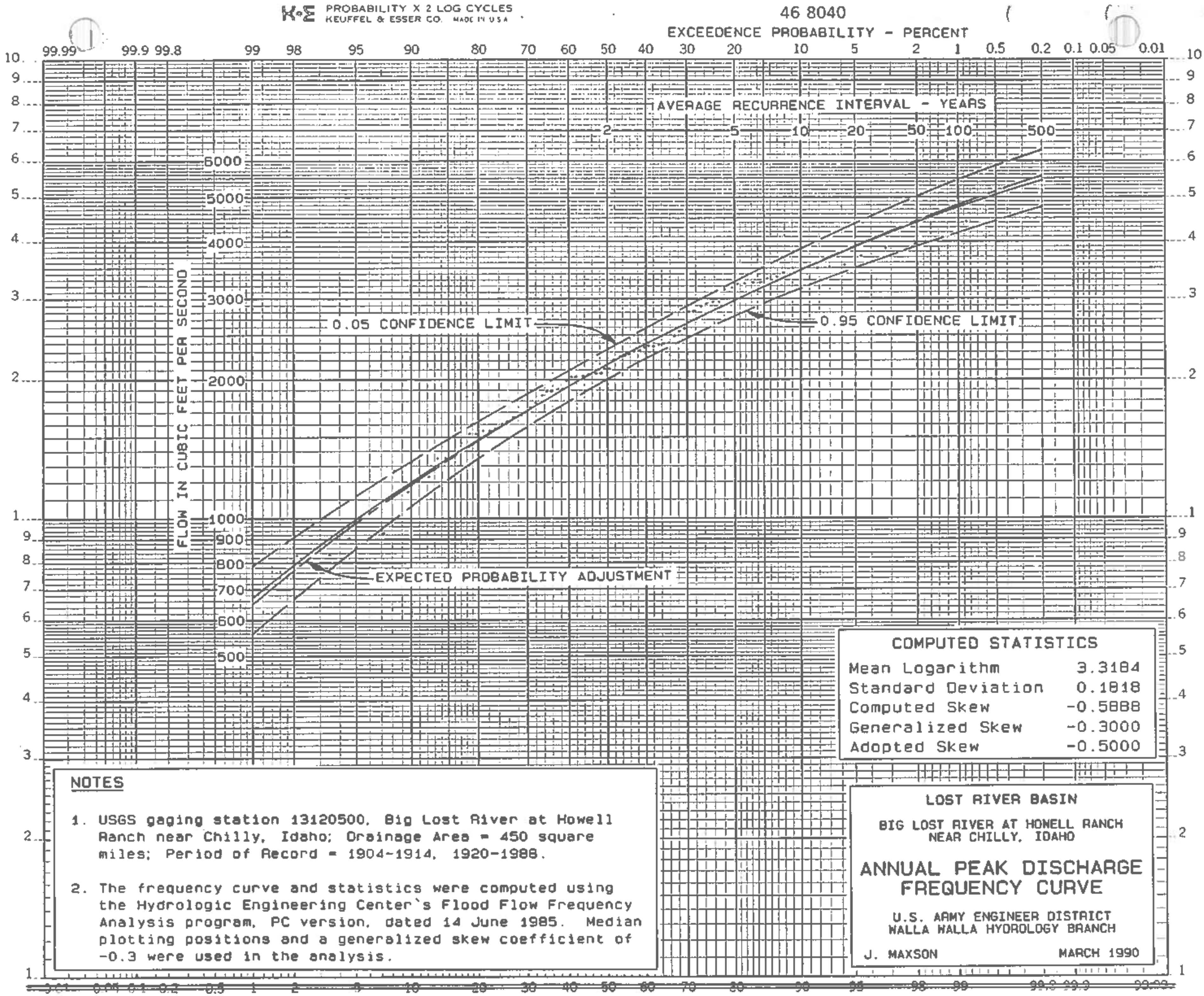
Big Lost River below
Mackay Reservoir, Idaho

REGULATED ANNUAL PEAK
DISCHARGE FREQUENCY CURVE

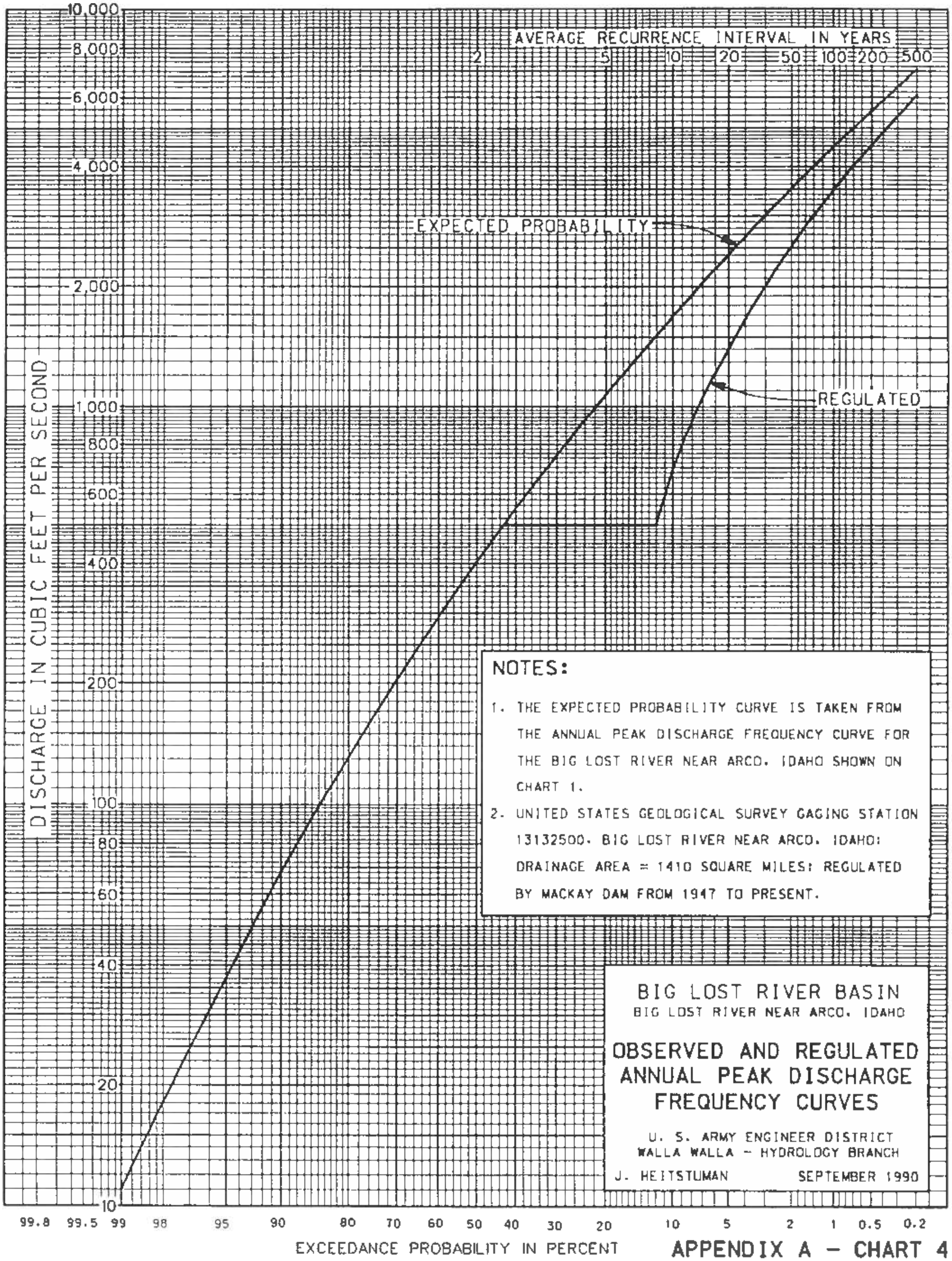
U.S. Army Engineer District
Walla Walla
Hydrology Branch

J. Sands April 1988

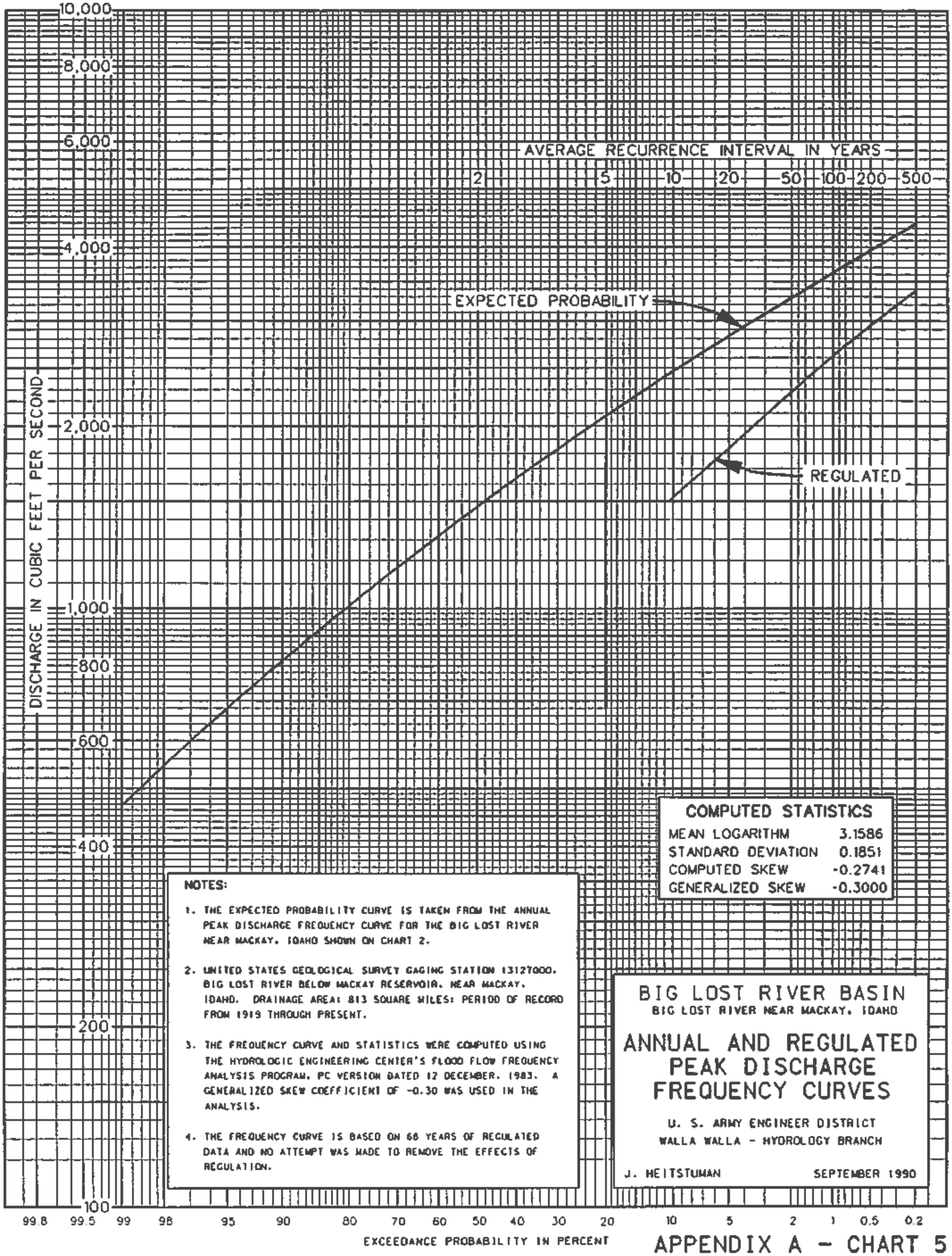
APPENDIX A - CHART 2



APPENDIX A - CHART 3



APPENDIX A – CHART 4



COMPUTED STATISTICS

MEAN LOGARITHM	3.1586
STANDARD DEVIATION	0.1851
COMPUTED SKEW	-0.2741
GENERALIZED SKEW	-0.3000

NOTES:

1. THE EXPECTED PROBABILITY CURVE IS TAKEN FROM THE ANNUAL PEAK DISCHARGE FREQUENCY CURVE FOR THE BIG LOST RIVER NEAR MACKAY, IDAHO SHOWN ON CHART 2.

2. UNITED STATES GEOLOGICAL SURVEY GAGING STATION 13127000, BIG LOST RIVER BELOW MACKAY RESERVOIR, NEAR MACKAY, IDAHO. DRAINAGE AREA: 813 SQUARE MILES; PERIOD OF RECORD FROM 1919 THROUGH PRESENT.

3. THE FREQUENCY CURVE AND STATISTICS WERE COMPUTED USING THE HYDROLOGIC ENGINEERING CENTER'S FLOOD FLOW FREQUENCY ANALYSIS PROGRAM, PC VERSION DATED 12 DECEMBER, 1983. A GENERALIZED SKEW COEFFICIENT OF -0.30 WAS USED IN THE ANALYSIS.

4. THE FREQUENCY CURVE IS BASED ON 68 YEARS OF REGULATED DATA AND NO ATTEMPT WAS MADE TO REMOVE THE EFFECTS OF REGULATION.

BIG LOST RIVER BASIN

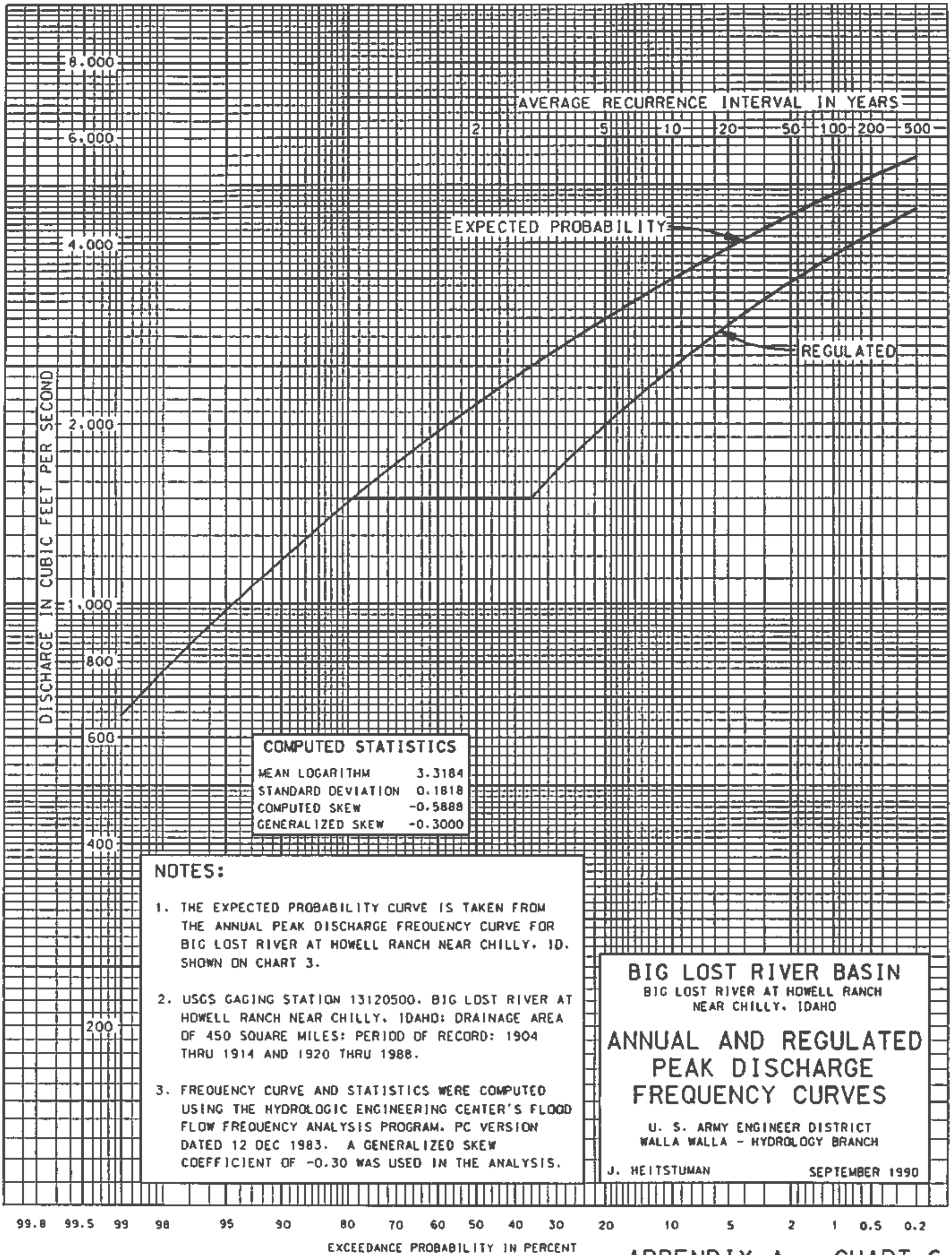
BIG LOST RIVER NEAR MACKAY, IDAHO

ANNUAL AND REGULATED PEAK DISCHARGE FREQUENCY CURVES

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

J. HEITSTUMAN — SEPTEMBER 1990

APPENDIX A - CHART 5



COMPUTED STATISTICS	
MEAN LOGARITHM	3.3184
STANDARD DEVIATION	0.1818
COMPUTED SKEW	-0.5888
GENERALIZED SKEW	-0.3000

NOTES:

1. THE EXPECTED PROBABILITY CURVE IS TAKEN FROM THE ANNUAL PEAK DISCHARGE FREQUENCY CURVE FOR BIG LOST RIVER AT HOWELL RANCH NEAR CHILLY, ID. SHOWN ON CHART 3.

2. USGS GAGING STATION 13120500, BIG LOST RIVER AT HOWELL RANCH NEAR CHILLY, IDAHO; DRAINAGE AREA OF 450 SQUARE MILES; PERIOD OF RECORD: 1904 THRU 1914 AND 1920 THRU 1988.

3. FREQUENCY CURVE AND STATISTICS WERE COMPUTED USING THE HYDROLOGIC ENGINEERING CENTER'S FLOOD FLOW FREQUENCY ANALYSIS PROGRAM, PC VERSION DATED 12 DEC 1983. A GENERALIZED SKEW COEFFICIENT OF -0.30 WAS USED IN THE ANALYSIS.

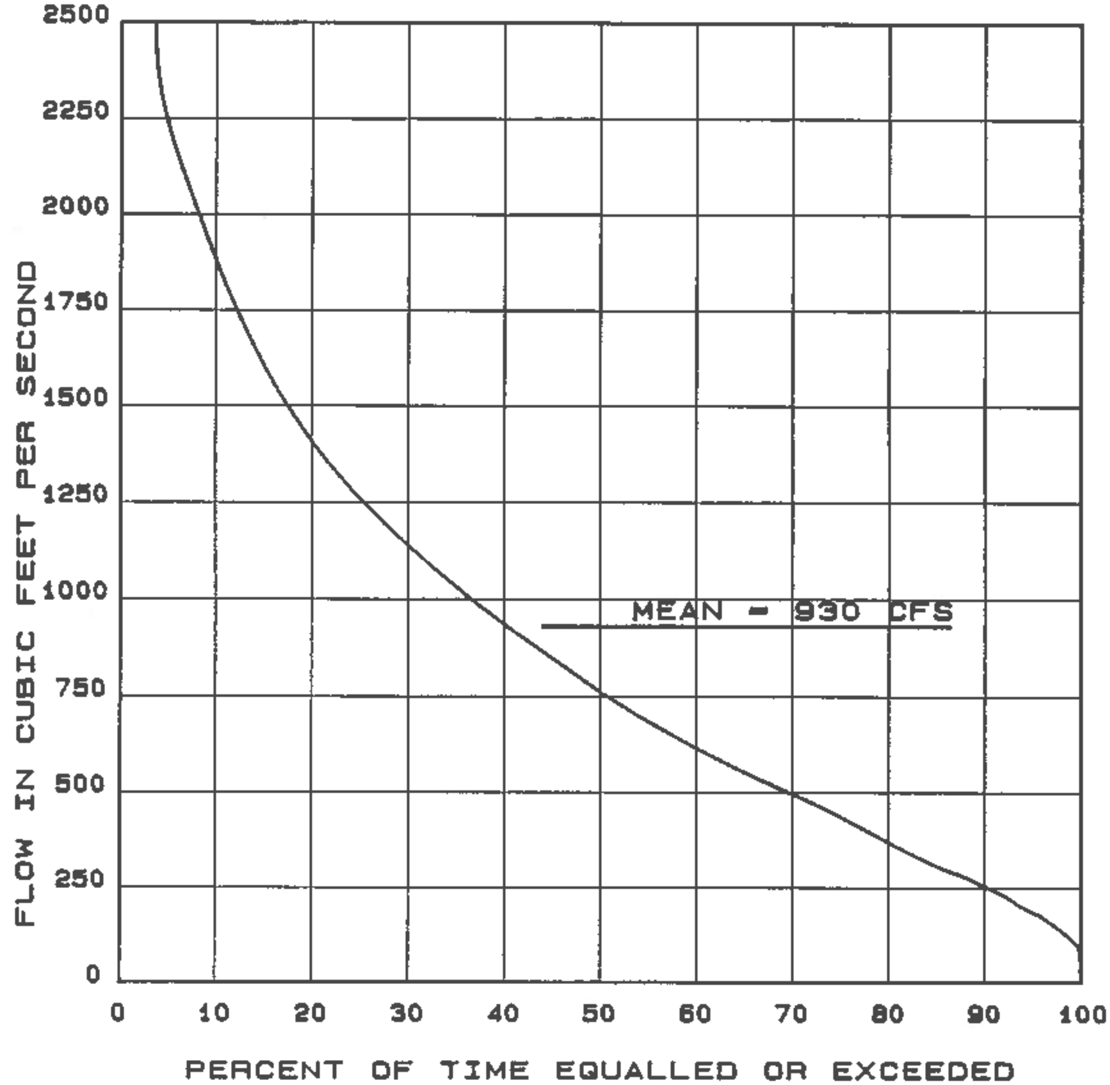
BIG LOST RIVER BASIN
BIG LOST RIVER AT HOWELL RANCH
NEAR CHILLY, IDAHO

ANNUAL AND REGULATED
PEAK DISCHARGE
FREQUENCY CURVES

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

J. HEITSTUMAN SEPTEMBER 1990

APPENDIX A - CHART 6



NOTES:

1. The discharge data was obtained from USGS gaging station 13120500, Big Lost River at Howell Ranch near Chilly, Idaho; Drainage Area = 450 square miles.

2. Period of record for this analysis is October, 1948 through September, 1988.

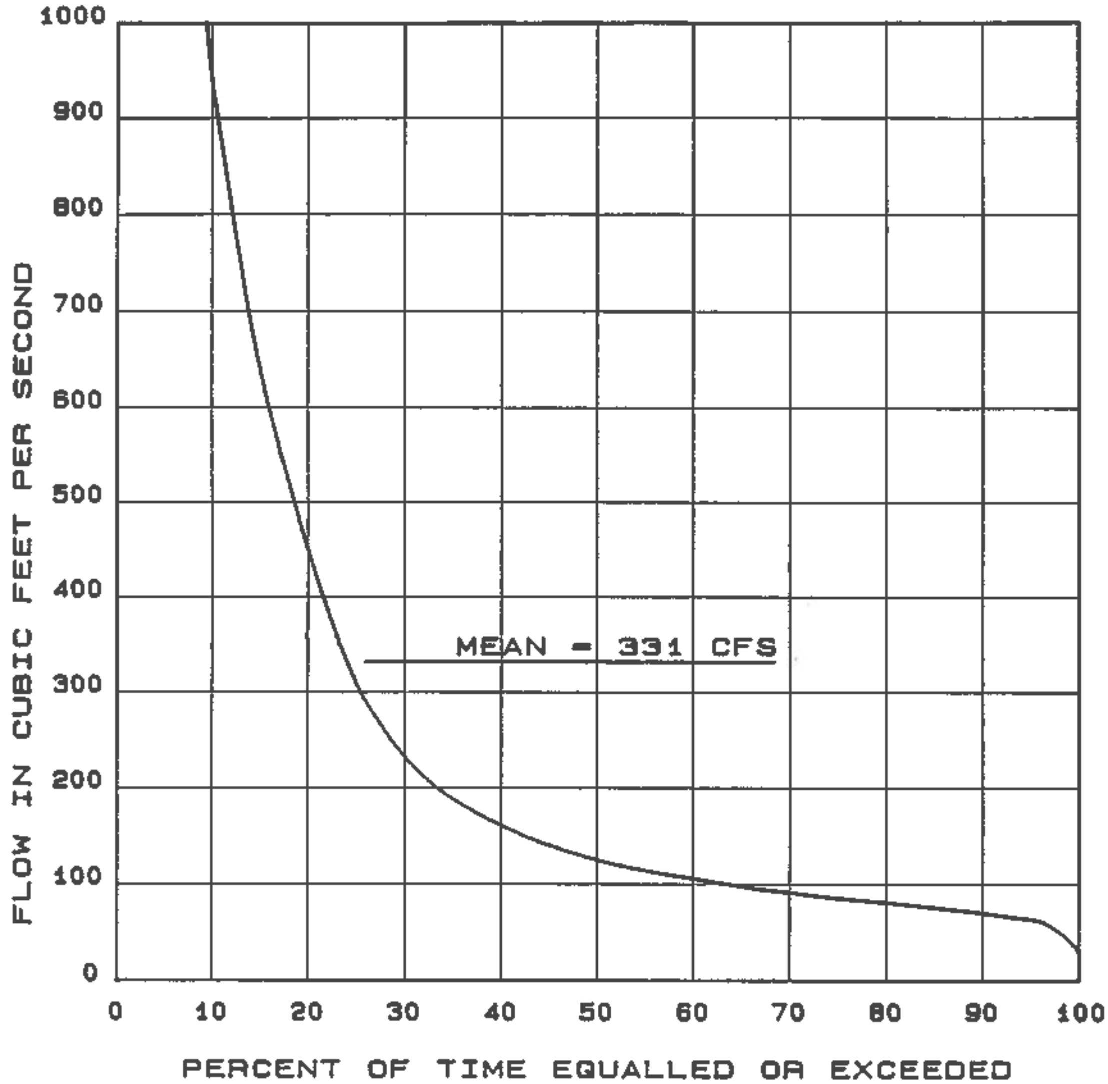
3. Maximum flow = 3820 CFS, 25 May, 1967.
   Minimum flow = 31 CFS, 1 May, 1975.

BIG LOST RIVER
AT HOWELL RANCH NEAR CHILLY, ID

FLOW DURATION CURVE
(1 MAY - 31 JULY)

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

MAXSON/SCHUSTER JAN 1990



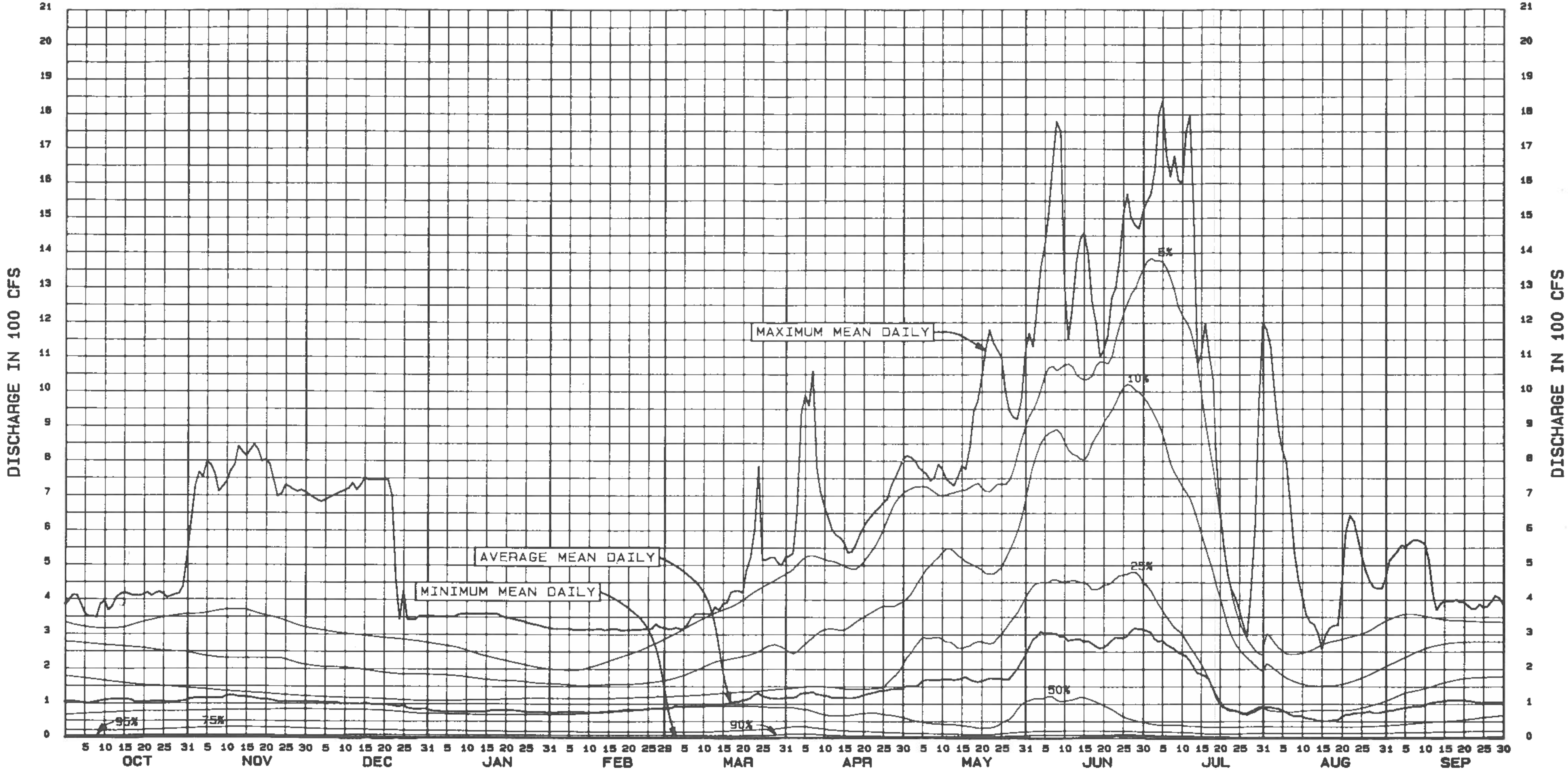
NOTES:

1. The discharge data was obtained from USGS gaging station 13120500, Big Lost River at Howell Ranch near Chilly, Idaho; Drainage Area = 450 square miles.

2. Period of record for this analysis is October, 1948 through September, 1988.

3. Maximum flow = 3820 CFS, 25 May, 1967. Minimum flow = 31 CFS, 6 Dec, 1960.

BIG LOST RIVER AT HOWELL RANCH NR CHILLY, ID
ANNUAL FLOW DURATION CURVE
U.S. ARMY ENGINEER DISTRICT WALLA WALLA - HYDROLOGY BRANCH
MAXSON/SCHUSTER JAN 1990



NOTES:

1. PERIOD OF RECORD = SEP 1946 – SEP 1961, JUN 1966 – OCT 1980, APR 1981 – SEP 1981, & MAY 1982 – DEC 1986.

2. DRAINAGE AREA = 1,410 SQUARE MILES.

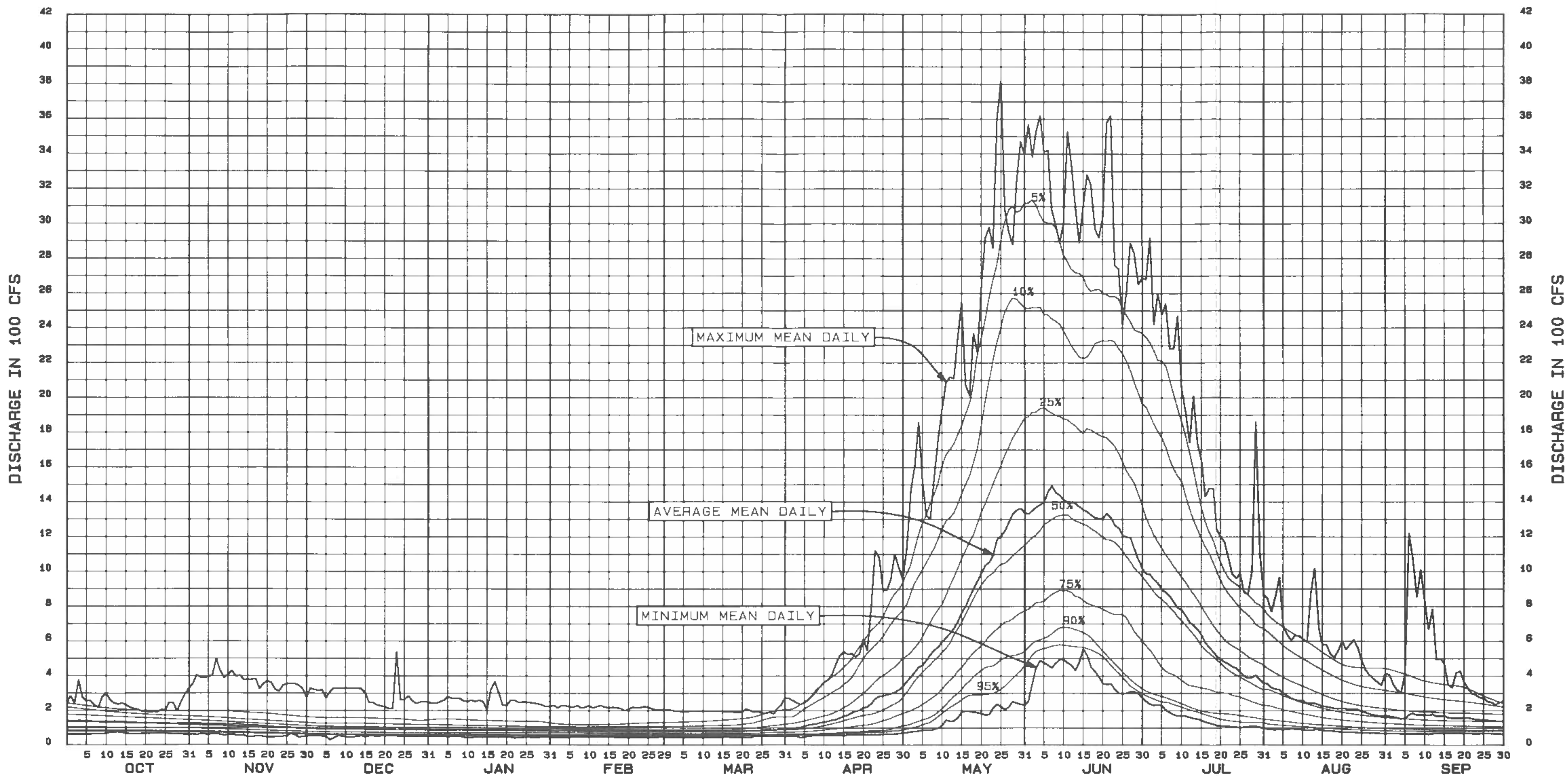
3. USGS GAGING STATION NUMBER = 13132500.

4. EXCEEDENCE LINES REPRESENT THE PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY.

BIG LOST RIVER
NEAR ARCO, IDAHO

SUMMARY HYDROGRAPHS

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA – HYDROLOGY BRANCH
SCHUSTER NOVEMBER, 1988



NOTES:

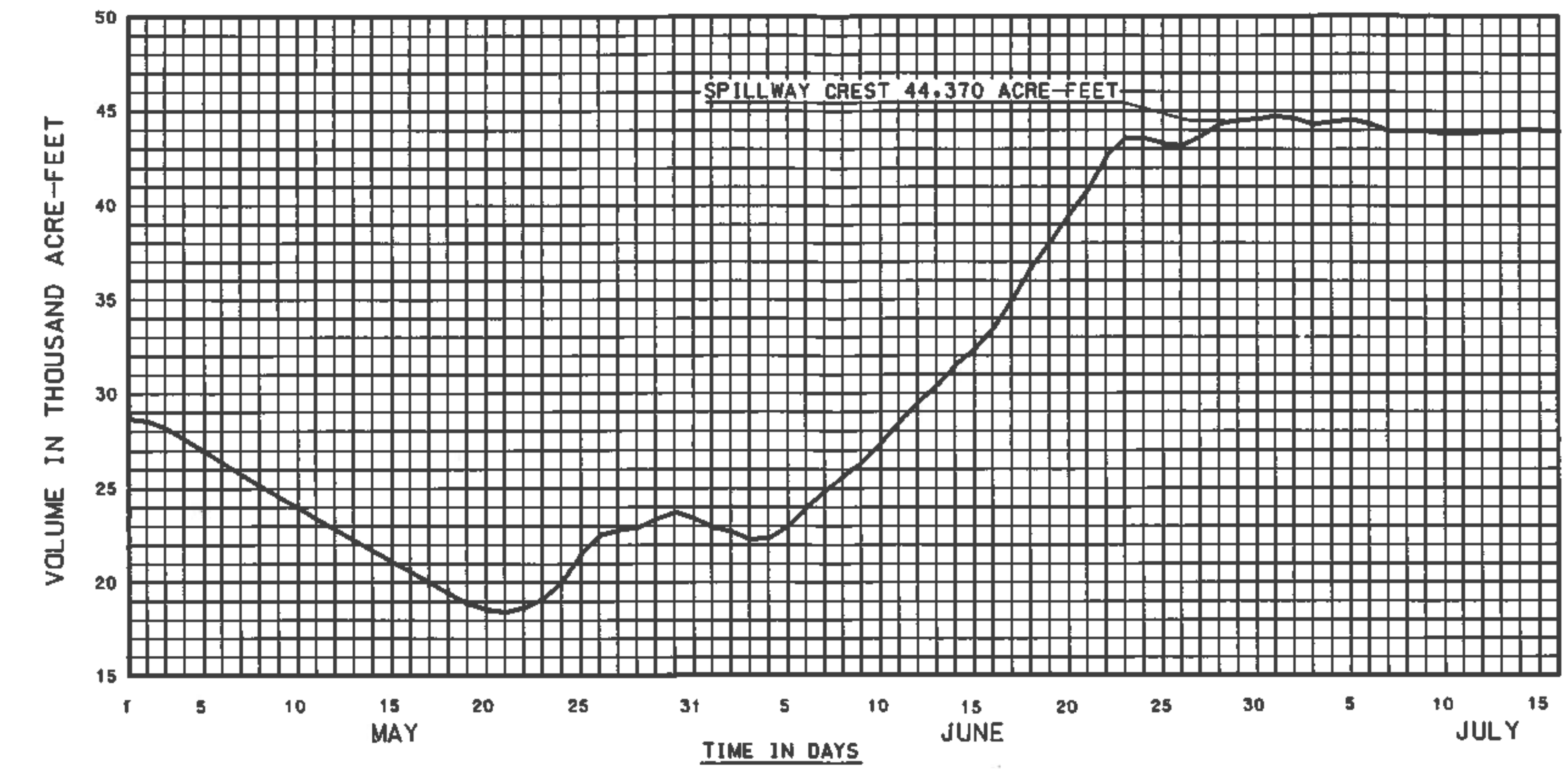
1. USGS GAGE #13120500, BIG LOST RIVER BLW HOWELL RANCH NR. CHILLY, IDAHO.
2. PERIOD OF RECORD - OCT, 1948 THRU SEP 1988.
3. DRAINAGE AREA - 450 SQUARE MILES.
4. EXCEEDENCE LINES REPRESENT THE PERCENTAGE OF TIME THE FLOW IS EQUALLED OR EXCEEDED ON THAT PARTICULAR DAY.

BIG LOST RIVER
AT HOWELL RANCH NR CHILLY, IDAHO

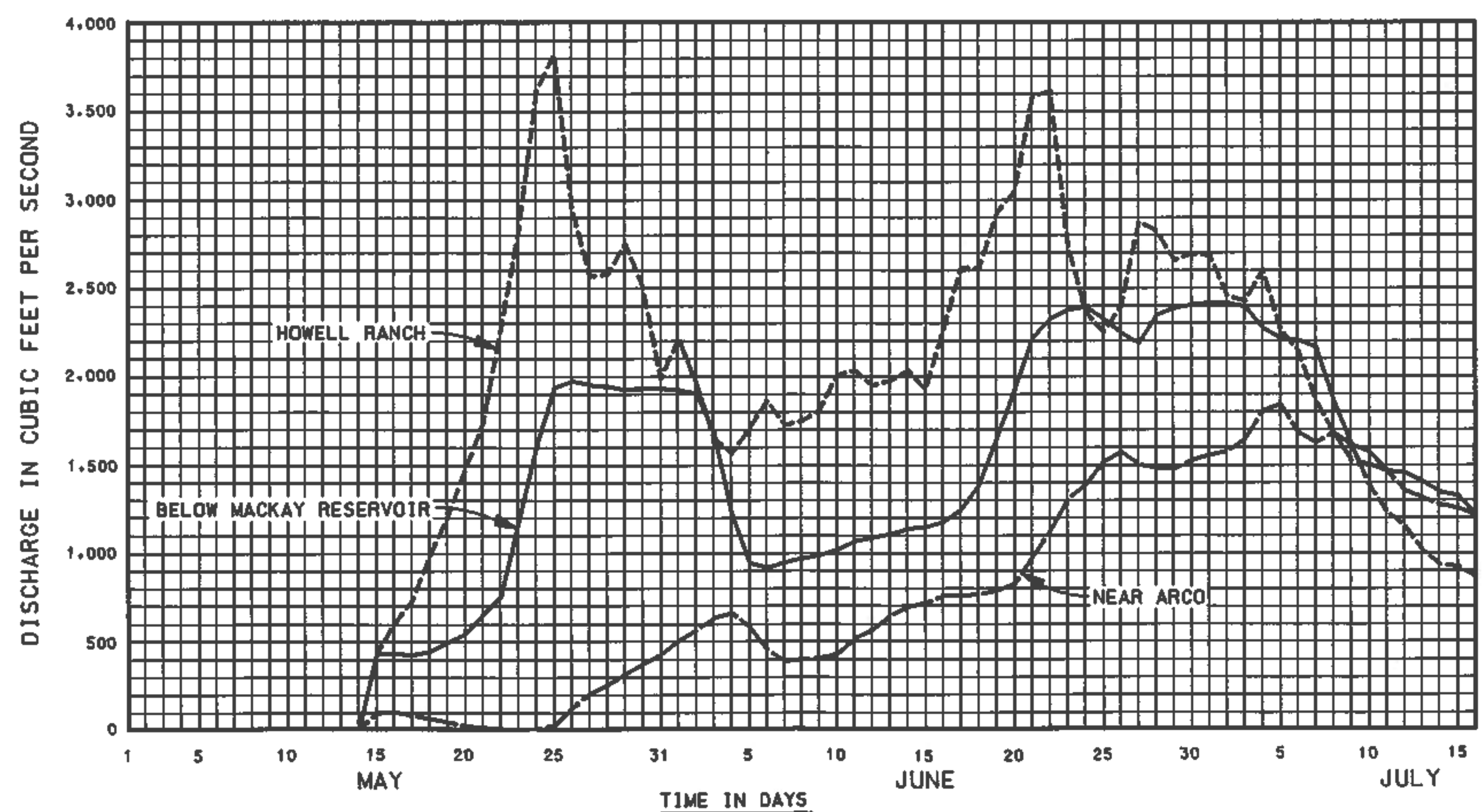
SUMMARY HYDROGRAPHS

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH
SCHUSTER JANUARY 1990

13120500



MACKAY RESERVOIR



SELECTED GAGING STATIONS

NOTES:

1. ALL DISCHARGES ARE MEAN DAILY.
2. FLOWS BELOW MACKAY RESERVOIR DO NOT INCLUDE DIVERSIONS INTO SHARP DITCH.
3. INSTANTANEOUS PEAK FLOW ON 25 MAY AT HOWELL RANCH NEAR CHILLY, IDAHO WAS 4,420 CUBIC FEET PER SECOND.

BIG LOST RIVER BASIN

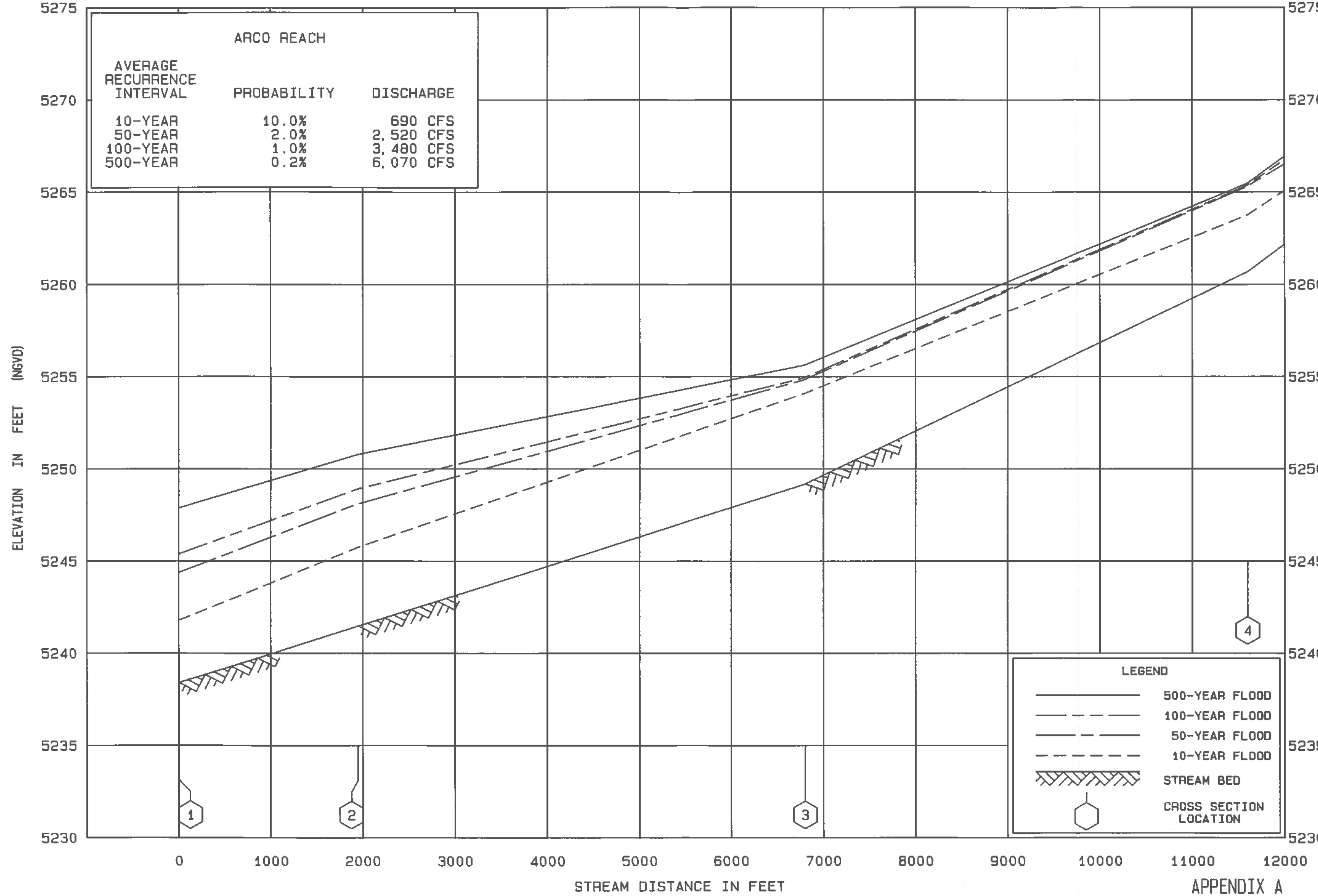
MAY-JULY 1967

HYDROGRAPHS

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH

J. HEITSTUMAN   NOVEMBER 1990

APPENDIX A - CHART 11



AVERAGE RECURRENCE INTERVAL	PROBABILITY	DISCHARGE
10-YEAR	10.0%	690 CFS
50-YEAR	2.0%	2,520 CFS
100-YEAR	1.0%	3,480 CFS
500-YEAR	0.2%	6,070 CFS

APPENDIX A

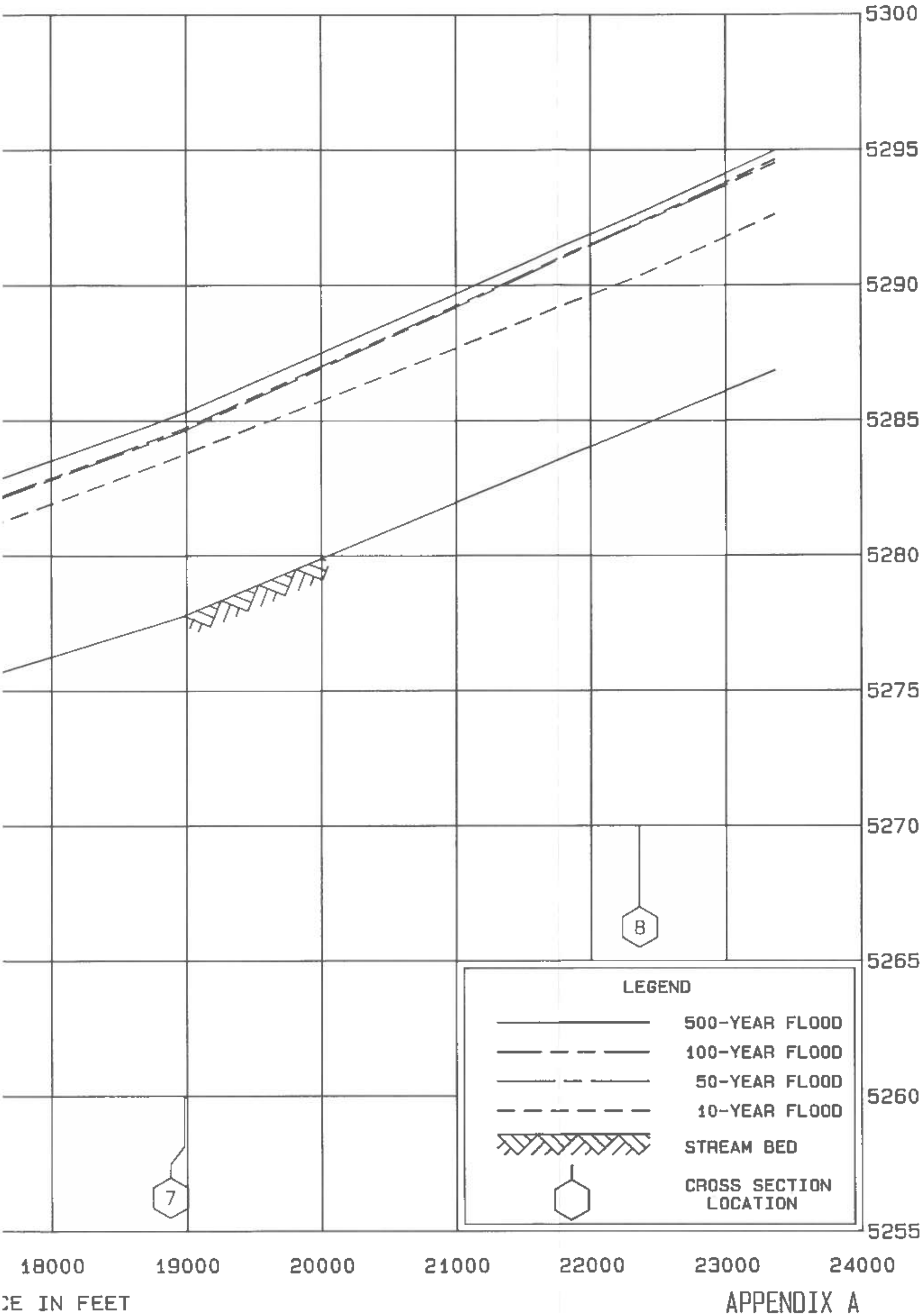
FLOOD PROFILES - NOV 90

ARCO REACH

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA

FEASIBILITY STUDY
BIG LOST RIVER, ID

CHART 12



APPENDIX A

FLOOD PROFILES - NOV 90

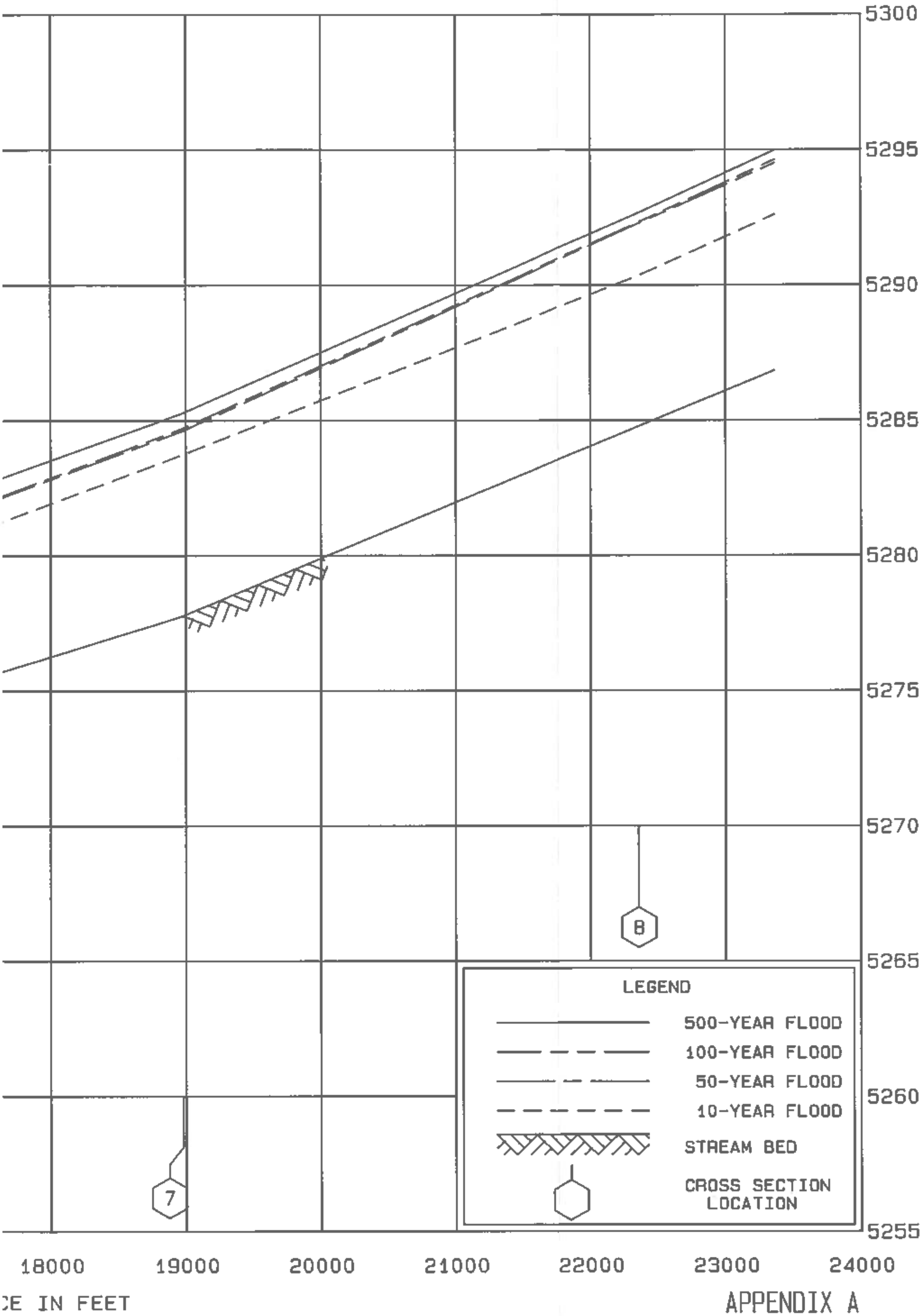
ARCO REACH

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA

FEASIBILITY STUDY

BIG LOST RIVER, ID

CHART 13



APPENDIX A

FLOOD PROFILES - NOV 90

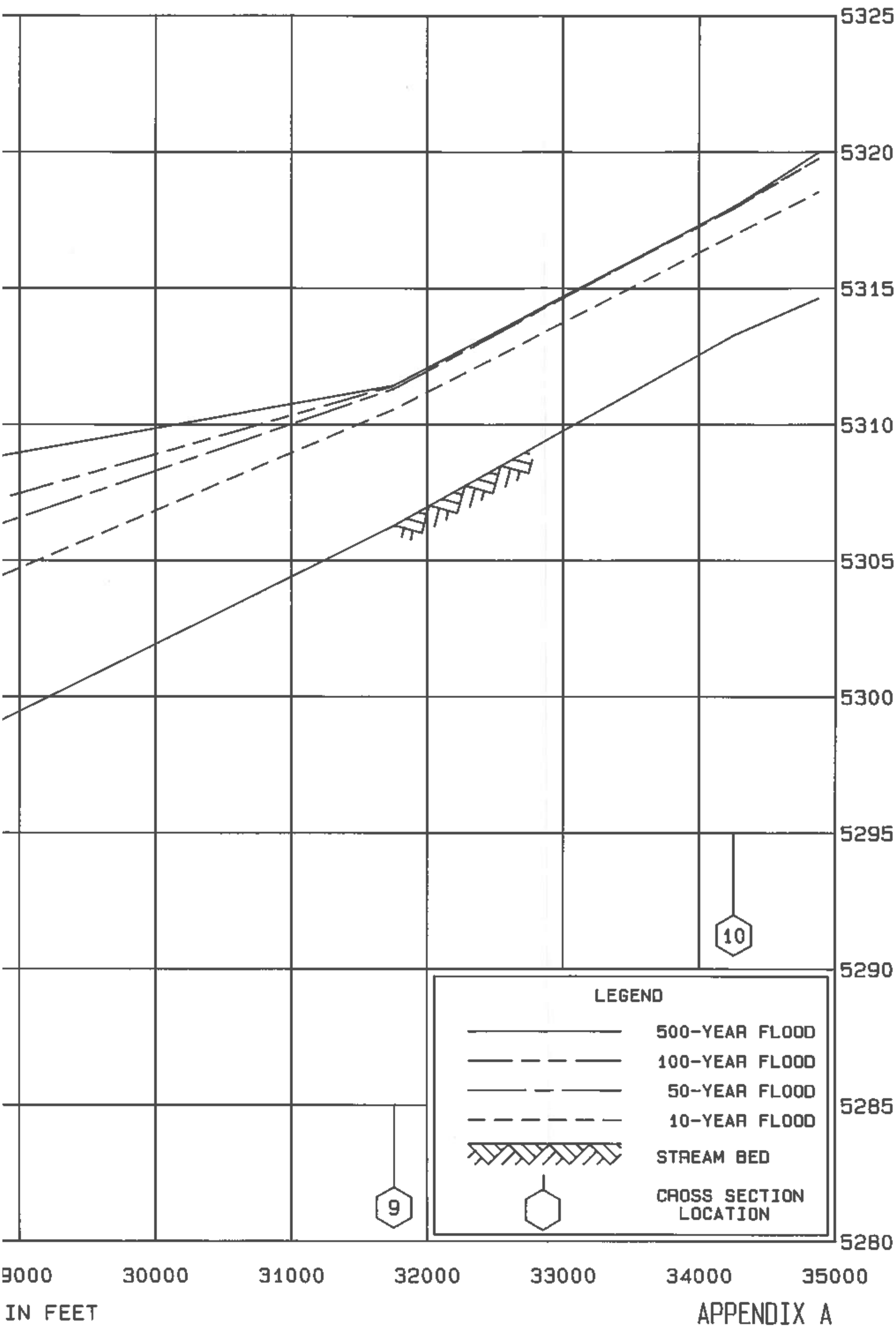
ARCO REACH

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA

FEASIBILITY STUDY

BIG LOST RIVER, ID

CHART 13



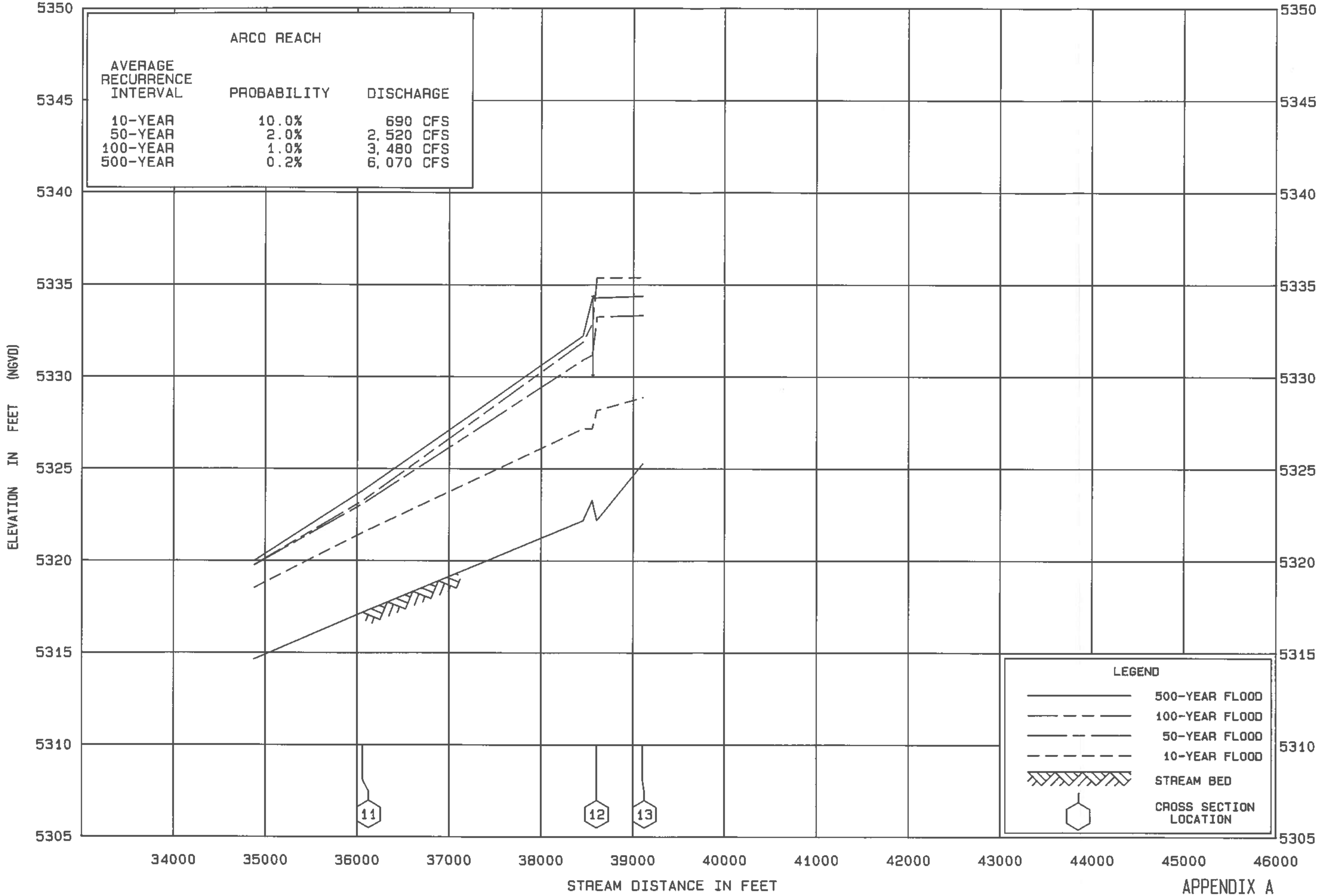
FLOOD PROFILES - NOV 90

ARCO REACH

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA

FEASIBILITY STUDY

BIG LOST RIVER, ID



APPENDIX A

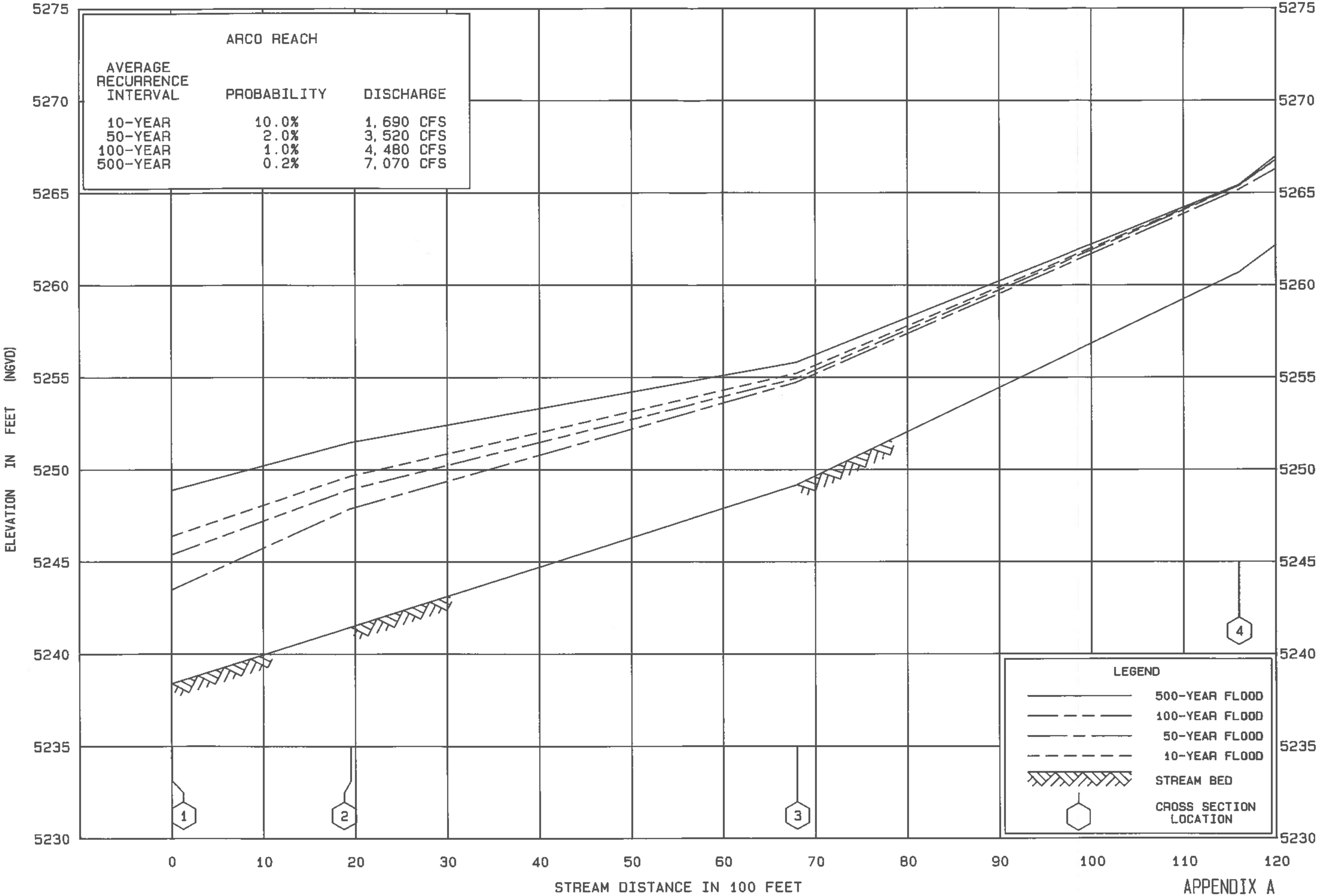
FLOOD PROFILES - NOV 90

ARCO REACH

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA

FEASIBILITY STUDY
BIG LOST RIVER, ID

CHART 15



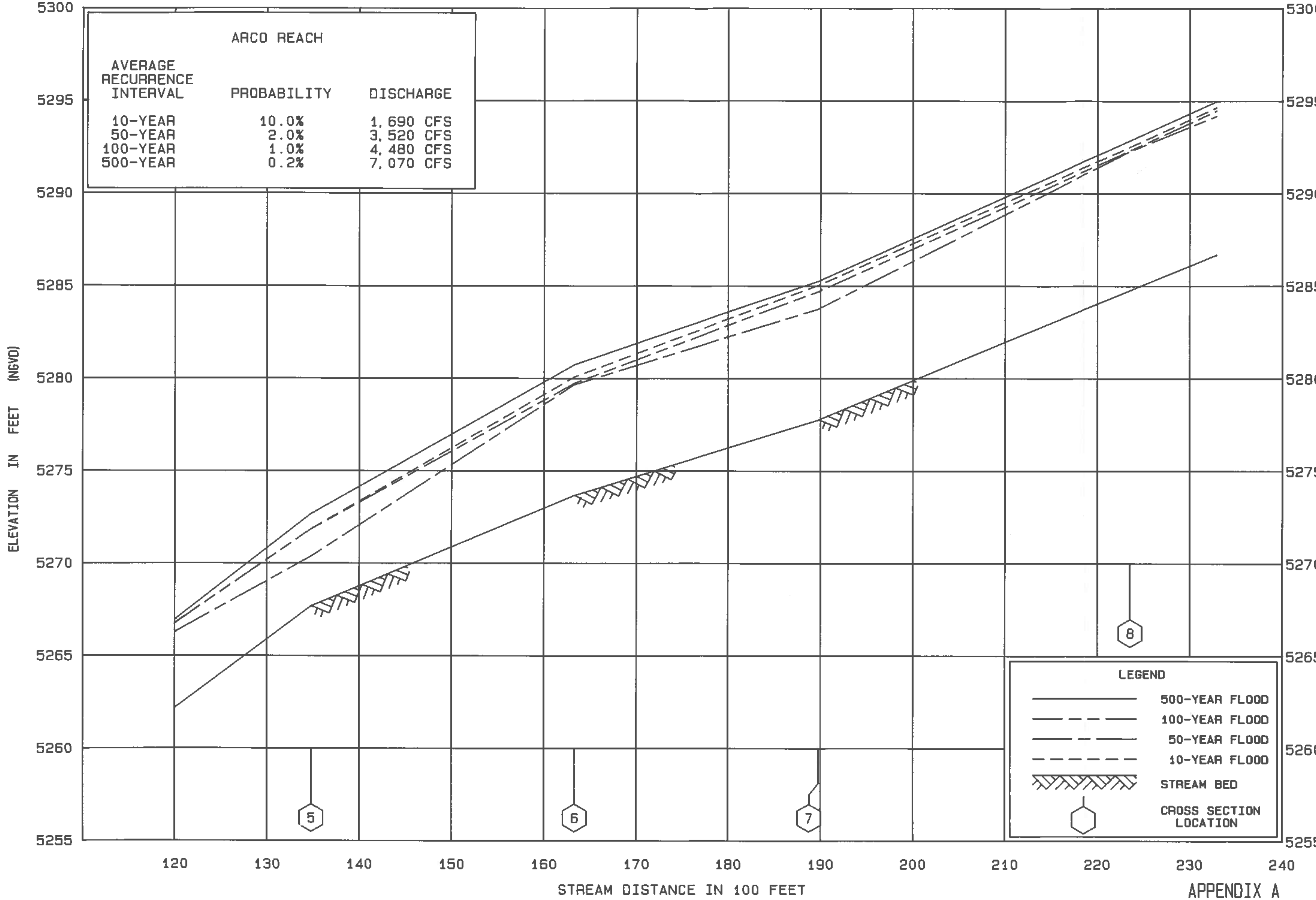
NATURAL FLOOD PROFILES - NOV 90

ARCO REACH

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA

FEASIBILITY STUDY
BIG LOST RIVER, ID

CHART 16



APPENDIX A

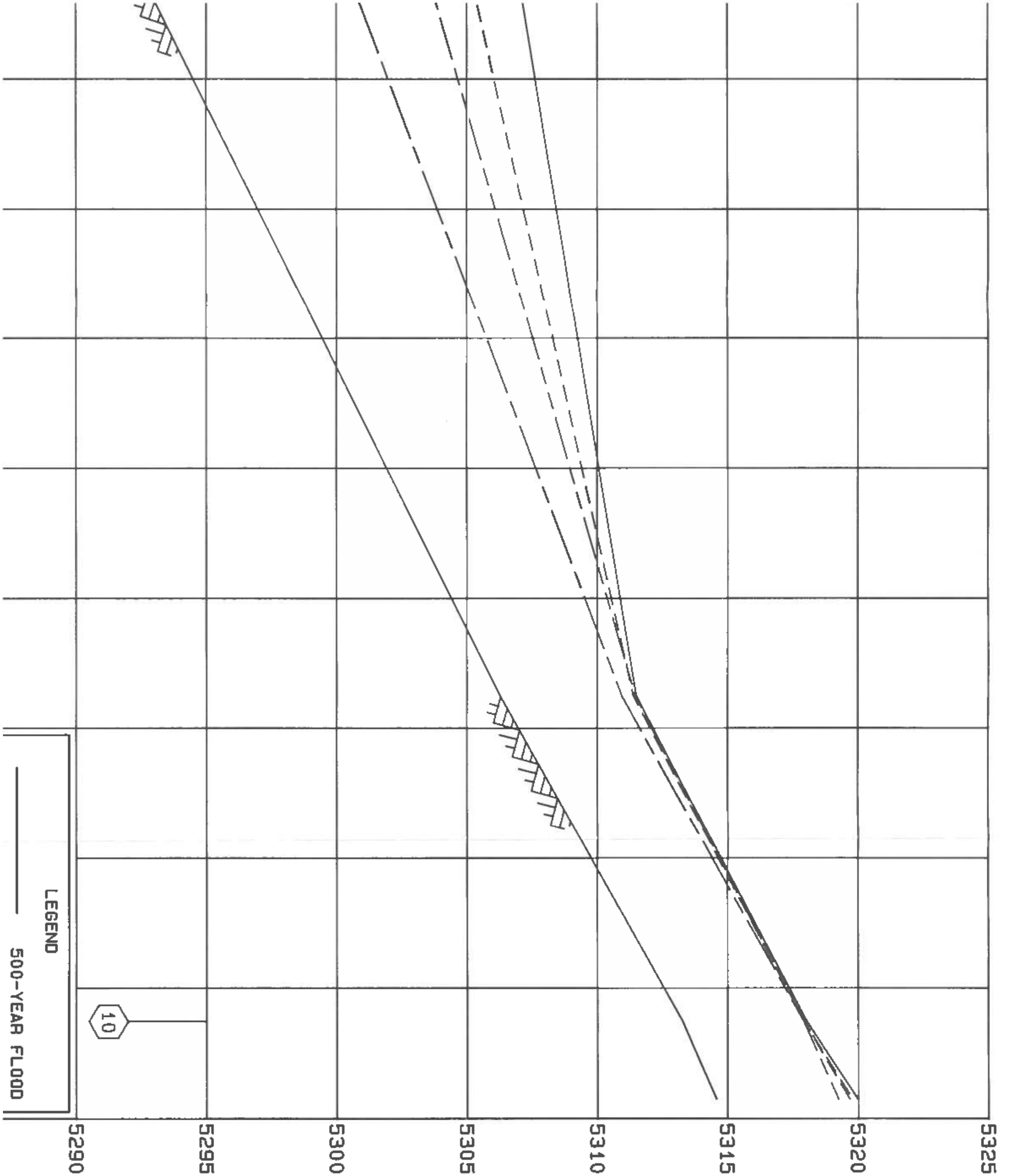
NATURAL FLOOD PROFILES - NOV 90

ARCO REACH

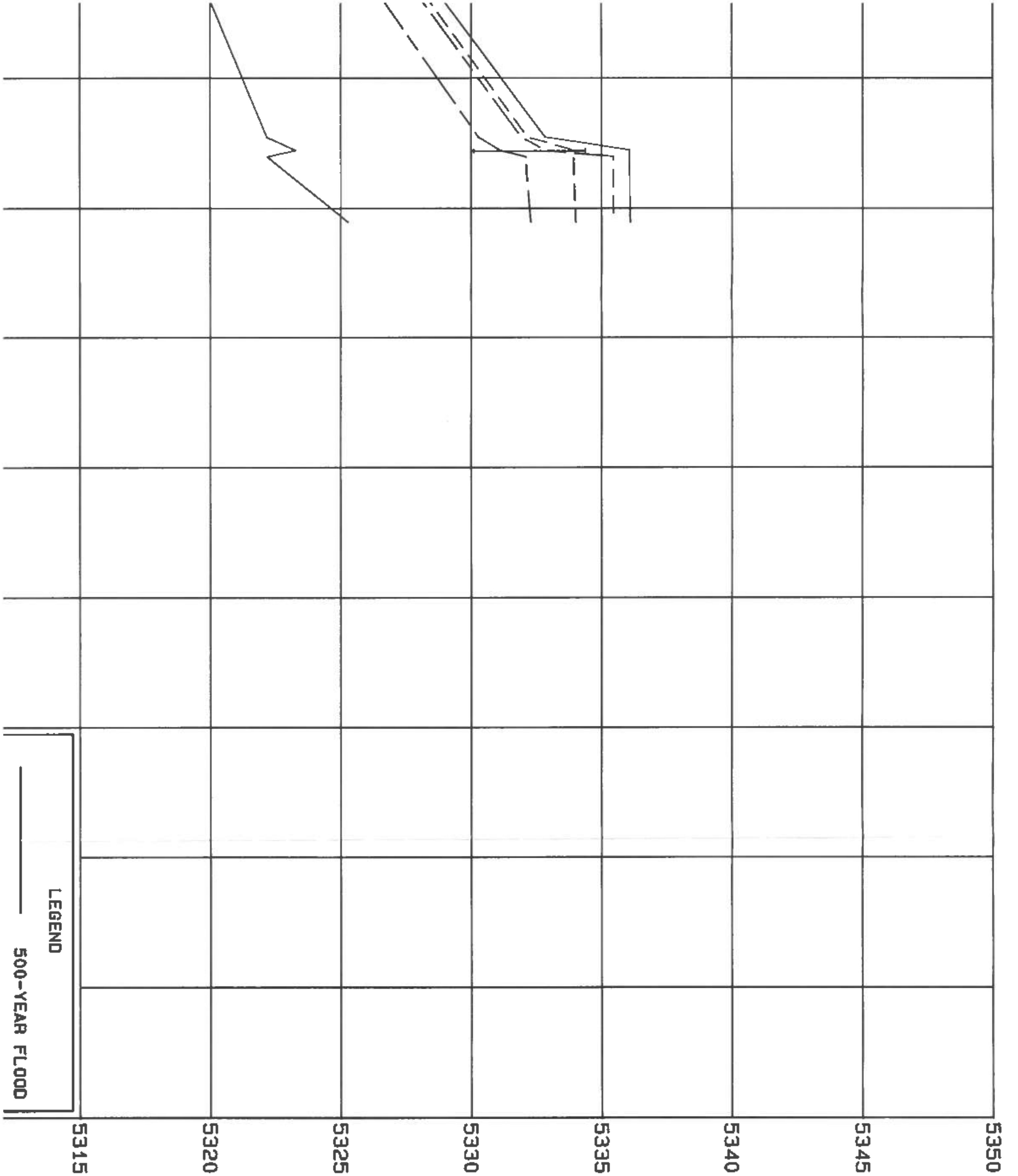
U.S. ARMY ENGINEER DISTRICT
WALLA WALLA

FEASIBILITY STUDY
BIG LOST RIVER, ID

CHART 17



...INEER DISTRICT ... WALLA ...ITY STUDY ...RIVER, ID	NATURAL FLOOD PROFILES - NOV 90 ARCO REACH



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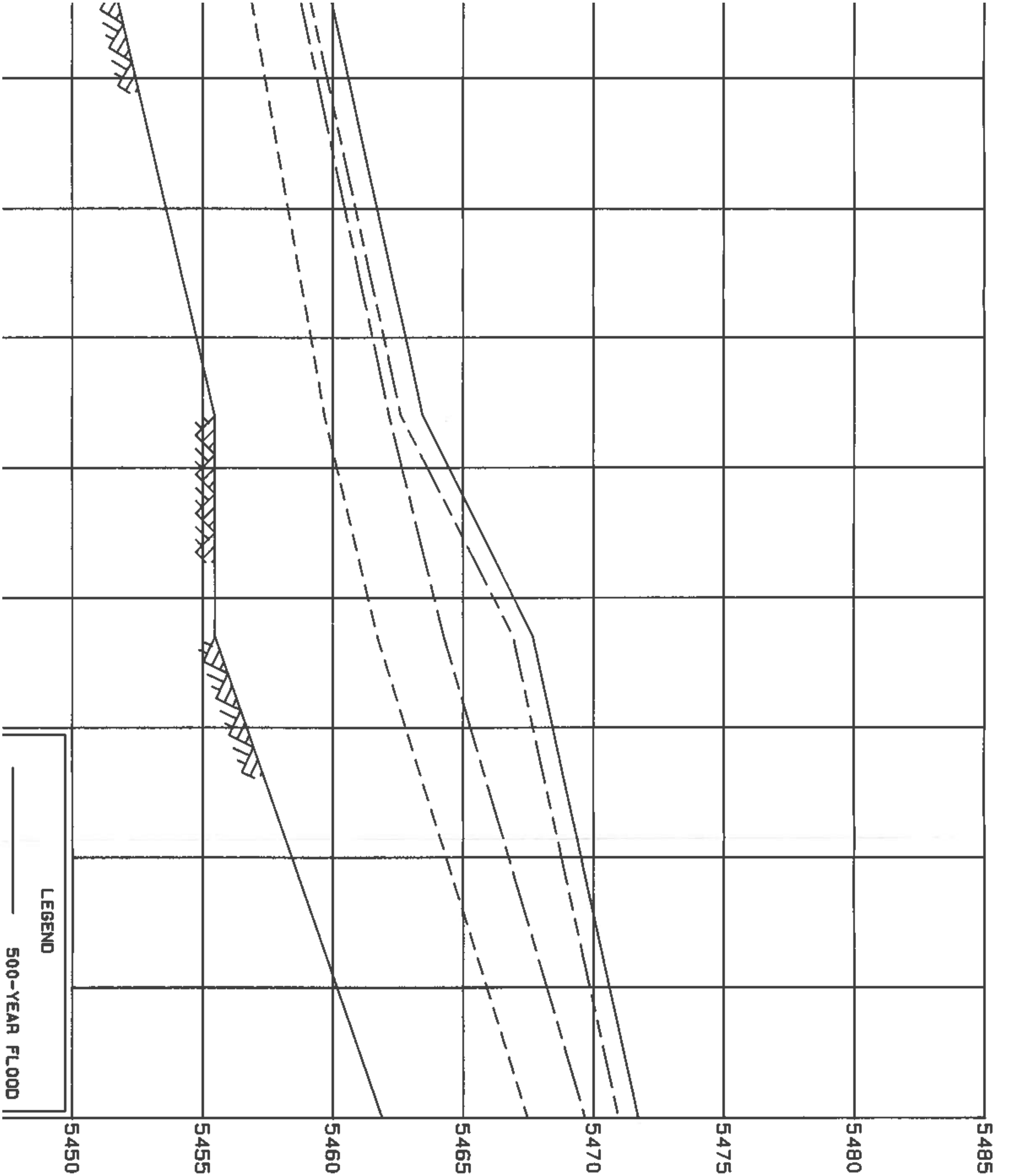
RIVER, ID

NATURAL FLOOD PROFILES - NOV 90

ARCO REACH



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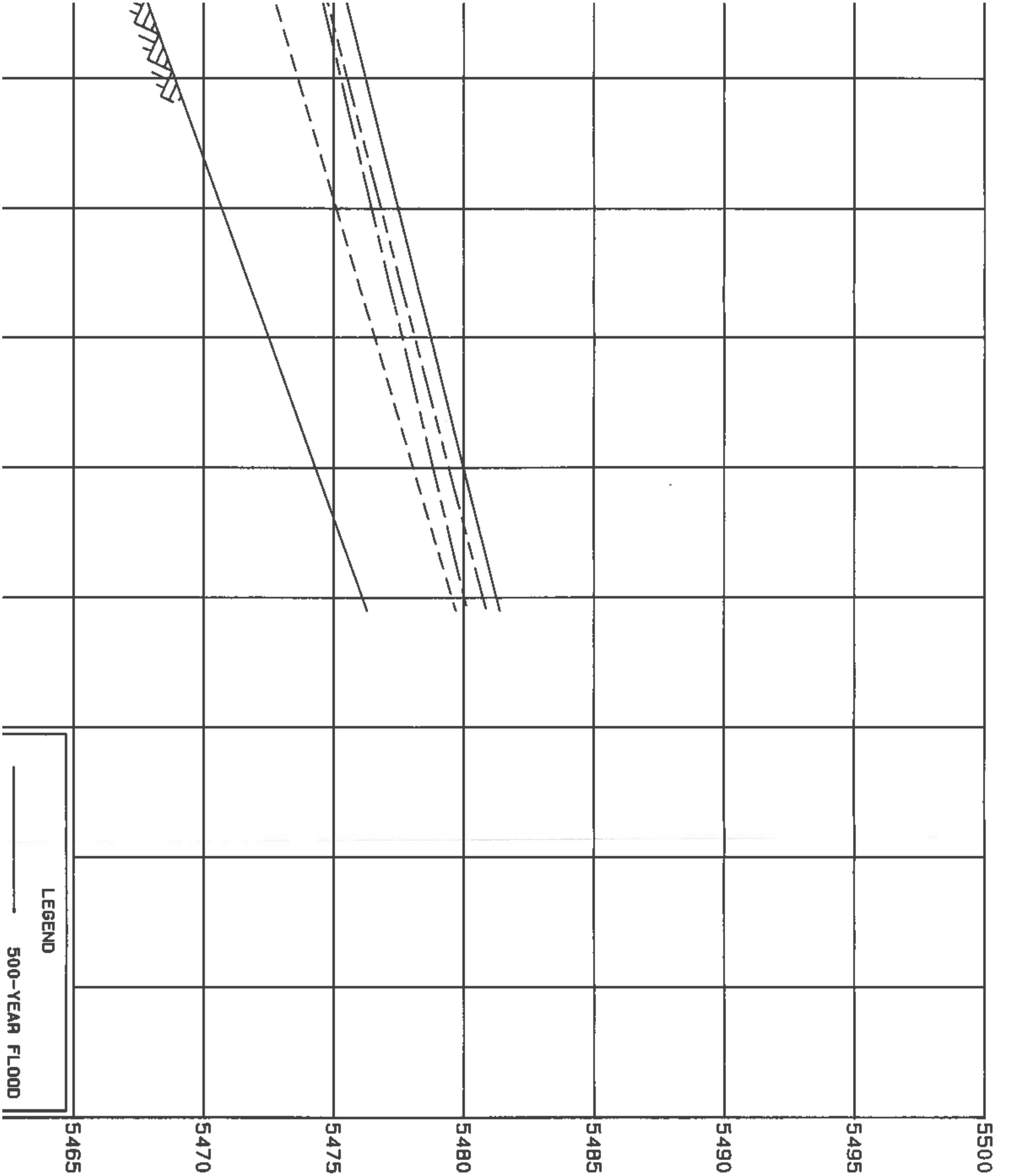
RIVER, ID

FLOOD PROFILES - NOV 90

MOORE REACH



INEER DISTRICT
WALLA
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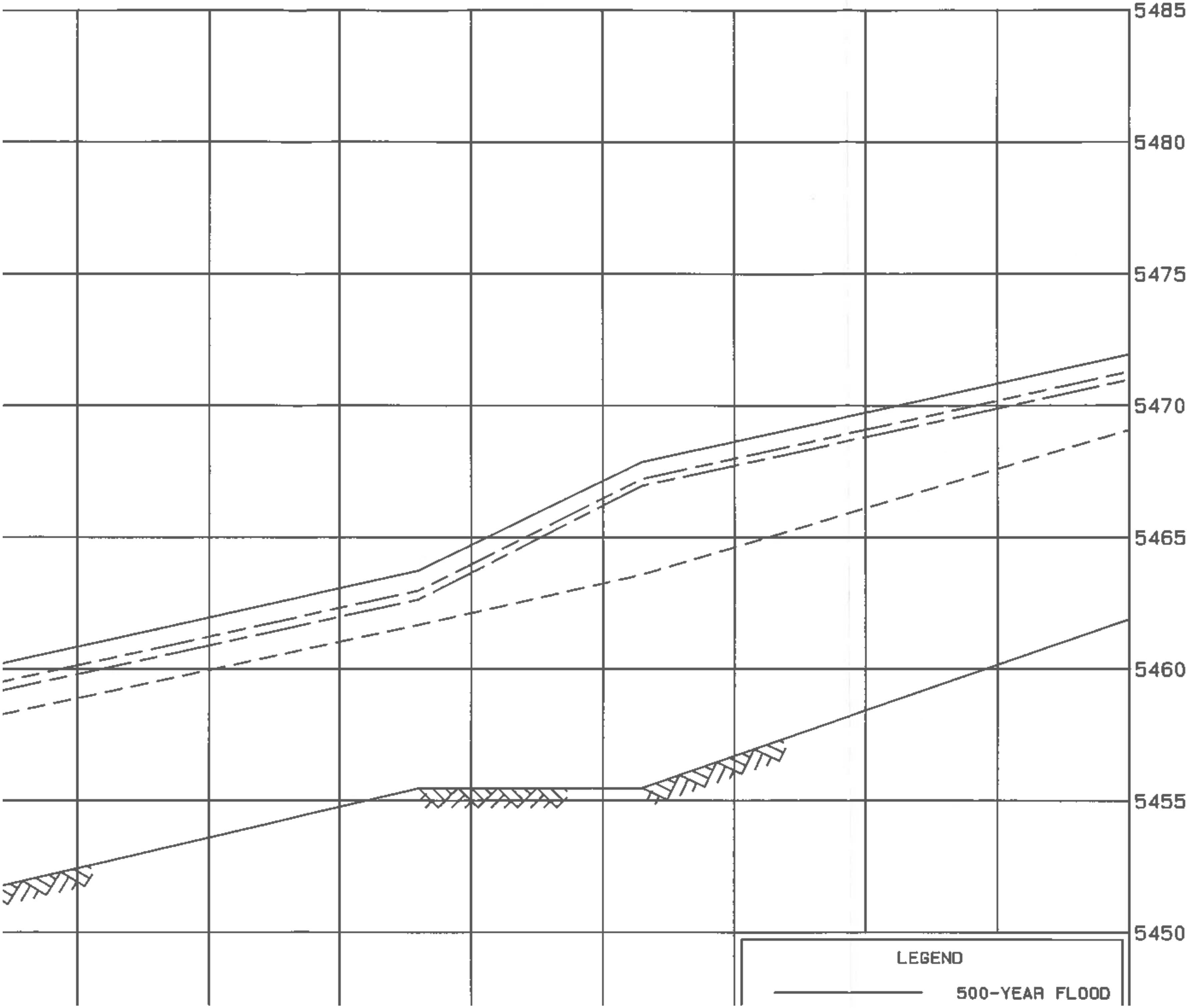
RIVER, ID

FLOOD PROFILES - NOV 90

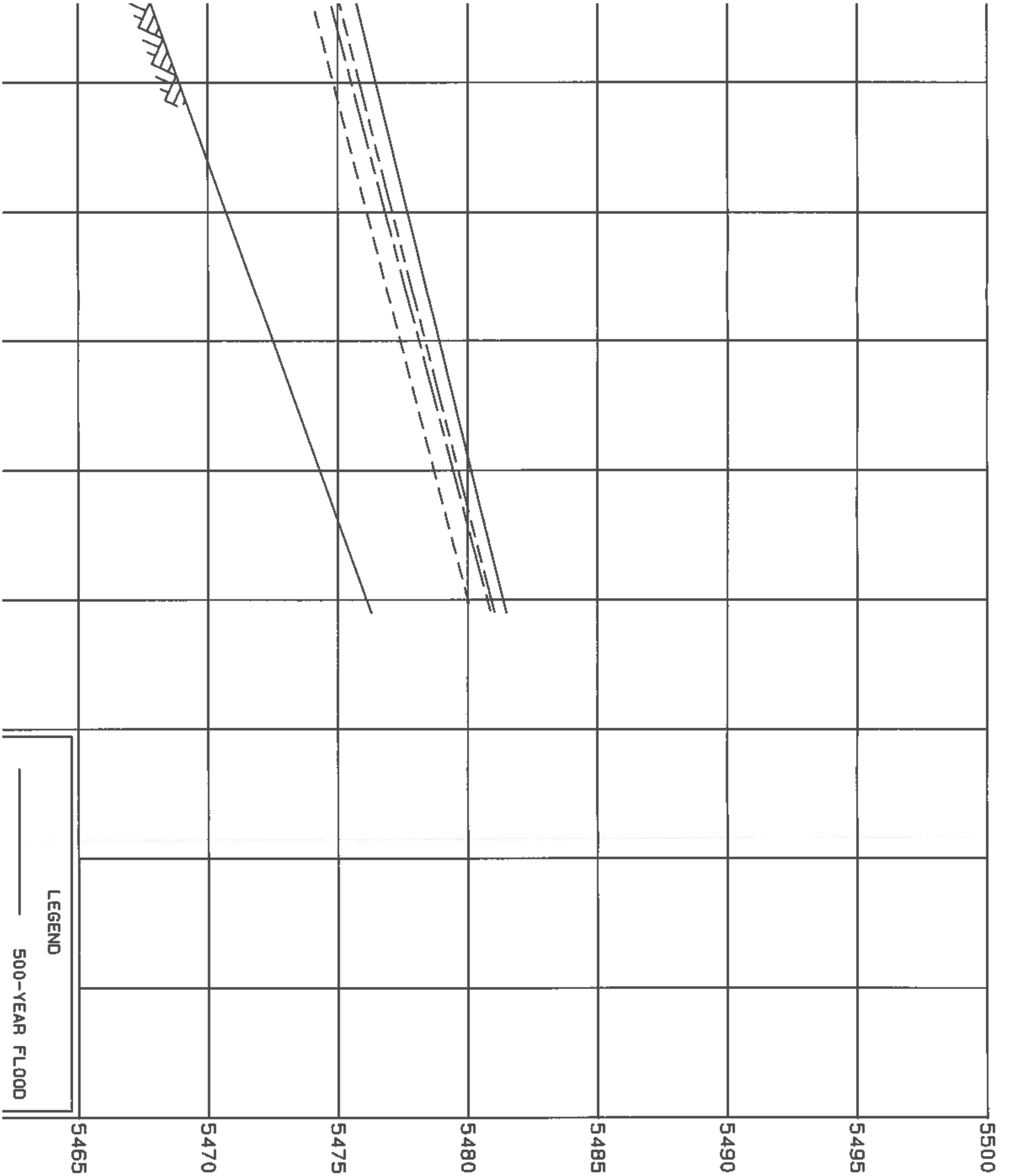
MOORE REACH

MOORE REACH

NATURAL FLOOD PROFILES - NOV 90



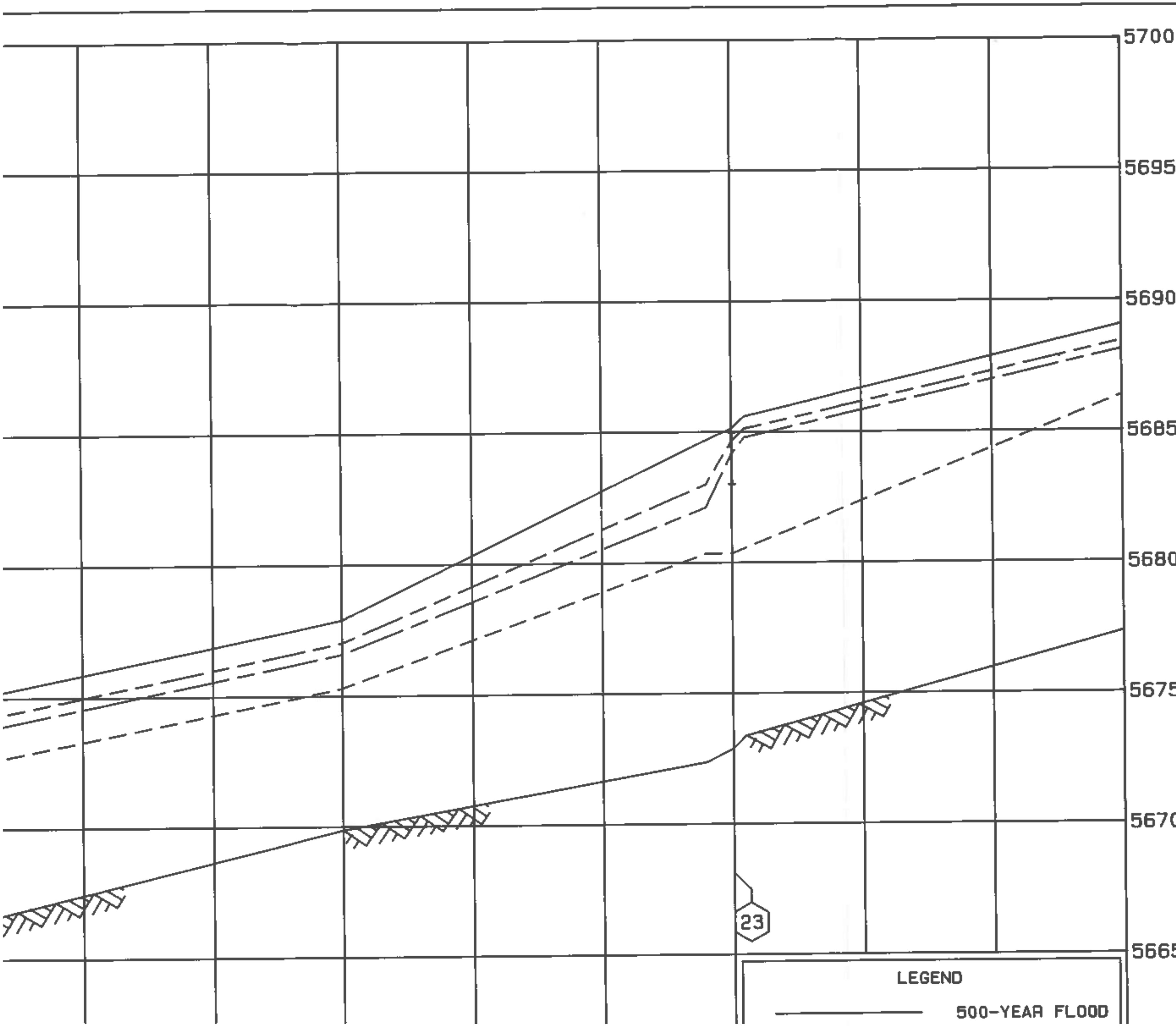
INEER DISTRICT
WALLA
ITY STUDY
RIVER, ID



GINEER DISTRICT
A WALLA
ITY STUDY
RIVER, ID

NATURAL FLOOD PROFILES - NOV 90

MOORE REACH



FLOOD PROFILES - NOV 90

LESLIE REACH

...ITY STUDY

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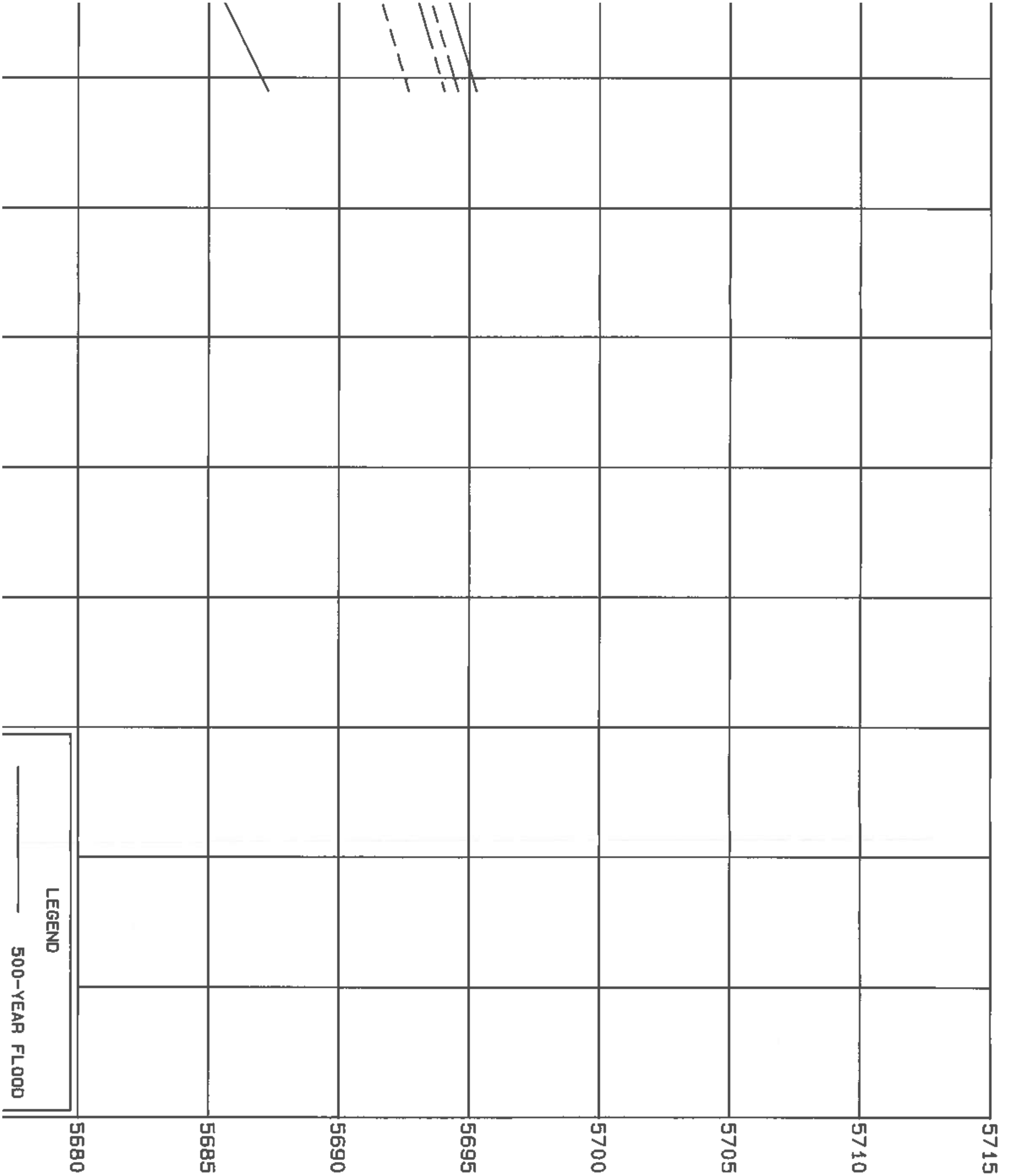

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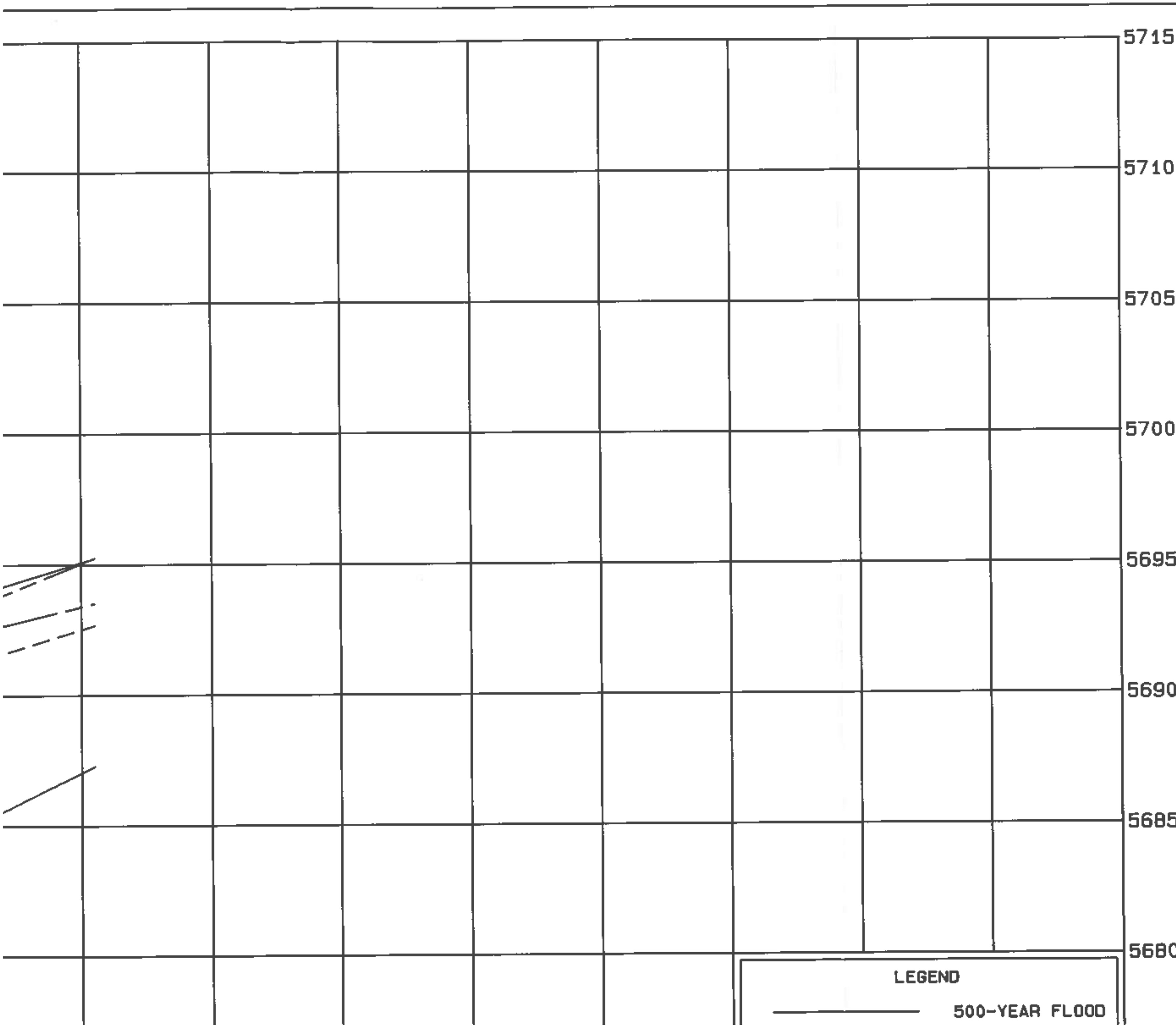

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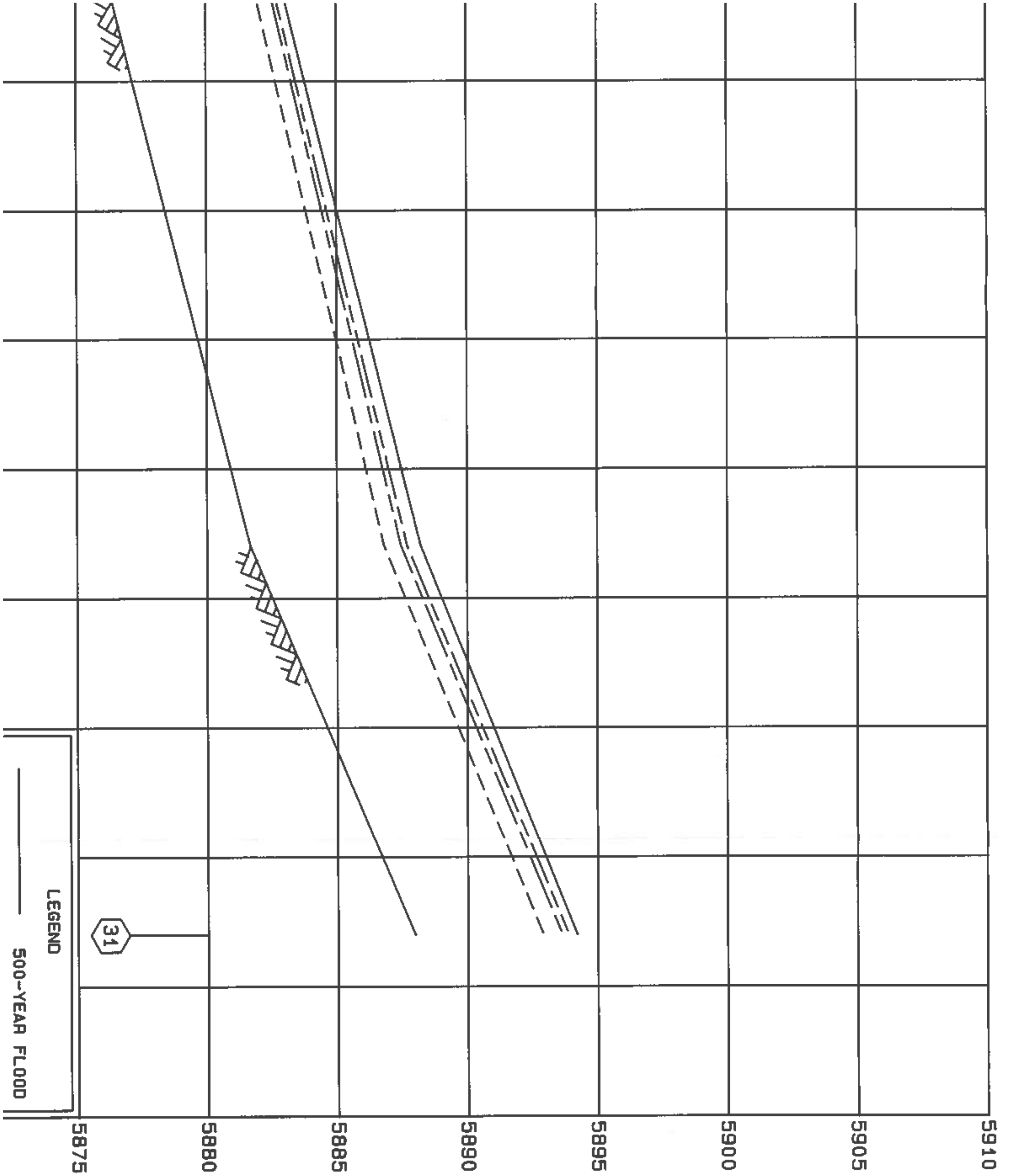

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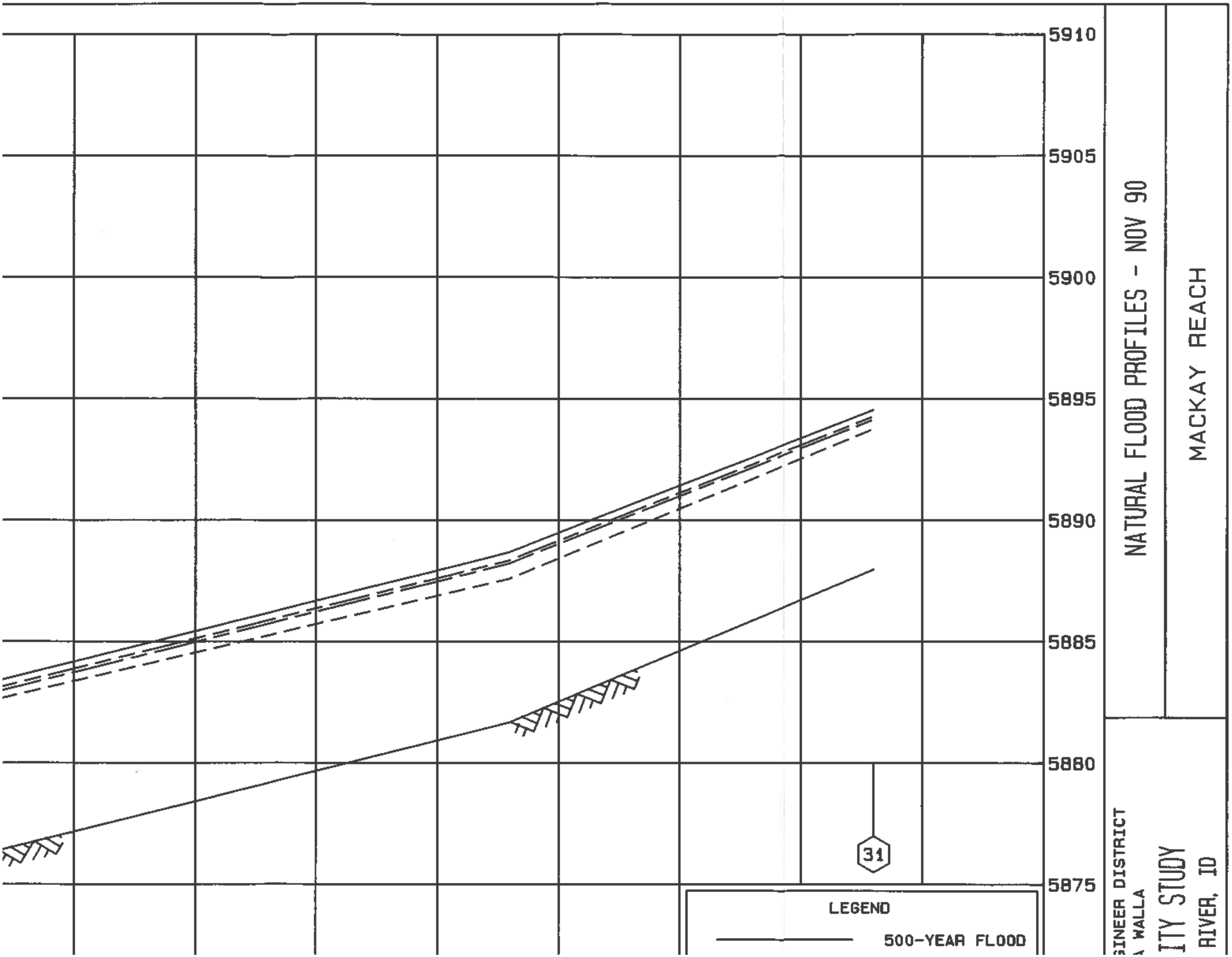
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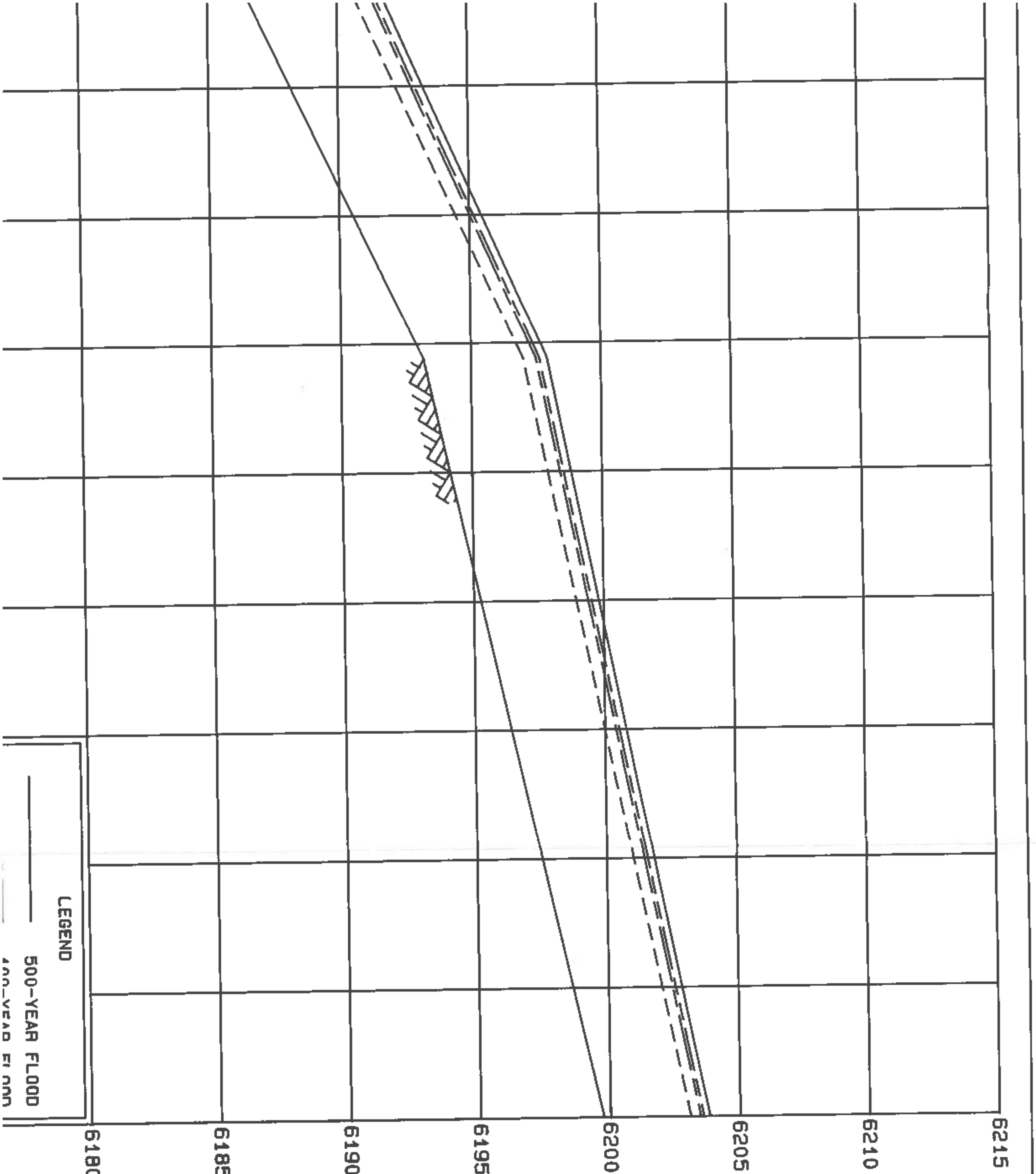

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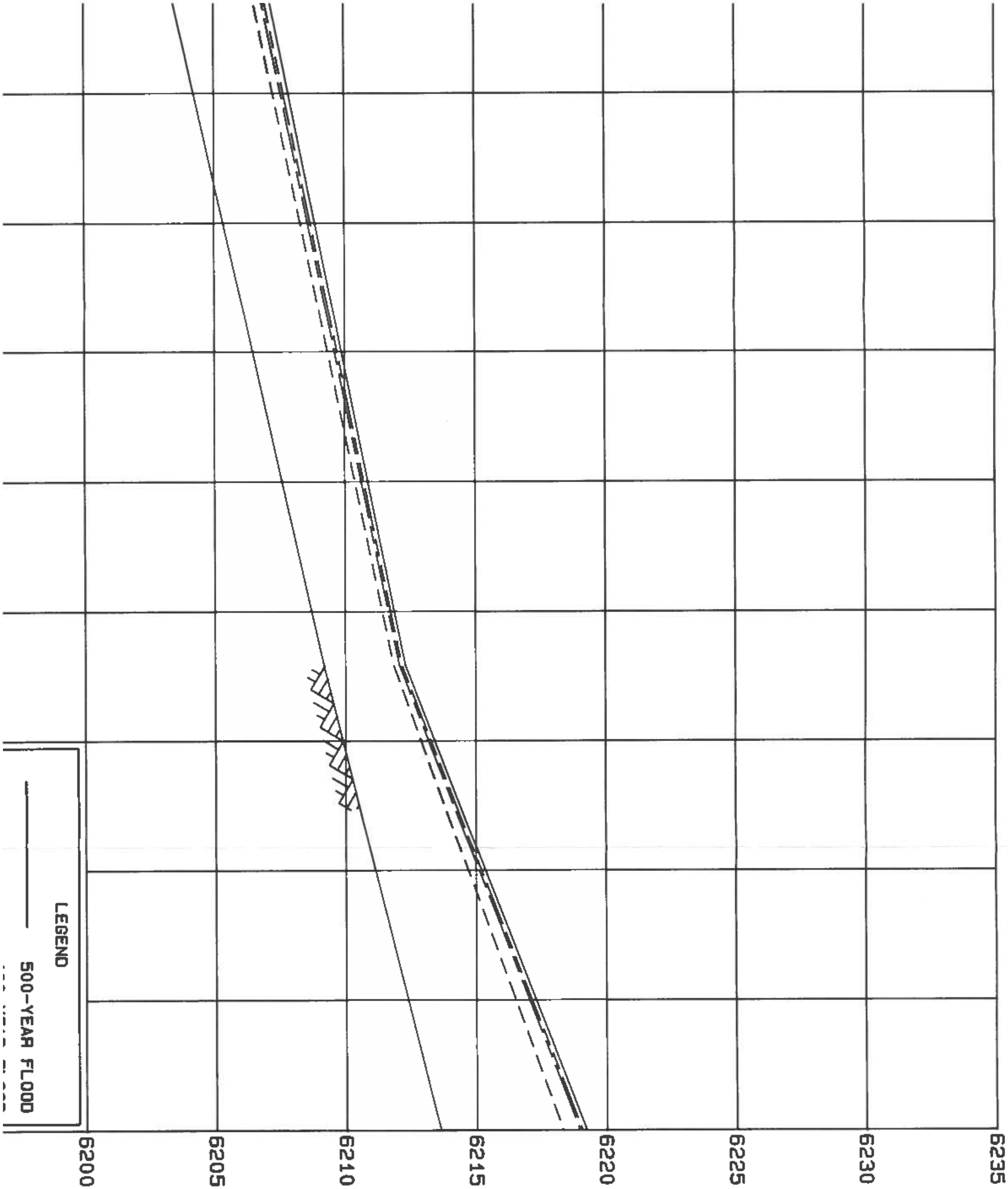

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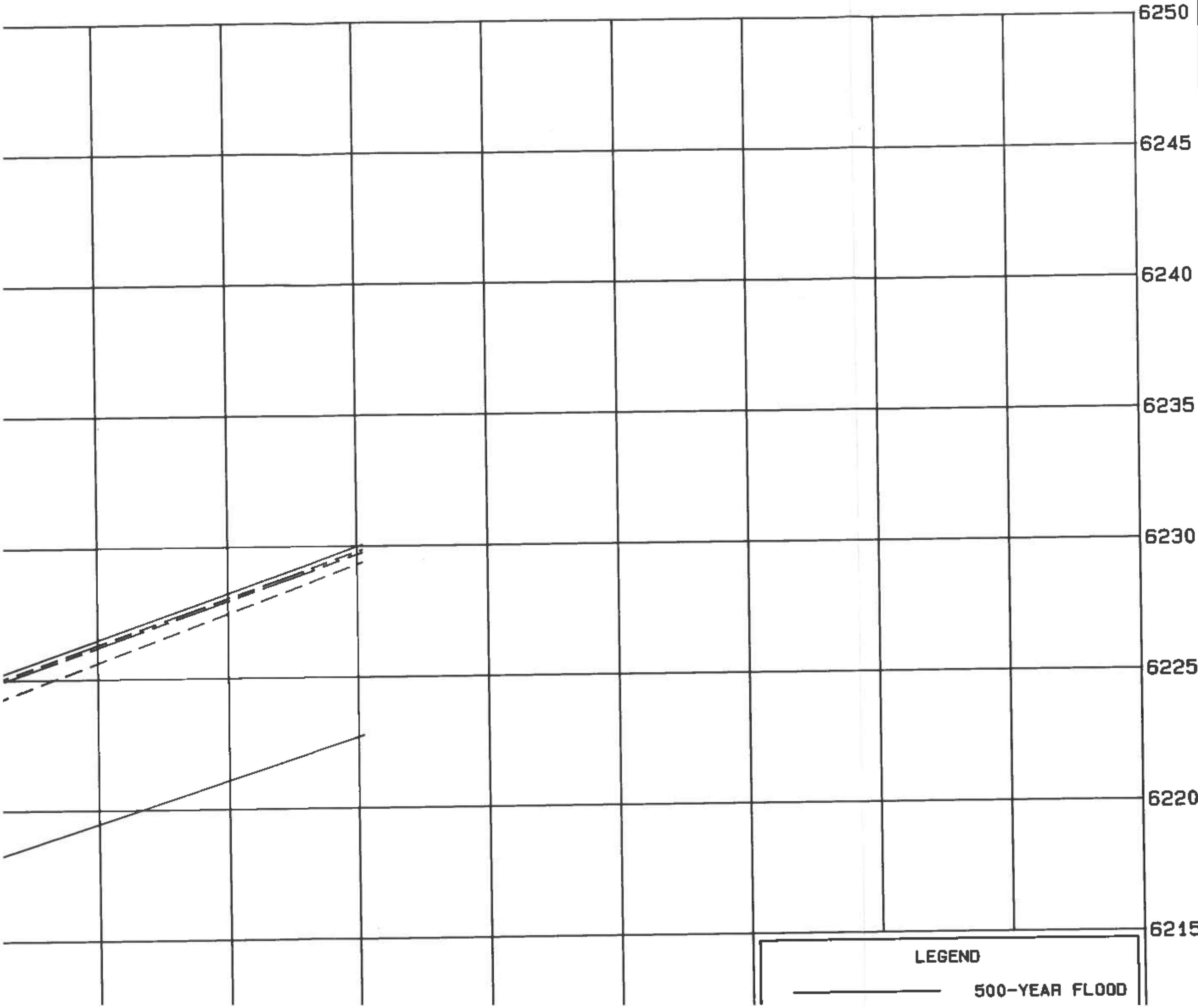

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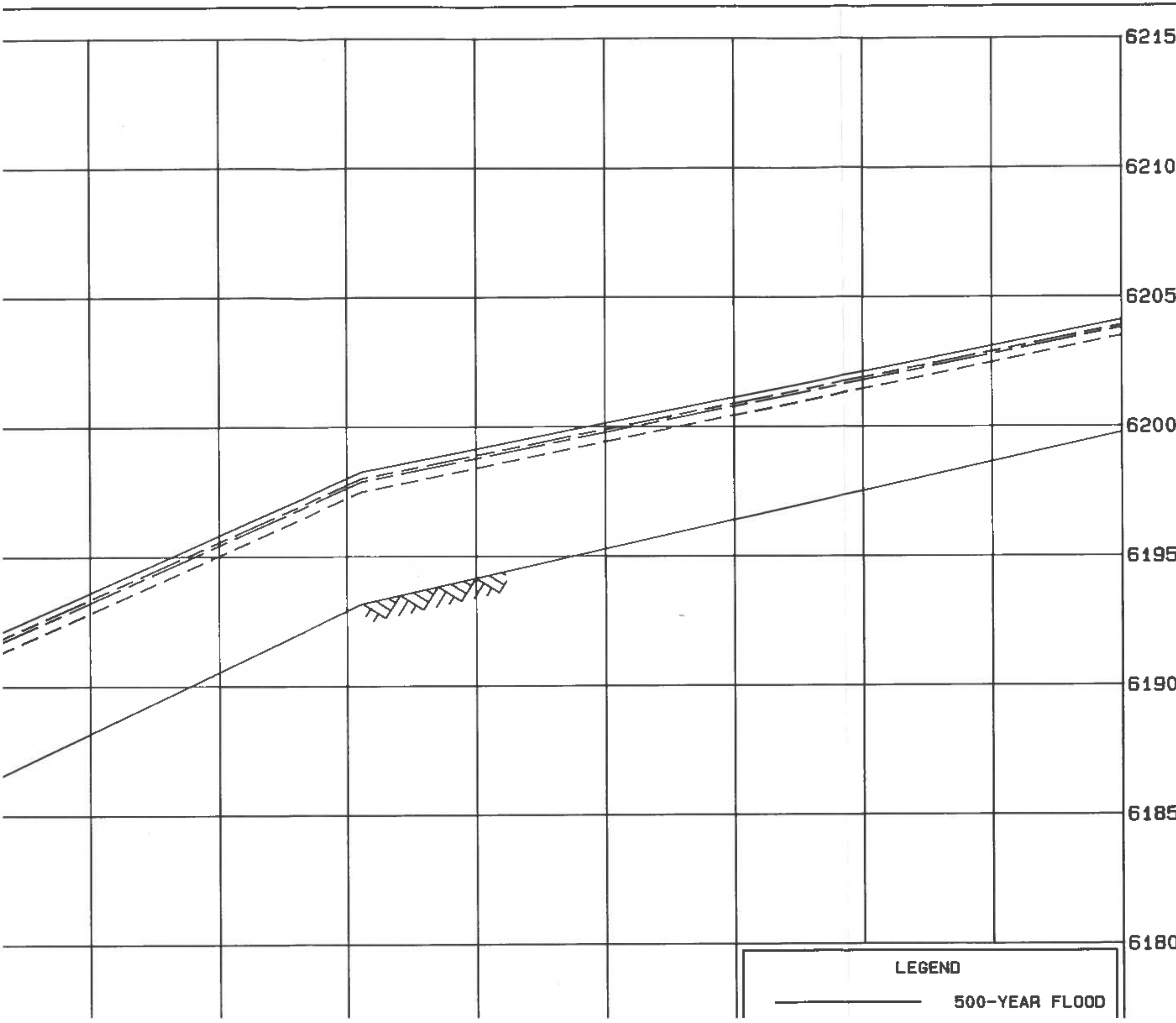

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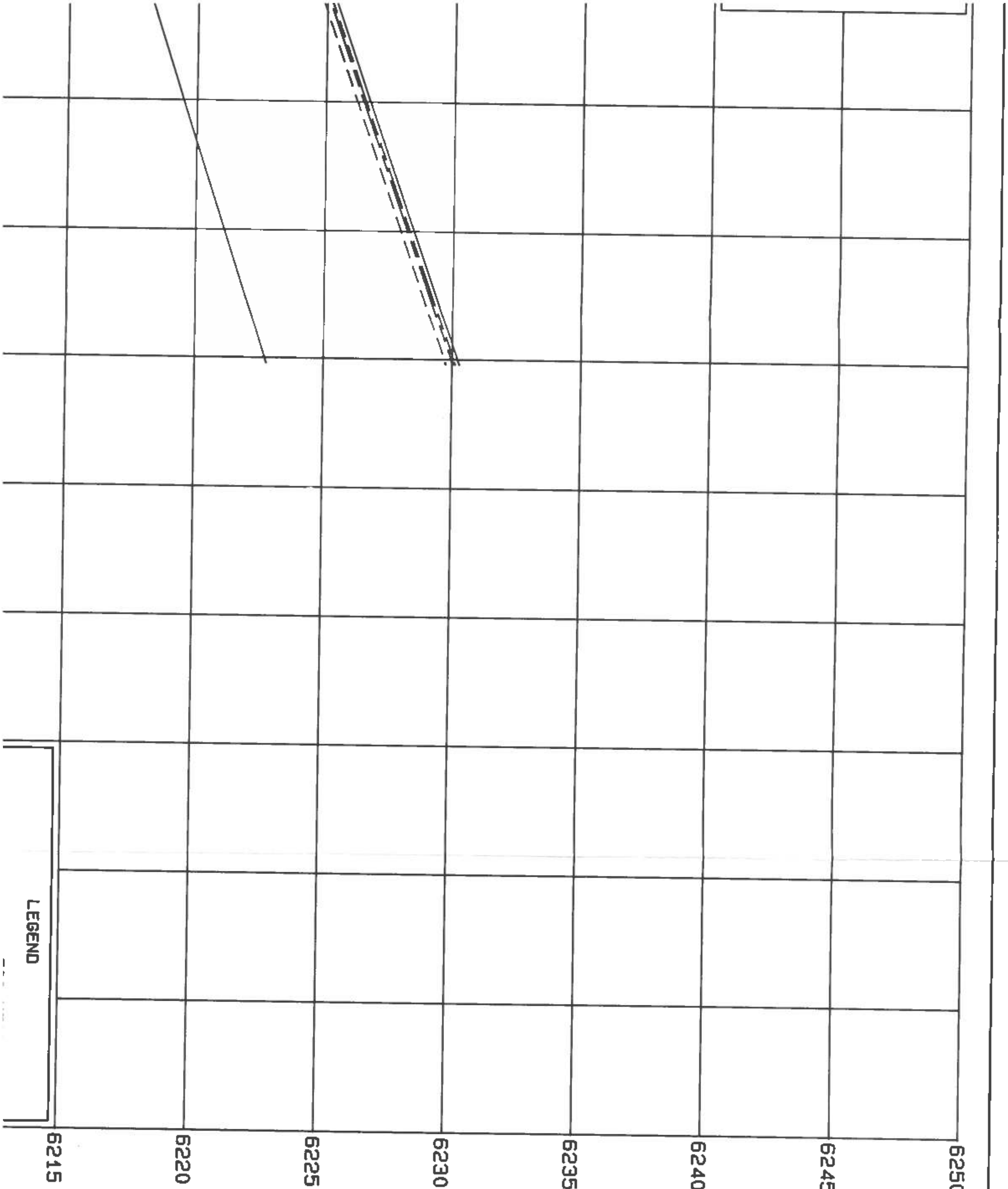

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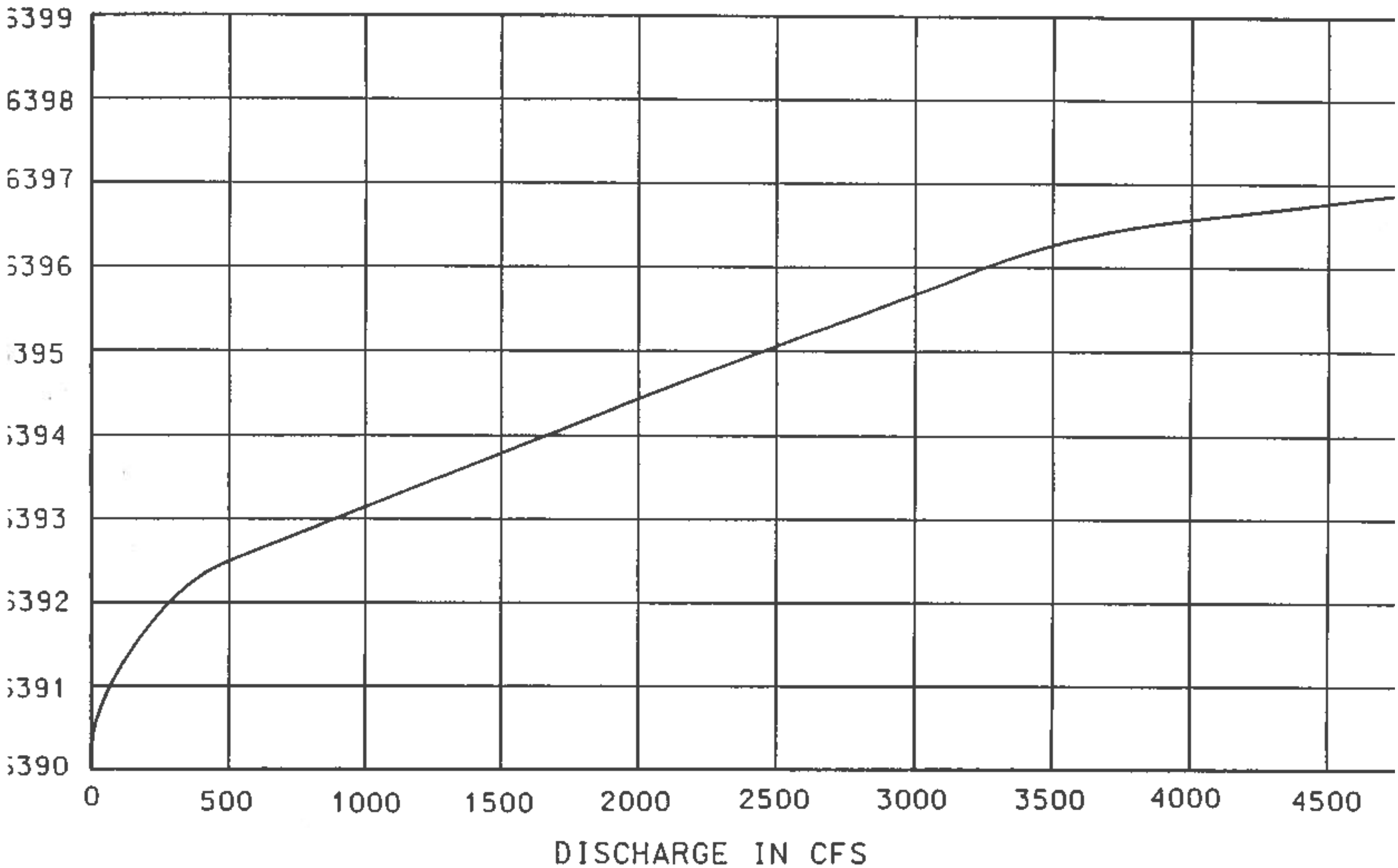

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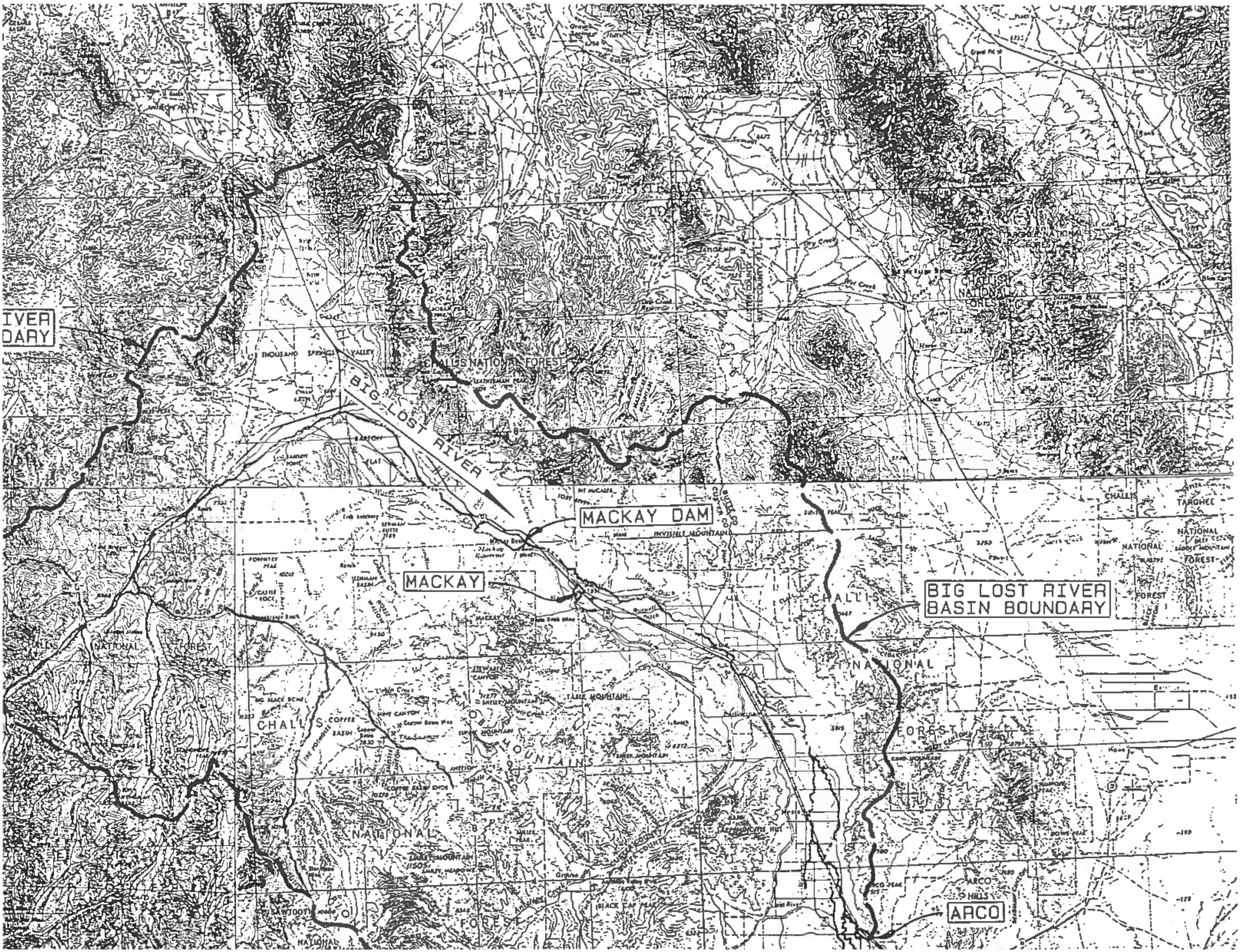

BIG LOST RIVER
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BASIN BOUNDARY
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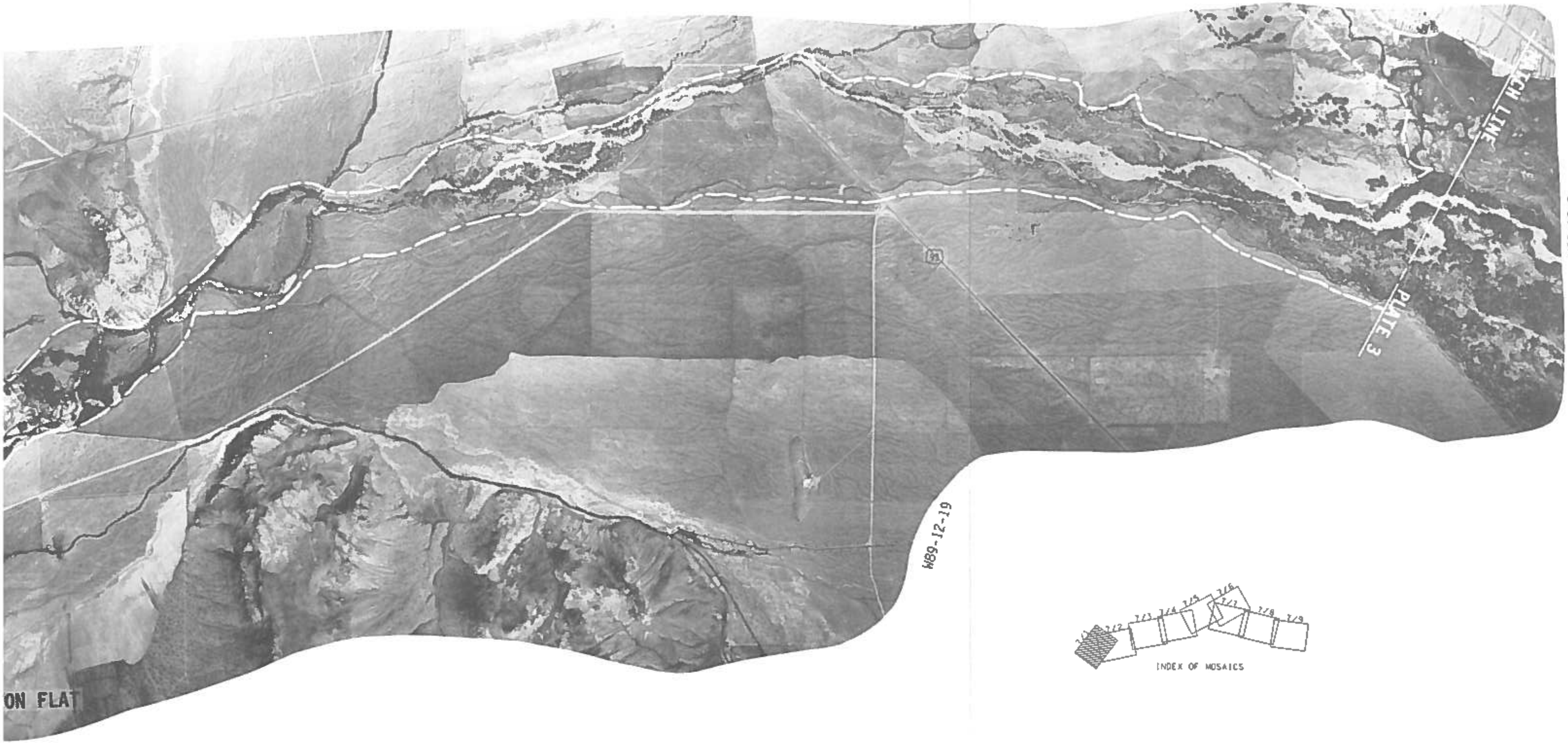
CHALLIS NATIONAL FOREST
WHITE KNOB MOUNTAINS



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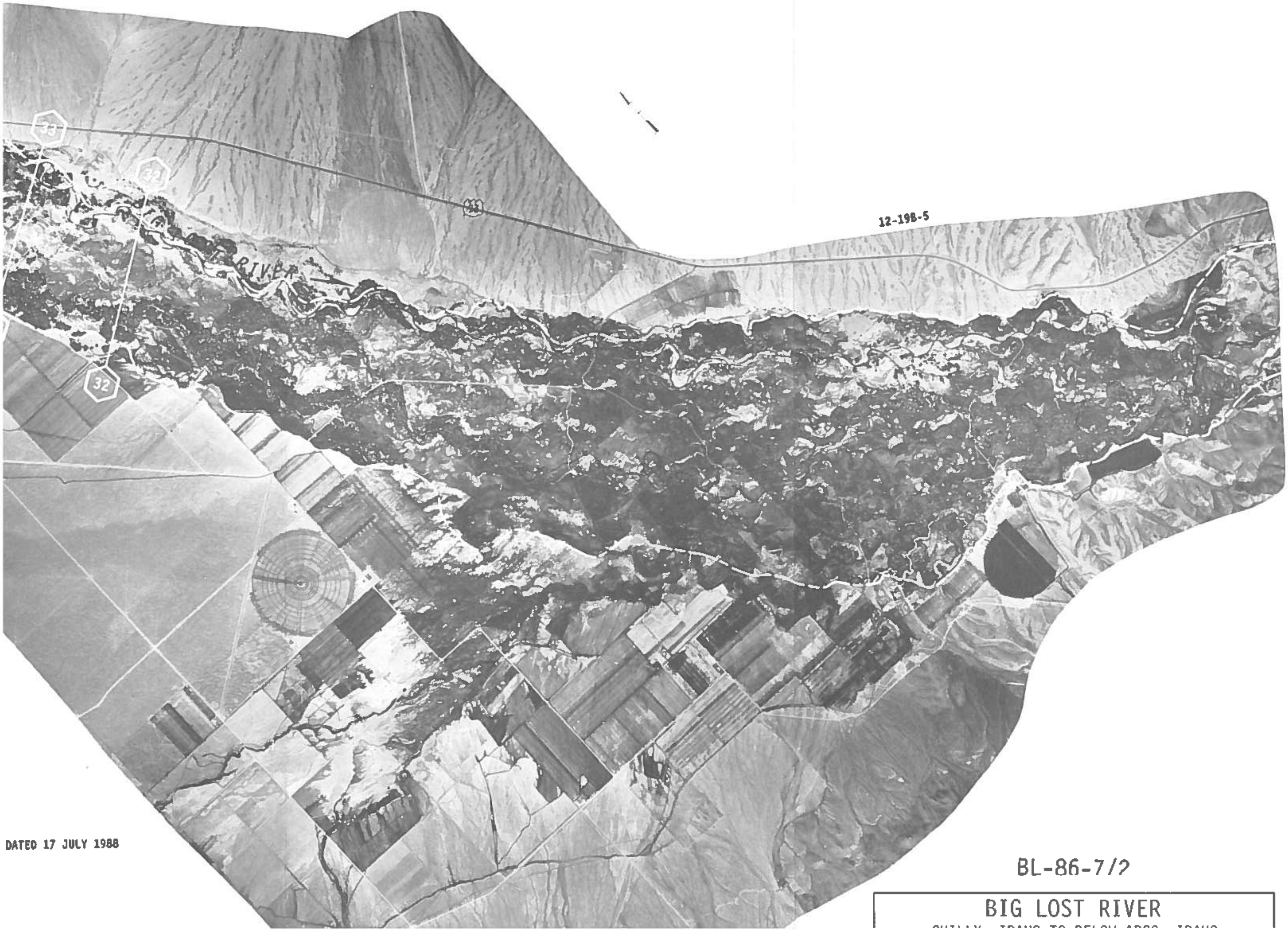

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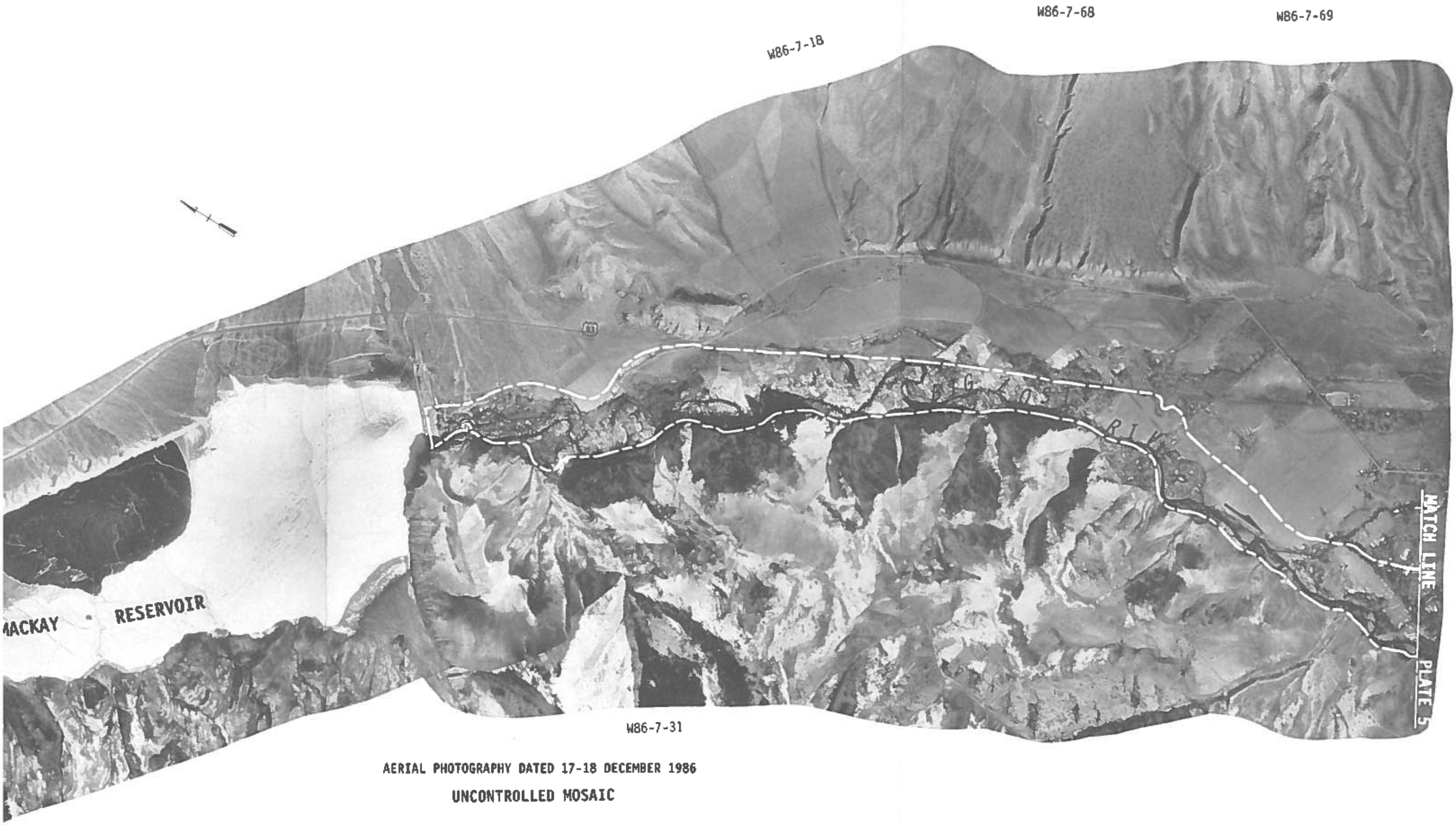

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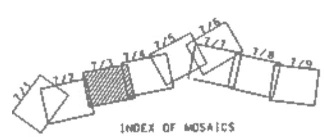

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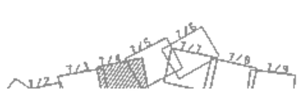

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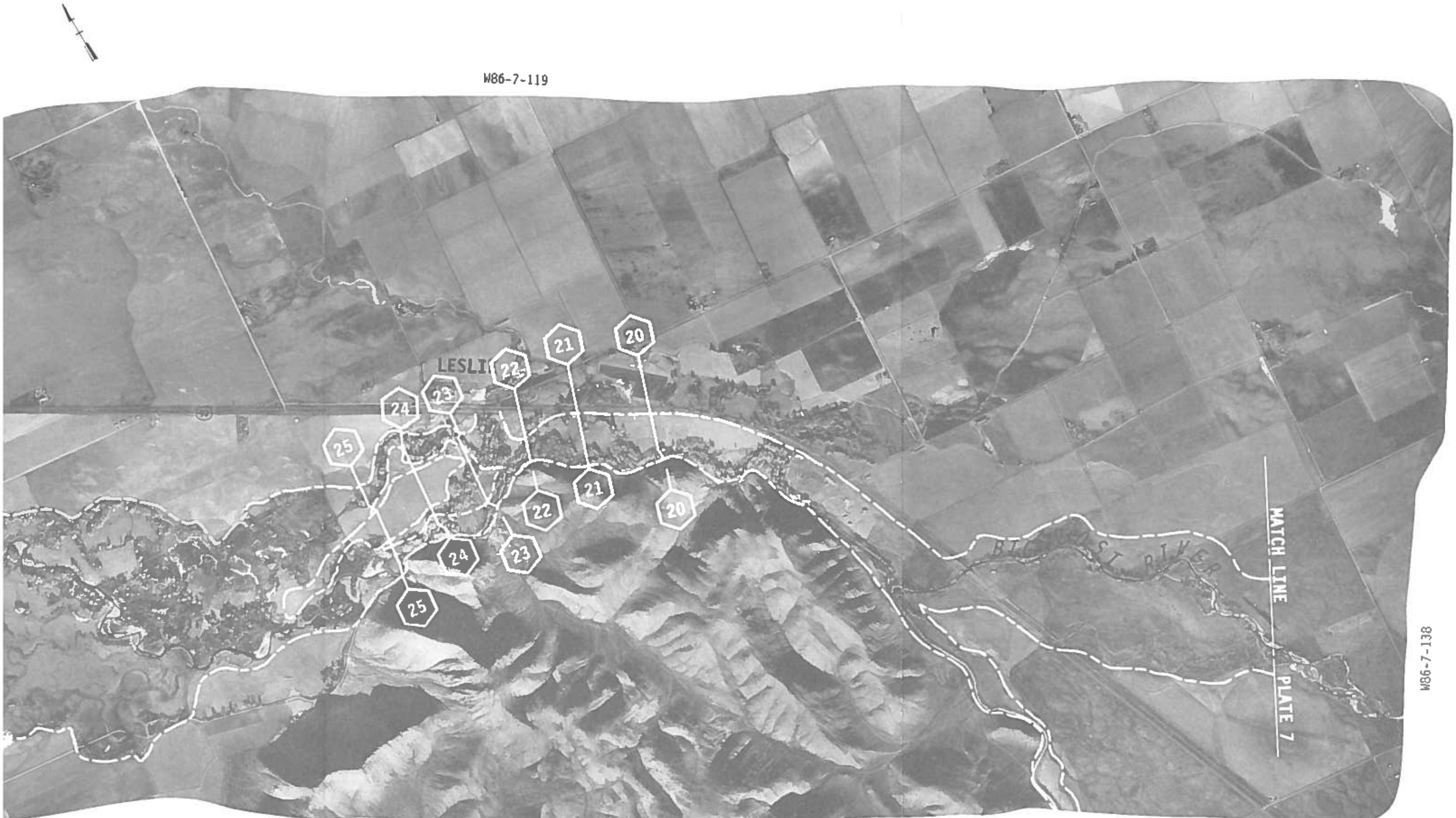

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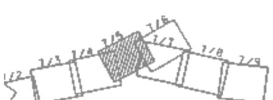

BIG LOST RIVER
CHILLY, IDAHO TO BELOW ARCO, IDAHO

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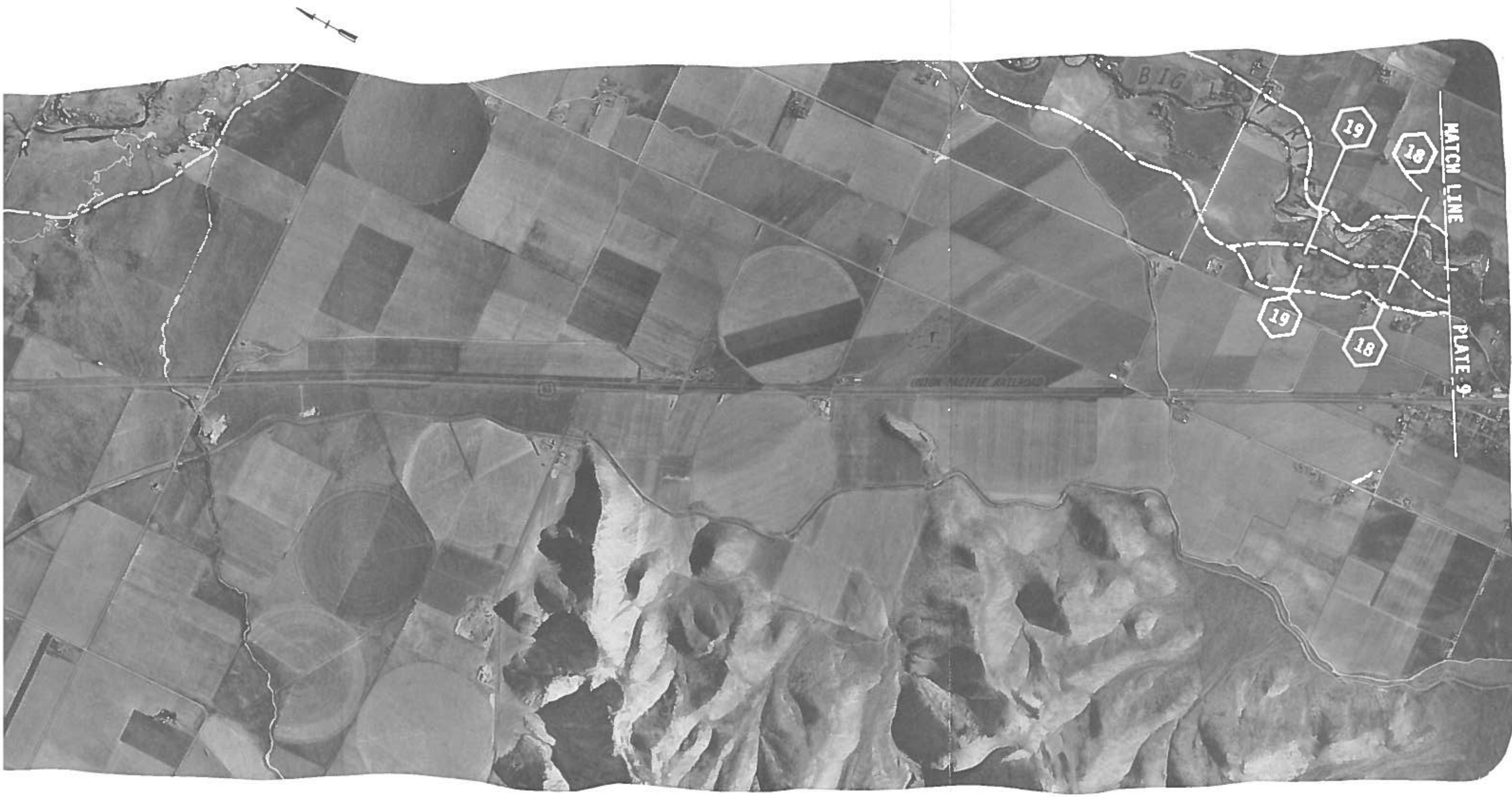

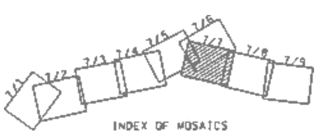

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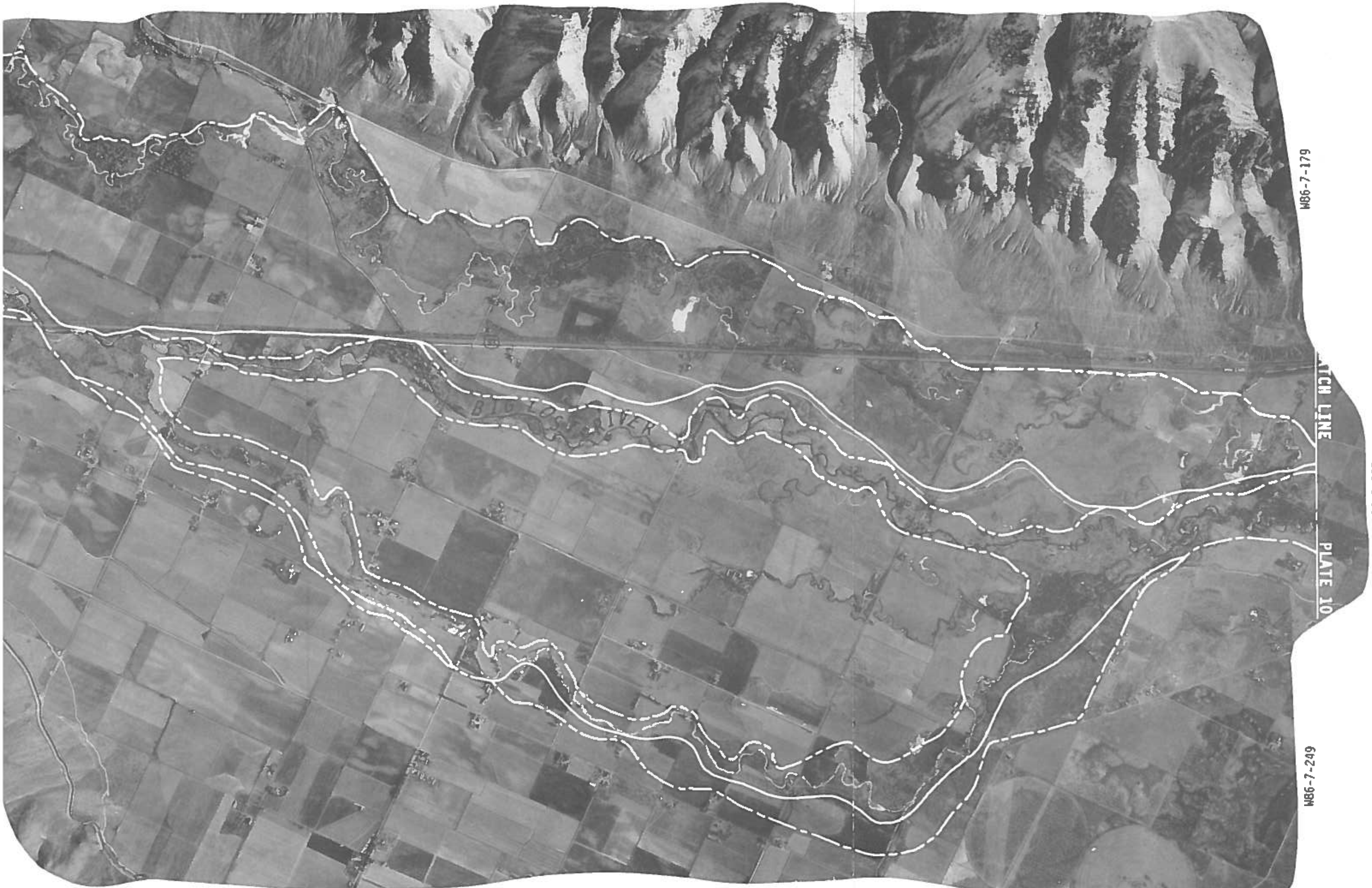

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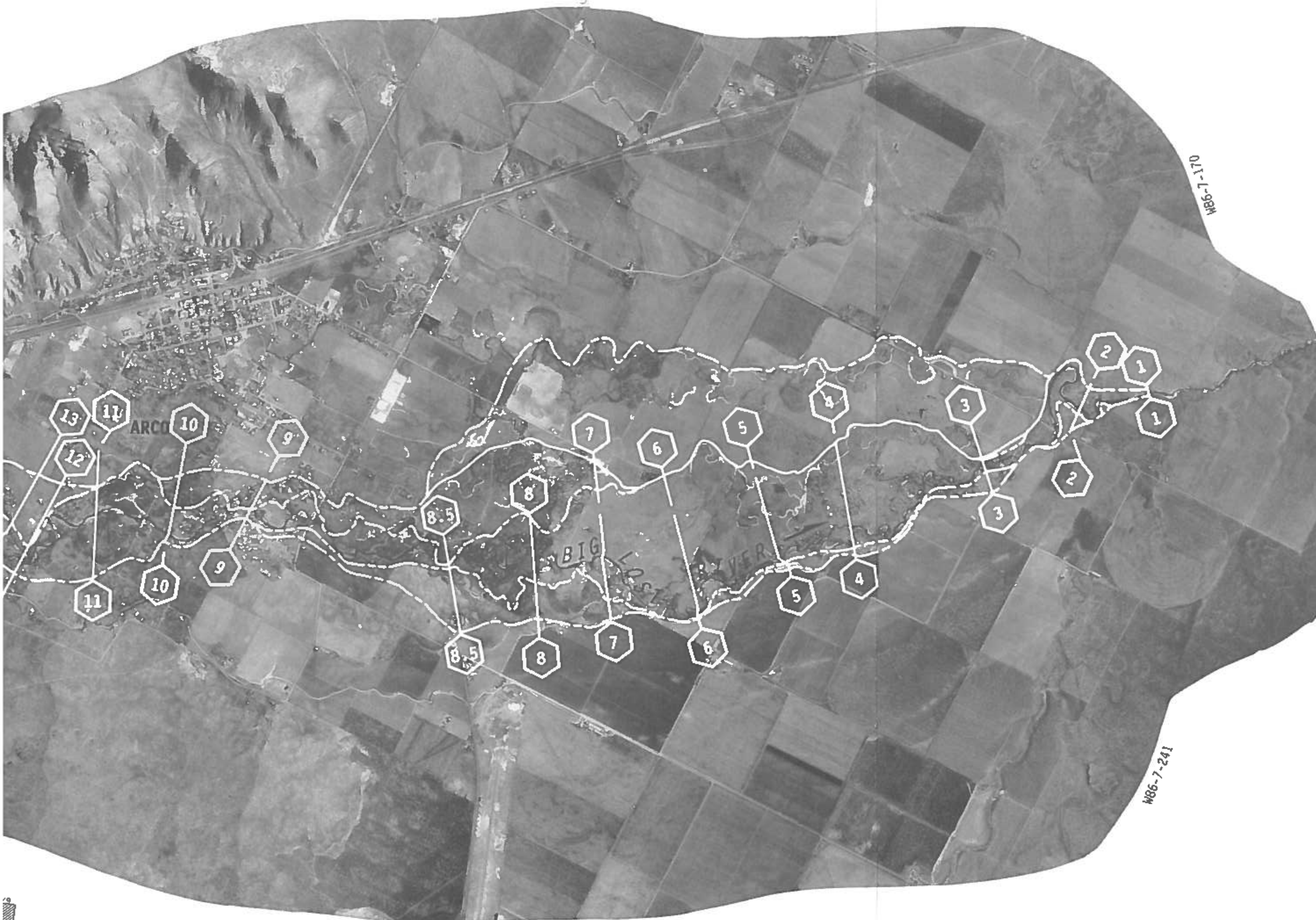

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BIG LOST RIVER

APPENDIX F

Sedimentation Analysis for the Proposed Flood Control Diversion Near Chilly

SEDIMENTATION ANALYSIS FOR THE PROPOSED FLOOD CONTROL DIVERSION NEAR CHILLY

The objective of this analysis was to determine the average annual amount and type of sediment that would likely enter the diversion canal, and what effect the sediment would have on the operation of the canal and infiltration basin.

The proposed project consists of a diversion structure on the Big Lost River, a 7,000-foot-long connecting canal, and a 1,250 by 2,500 feet infiltration basin (see plate 1). The canal, which is excavated in natural soils, has a bottom width of 30 feet; side slope of 1 vertical on 4 horizontal, and thalweg slope of 0.0005 feet/feet. The infiltration basin is rectangular with a level bottom and a design ponding depth of 10 feet.

The proposed canal and infiltration basin will be operated during periods of high flow above 1,500 cfs to reduce flooding along the Big Lost River. River flow in excess of 1,500 cfs will be diverted into the canal until the canal reaches the maximum design flow of 1,000 cfs. The canal discharge will be held constant at the maximum level during any further increase in the river discharge.

In August 1984 the U.S. Geological Survey published a report titled "Erosion, Channel Change, and Sediment Transport in the Big Lost River, Idaho," Report number 84-4147. This report covers the river geomorphology in some detail and provides the primary source of sediment transport data used in this analysis.

Table 1 presents flow duration data for flows above 1,500 cfs on Big Lost River. This data was taken from 41 years of mean daily discharge records at the USGS gauge "Howell Ranch Near Chilly." Note that the canal would be used an average of 16 days per year, and that flows would be less than 1,000 cfs more than 80 percent of the time the canal is in use. Table 3 indicates that more than half of the sediment will enter the canal during flows below 1,000 cfs.

Table 2 presents the estimated sediment discharge in the Big Lost River for each flow range as well as the yearly average total sediment discharge for each sediment classification. Regression equations relating sediment discharge to water discharge found on page 44 of the above USGS report were used to calculate the average annual sediment discharge for each flow range and sediment classification.

canal discharge is equal to that of the main river for all size fractions. Actually, the transport of bed load into the canal is highly dependent on the location and configuration of the diversion structure. A well-designed structure could flush most of the sediment downstream, while a poor design might result in nearly one-half of the river bed load entering the canal (1,327 tons per year).

A rough analysis of sediment transport in the diversion canal was performed. Using the Meyer-Peter's bed load formula and Shields criteria for incipient motion, it was estimated that about one-half of the bed load material would deposit in the canal. This could range from negligible up to an estimated maximum of 665 tons per year (529 cubic yards per year)--if one-half (1,327 tons per year) of the bed load enters the canal. It is also likely that the catchment basin above the diversion structure will eventually fill in with large gravel and cobbles.

Preliminary calculations, using Colby's method, suggest that most of sand, silt, and clay will be carried through the canal and into the infiltration basin at all flow levels.

The overall average deposit, spread out uniformly over the 61 acres of the pond, would amount to about 0.5 inches per year. Due to the low velocities in the infiltration basin, it should be assumed that sand and the coarser fraction of the silt will form a delta deposit fanning out from the point of discharge into the basin. The finer materials will spread out more uniformly. The silt and clay fraction, spread out uniformly over the basin, would require about 55 years to develop a layer 1 foot thick. Near the inflow point sand would be several feet thick.

BIG LOST RIVER AT USGS GAGE HOWELL RANCH NEAR CHILLY, IDAHO
PERIOD OF RECORD: 1948-1989 (41 YEARS)

FLOW RANGE	AVERAGE Q	TOTAL* DAYS	DAYS/ YEAR	CUMULATIVE DAYS/YEAR	PER- CENT
1500 - 1750	1625	176	4.29	4.29	27.1
1750 - 2000	1875	168	4.10	8.39	52.9
2000 - 2250	2125	117	2.85	11.24	70.9
2250 - 2500	2375	65	1.59	12.83	80.9
2500 - 2750	2625	54	1.32	14.15	89.2
2750 - 3000	2875	35	0.85	15.00	94.6
3000 - 3250	3125	17	0.41	15.41	97.2
3250 - 3500	3375	10	0.24	15.66	98.8
3500 - 3750	3625	7	0.17	15.83	99.8
3750 - 4000	3820**	1	0.02	15.85	100.0

* Number of days during the 41-year record when flow fell within the indicated range.

** Only one flow (3820) was recorded above 3750 cfs.

BIG LOST RIVER
SEDIMENT DISCHARGE IN TONS PER YEAR

AVERAGE Q	SILT & CLAY	SAND	TOTAL SUSPENDED	BEDLOAD	TOTAL LOAD
1625	940	1,056	1,959	331	2,592
1875	1,312	1,452	2,670	448	3,527
2125	1,269	1,388	2,533	422	3,342
2375	946	1,023	1,854	307	2,444
2625	1,023	1,096	1,974	324	2,600
2875	843	895	1,603	262	2,109
3125	510	537	958	156	1,259
3375	368	384	682	110	896
3625	311	322	570	92	748
3820	51	53	93	15	122
	7,574	8,207	14,896	2,467	19,637

TOTAL SILT+CLAY+SAND+BEDLOAD 18247.66
PERCENT OF TOTAL LOAD 0.929227

ADJUSTED SEDIMENT LOAD TOTALS
IN TONS PER YEAR

SILT & CLAY	SAND	SUSPENDED	BEDLOAD	TOTAL LOAD
8,151	8,832	16,983	2,655	19,637

Note: Separate regression equations were used for each of five sediment classifications leading to an inconsistency in the sum of the totals. These values were adjusted in the table above to match the calculated total load.

SEDIMENT SUPPLY TO CANAL LEADING TO INFILTRATION BASIN
IN TONS PER YEAR FOR EACH FLOW RANGE

BIG LOST Qt	CANAL Qc	RATIO Qc/Qt	SILT & CLAY	SAND	SUSPENDED SEDIMENT	BED-LOAD	TOTAL LOAD	CUMULA-TIVE	PER-CENT
1625	125	0.077	78	87	172	27	199	199	4
1875	375	0.200	283	313	610	97	707	906	17
2125	625	0.294	402	439	850	133	983	1889	35
2375	875	0.368	375	406	779	122	900	2790	51
2625	1000	0.381	420	449	857	133	990	3780	70
2875	1000	0.348	316	335	636	98	734	4515	83
3125	1000	0.320	176	185	349	54	403	4916	91
3375	1000	0.296	117	123	230	35	265	5182	96
3625	1000	0.276	92	96	179	27	206	5388	99
3875	1000	0.258	14	15	27	4	31	5419	100

TONS PER YEAR

TOTALS:			2272	2448	4689	730	5419

VOLUME IN CUBIC YARDS/YEAR

TOTALS:			2104	1950	4054	581	4635

Note: The total volumes above assume the infiltration basin will dry out between uses. Estimated unit weights for silt/clay and sand were 80 and 93 lbs/ft^3 respectively.

APPEDNIX G

Summary of Wildlife Coordination Activities Associated with the Big Lost Feasibility Study

The Boise, Idaho Ecological Services Field Office of the U.S. Fish and Wildlife Service (USFWS) was first notified of our intent to proceed with a feasibility study for the Big Lost River by letter dated 20 September 1989. At that time preliminary, general information regarding installation of a dam and headworks that would divert flood flows into an adjacent flat sagebrush area was presented. Discussions regarding the scope of potential impacts, based on USFWS's 25 September 1987 Planning Aid Letter (PAL) Report, ensued for nearly 7 months.

By letter dated April 16, 1990, a scope of work for initial investigations was transmitted to USFWS that detailed tasks to be performed during Fiscal Year (FY) 1990. It was agreed that necessary tasks to evaluate potential impacts to wildlife would proceed in two phases spanning two fiscal years. The following tasks were identified for FY90:

a. HEC-2 Analysis--Utilizing Corps of Engineers-furnished maps, including identified transects to be sampled for hydrologic- and economic-specific applications, USFWS would identify necessary transects in an attempt to utilize HEC-2 results to make predictions about future riparian conditions and associated habitats that would be affected by changes in surface and subsurface flow regimes as a result of the project. USFWS personnel spent 1 day in the field with Corps survey personnel to determine if their survey needs were compatible with Corps methodology.

b. Wildlife Habitat Evaluation--Utilizing the Habitat Evaluation Procedures (HEP), habitat losses would be assessed in Habitat Units [(HU)--combined measure of quantity and quality of the habitats] by first establishing the existing conditions for a variety of wildlife evaluation species representing all existing habitat types. These baseline HU's would then be compared to the HU's predicted to remain under the with-project condition constituting the impact requiring mitigation. The following tasks were defined for FY90:

(1) Selection of evaluation species (models).

(2) Identification of cover (vegetation) types.

(3) Preliminary vegetation mapping for species model testing.

(5) Model testing.

Through mutual agreement between USFWS and the Corps, USFWS shifted the focus of FY90 efforts to the vegetation mapping, completing photo interpretation, including ground truthing, of the project area and predicted affected downstream reaches from Corps-furnished, BLM aerial photography. In addition, potential impacts identified in the PAL scope of work to pronghorn antelope and sage grouse were cursorily investigated.

Investigations were undertaken by the Corps biologist regarding design criteria for canals and possible big game crossings to minimize potential impacts to antelope migrating between winter and summer ranges. Also, location of known sage grouse leks (strutting grounds associated with reproduction) were located from existing data. It was recognized that although the location of these lek areas are traditional in nature, the age and reliability of the existing data, plus the potential for environmental changes to the area that could have influenced the suitability of these areas as leks warranted undertaking current surveys of the area to document current utilization.

An attempt was made by the Corps to undertake such surveys to be conducted by Idaho Department of Fish and Game (IDFG). However, IDFG could not find available personnel so this survey had to be delayed for the following FY. Regardless, the Corps utilized existing information and incorporated certain features in their project design to minimize these potential impacts to antelope and grouse.

Additional investigations and evaluations (including tasks identified for FY90 and completed) that were scheduled for FY91 included the following:

a. Completion of HEC-2 analysis--this task was somewhat questionable in that Corps hydrologists did not believe that the predictions USFWS was intending to make with this data was possible. A meeting was to be scheduled to explore the potentials and possibilities in using HEC-2 data but did not occur upon termination of the feasibility study.

b. Fisheries investigations--

(1) Two 6-day population surveys were planned including the reach from the East Fork Confluence to Mackay Dam. The primary concern was to determine the amount and significance of a native population leading toward justification of screening at the diversion site.

40+ mile stretch of river would be documented.

c. Wildlife investigations--

(1) General population surveys concentrating on the riparian habitat from Chilly Butte to Arco and Barton Flats would be conducted during winter, spring, and early summer. Bird surveys would be emphasized, although aquatic furbearers along Big Lost River and big game use, particularly antelope fawning, would also be censused.

(2) Winter big game and sage grouse aerial and ground surveys would be conducted including Barton Flats and the Big Lost River area.

d. Identification of mitigation opportunities--

(1) Impact avoidance would be evaluated potentially considering use of fish screens at the diversion and minimum grade canal bank slopes to allow for easy big game passage.

(2) Onsite mitigation opportunities would be evaluated such as the potential to provide instream flow for fish below Mackay Reservoir or reestablishing riparian vegetation.

(3) Offsite mitigation opportunities would be evaluated potentially involving enhancement of another area to mitigate for lost crucial sage grouse habitat.

e. The HEP would be completed involving field sampling, data analysis, evaluation of future with and without various mitigation/enhancement opportunities, and evaluation of cost effectiveness of the mitigation opportunities in relation to habitat gains.

A meeting between the Corps and USFWS would have been held in the fall of 1990 to discuss and refine the intended scope of work. Discussions up to that time entertained the possibility of having a private contractor conduct the remaining tasks associated with the study. However, USFWS and the Corps, would still have to agree on the final scope of work as dictated by the Transfer Funding Agreement resulting from the Fish and Wildlife Coordination Act, Public Law 86-624 as amended.

Planning Aid Report
September 25, 1987

Prepared for:

U.S. Army Corps of Engineers
Walla Walla District

PRELIMINARY BIOLOGICAL EVALUATION

Big Lost River

Boise, Idaho

Timothy Bodurtha
Wildlife Biologist

Figures Pages

Tables Pages

Big Lost River Valley
Planning Aid Report

Timothy S. Bodurtha
Wildlife Biologist

United States Department of the Interior
Fish and Wildlife Service
Boise Field Office

September 1, 1987

This report evaluates the potential impacts of proposed project alternatives on fish and wildlife habitats in the Big Lost River drainage. Frequent flooding has been a major problem in the Big Lost River Valley. The proposed projects are designed to control flooding. Project designs considered include: diversion of flood flows through canal systems, increasing existing reservoir and spillway capacity, regulation of existing reservoir for flood control, and construction of a dam for impoundment of peak flows on a major tributary to the Big Lost River. Without the project(s), uncontrolled flood waters will continue. Fish and wildlife habitats could be impacted or remain relatively stable. With the project(s), there is increased potential to provide flood damage protection. The consequences to fish and wildlife resources are contingent on which proposed project is considered. Impacts to fish and wildlife resources will vary from nearly no impacts to potentially significant changes. The analysis is based on existing data and qualitative site evaluation. It is part of a reconnaissance-level evaluation by the U.S. Army Corps of Engineers. Recommendations are provided for a feasibility level analysis. The study was conducted under the authority of the Fish and Wildlife Coordination Act.

Preface

In May, 1987, the U.S. Fish and Wildlife Service (Service) initiated a study of the Big Lost River in Idaho's Butte and Custer Counties (Figure 1). The study was accomplished in coordination with, and as part of, a U.S. Army Corps of Engineers, Walla Walla District (Corps) reconnaissance-level evaluation. The Service's purpose was to identify potential fish and wildlife impacts, needs, and opportunities related to proposed water resource development alternatives intended to address flooding in the area and potential safety of Mackay Dam issue. This Planning Aid Report was prepared by the Service in fulfillment of its obligations as defined in the Scope of Work. This preliminary investigation is based primarily on available information which can be used as a framework for detailed Fish and Wildlife Coordination Act investigations should feasibility-level studies be required. Evaluation objectives considered were:

1. A description of base fish and wildlife resource conditions as quantitative as possible while relying on existing information with minimal field investigations.

2. Projections of future without project fish and wildlife habitat conditions.

3. Appraisal of existing fish and wildlife resource utilization (user-days).

4. Qualitative descriptions of project-related detrimental impacts to fish and wildlife.

5. Appraisal of flow augmentation opportunities to enhance fish and wildlife resources.

6. Identification of significant data gaps and study needs to be addressed during feasibility level phase of study.

7. Discussion of potential project impacts on endangered species or sensitive species in the area.

Background Information

Over-bank and ground-water flooding has been a major problem in the Big Lost River flood plain, particularly the 28 mile reach from Mackay to Arco where extensive agricultural development has occurred. In the past 44 years 12 major floods resulted in costly damage to farmlands, bridges, roads, and private property. The greatest damage took place in a five mile reach immediately

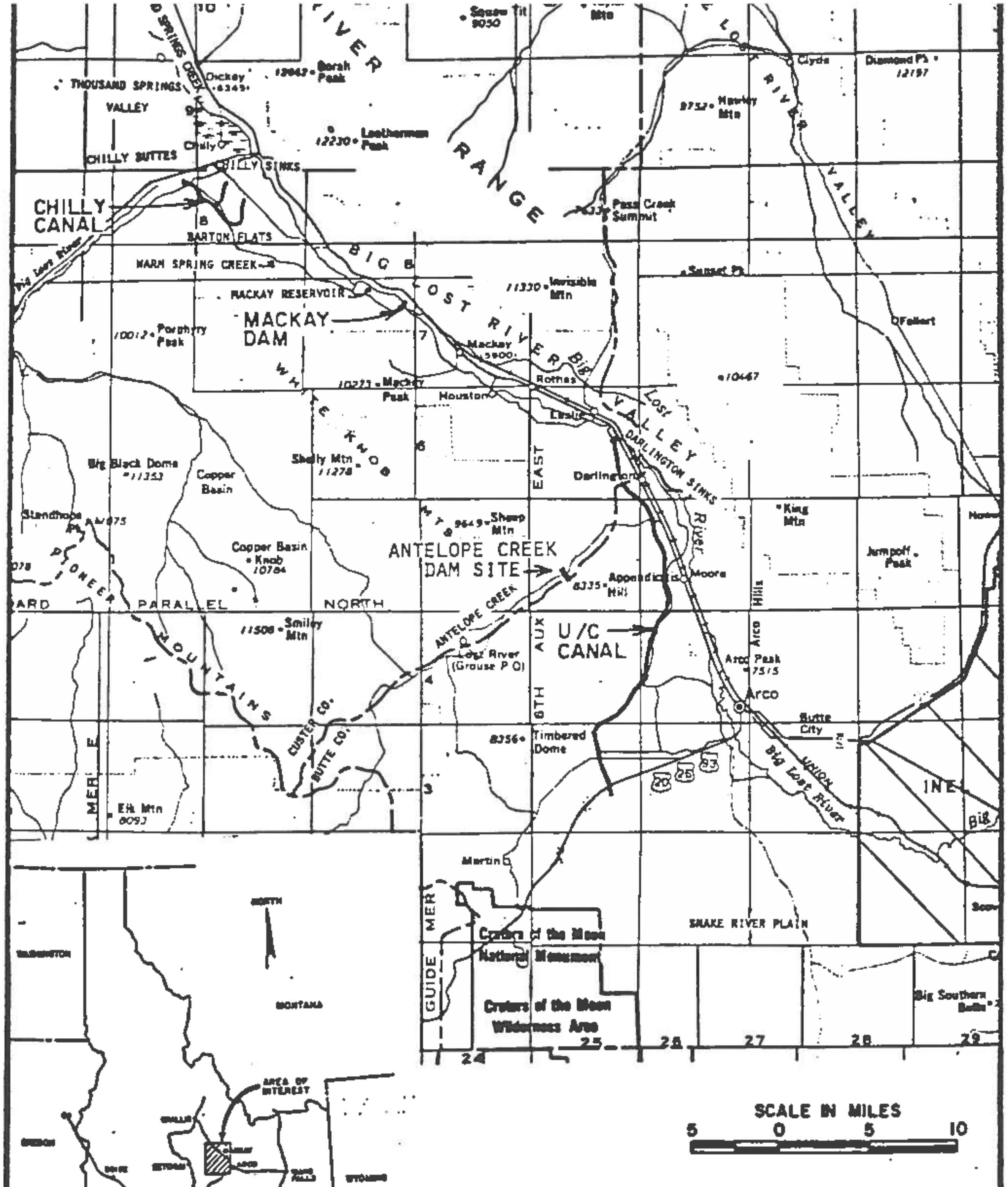

FIGURE 1 GENERAL LOCATION MAP

storage in Mackay Reservoir is for irrigation. Surface flows are affected by two major sink areas (regions of high infiltration) in the main valley, Chilly Sinks and Darlington Sinks (Figure 1). Finally, east of Arco the river recedes entirely into the Lost River Sinks of the Snake River Plain. Flows delayed by the sinks can produce undependable agricultural yields to downstream irrigators (Bureau of Reclamation 1960). The Bureau of Reclamation (1960) reported that approximately 16,000 acres of land between Antelope Creek and Arco (Arco Division) are inadequately irrigated. Another 9,000 acres southwest of Arco can only be irrigated by ground water (Ground-water Division).

Runoff cycles in the upper Big Lost River drainage affect the hydraulic geometry of the river channel through erosion, channel change, and sediment transport. The upper watershed above Mackay Reservoir has been affected by grazing practices on range lands, diversion for irrigation, and emplacement of structures to conserve water during drought periods. Cutbanks, bank failures, channel shifting, and deposition occurs along these reaches. Suspended solids are transported into Mackay Reservoir and owing to the low trap efficiency of the reservoir, are seasonally transported through the system without settling (Williams and Krupin 1984).

The October 28, 1983 Idaho earthquake significantly affected the hydrologic regime in the upper basin above Mackay Reservoir (Whitehead 1985). Ground water rose rapidly after the earthquake. Gradually, over a period of months, ground water returned to previous levels. Water levels in wells temporarily exceeded containment casings and ground water discharge from springs nearly doubled with one spring reaching ten times pre-earthquake flows. Safety of the residents downstream from Mackay Reservoir was of great concern at the time of the earthquake. The reservoir was about 90% full pool. The dam remained stable, although a temporary increase in seepage water and color change occurred. A considerable amount of rock material from the bluff near the right dam abutment also fell into the spillway (personal communication, George Gilbert, employee, Big Lost River Irrigation District).

Project Description

The Corps has identified several alternatives for reducing peak flows throughout the Big Lost River Valley. The proposed study alternatives are as follows:

1) Construct a diversion dam and canal system to divert flood flows from the Big Lost River into the Chilly Sinks/ Barton Flats area.

feet by raising the dam in conjunction with increasing the spillway capacity to maintain control of the probable maximum flood inflow volume.

3) Enlarge the emergency spillway on Mackay Dam to accommodate the probable maximum flood inflow volume and protect the dam from being overtopped.

4) Replace the old existing U/C headworks and diversion dam, enlarge the entire canal system to increase its capacity, and extend a new portion of the canal into the lava beds south of highway 20/26 for diversion of flood flows from the Big Lost River.

5) Construct a dam on Antelope Creek, a major tributary of the Big Lost River, for storage of flood flows and small hydropower generation.

6) Regulation of Mackay Dam through operational planning for flood control.

7) Construct upstream storage sites above Mackay Dam.

8) Construct levees to protect specific sites along the Big Lost River.

(Alternatives 7 and 8 are no longer being considered within this scope of work (personal communication, Dale Smelcer, Corps) and therefore will not be further addressed in this report.)

Figure 1 shows the project areas for the proposed canal diversions, Mackay Dam alternatives, and Antelope Creek Dam proposal.

Information Sources

The Service's findings are based on various reports, documents, and published information and are noted in the literature cited section. Additional information was obtained from consultation with individuals that are familiar with the area and issues addressed. Reference is made to these individuals within the report. Contacts were made with personnel from the Corps, Idaho Department of Fish and Game (Fish and Game), Bureau of Land Management (Bureau), Big Lost River Irrigation District, the Service's Boise Field Office, and other agencies and organizations. Maps, aerial photos, and project descriptions were provided by the Corps.

The Service's policy is to seek mitigation for fish and wildlife resources subject to adverse effects of environmental changes caused by resource development. Mitigation is recommended according to the value and scarcity of the habitat at risk. The specific elements that represent the desirable sequence of steps in the mitigation planning process are: 1) avoiding the impact altogether by not taking certain actions or parts of an action, 2) minimizing impacts by limiting the degree or magnitude of the action and its implementation, 3) rectifying the impact by replacing, rehabilitating, restoring the affected environment, 4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action, and, 5) compensating for the impact by replacing or providing substitute resources or environments. Further, the Service seeks to identify opportunities to enhance fish and wildlife resource values beyond mitigating for project imposed impacts. Enhancement is a project benefit. Such actions should be used to improve on the project cost benefit ratio.

EXISTING CONDITIONS

Geologic and Physiographic Features

The geology and physiographic features of the area have been described by Crosthwaite et al. (1970) and the following information is taken from that reference. Soils information was adapted from Bureau of Land Management (1983).

The intermountain basin of the Big Lost River is located in east-central Idaho and is bounded by high rugged mountain ranges. It is one of three major structural intermountain basins in the region. The upper valley basin above Mackay Dam is somewhat pentagonal in shape and includes 788 square miles. Downstream from the dam the valley is elongated and occupies about 612 square miles. The main valley trends northwest to southeast and is bounded by the Lost River Range on the northeast to southeast, the Boulder Mountains to the west-northwest, the Pioneer Mountains to the west-southwest, and the White Knob Mountains to the south-southwest (Figure 1).

Steep, rugged, and dissected mountains of high relief characterize the terrain surrounding the valley basin. Thirteen peaks in the upper basin exceed 11,000 feet, including Mt. Borah, at 12,656 feet. The boundary between treeline and alpine tundra is about 9,500 feet. Approximately 10% of the watershed is above 9,000 feet with the remaining 90% between 9,000 and 6,000 feet.

Lost River and the North Fork Big Lost River in Custer County. The river flows in a northeast direction and several smaller tributaries join the upper reaches in the 16 miles before entering the main basin in the Chilly Buttes area. It turns southeast in the upper valley near the confluence of Thousand Springs Creek, a major tributary to the Big Lost River. Near this location, flow from the Big Lost River sinks into the alluvium of the valley bottom for about 2 to 3 miles before resurfacing at normal discharge (200-300 cfs) prior to entering Mackay Reservoir. This area is known as the Chilly Sinks. Warm Springs Creek is the second of three major tributaries which enters just above Mackay Reservoir.

The Darlington Sinks is located downstream from Mackay Dam about midway between Mackay and Arco. Antelope Creek, the third major tributary, enters the Big Lost River near these sinks. Flows resurface upstream from Arco but are generally diminished. South of Arco the Big Lost River enters the Snake River Plain where it turns northeast and eventually disappears into the Lost River Sinks. Tributaries that flank the eastern boundary of the Lost River Range sink into the large alluvial fan deposits before reaching the Big Lost River except during very high flows. Both sinks of the mainstem typically have surface flows during peak runoff.

Glaciation during the Quanternary and Pleistocene eras has produced complex geological features in the Big Lost River region. The main valley is formed by large-scale downfaulting between two upfaulted blocks of the White Knob and Lost River Mountains. A major fault parallels the river above Bartlett Point cutting across several alluvial fans. A second east-west fault cuts across the valley where the river narrows (Mackay Narrows) at Mackay Dam. Faults are found in the valleys of Lone Cedar Creek and Elkhorn Creek. The Lost River Fault runs parallel to the range along the mountain front, intersecting the valley faults and cutting across alluvial fans to the east and northeast of the river. The northeast extension of the Boulder Range of the upper basin is faulted along the base, west of Thousand Springs Valley. The Pioneer Mountains contain numerous, large, northwest-southwest trending, parallel, and sometimes concentric, thrust and normal faults along the western and central portions of the watershed.

Glacial runoff over the ages has carried enormous quantities of sediment down into the valley of the river. Huge Quanternary alluvial fans enter the valley from the outlets of the tributary streams of the Lost River Range and White Knob Mountains. Terrace gravels fill a large portion of Thousand Springs Valley. This upper valley contains innumerable patterned ground features on units:

1) Carbonate Rocks - predominantly limestone and dolomite which comprise the majority of rock types in the Lost River and Boulder Range.

2) Noncarbonate Rocks - a complex group composed of quartzite, sandstone, argillite, siltstone, granite, and volcanics that predominate the Pioneer Mountains.

3) Old Cemented Alluvium Deposits - consists of poorly sorted sand, silt, and clay that becomes cemented when derived from calcareous rock such as limestone and dolomite. The deposits form the alluvial fans that dominate the Lost River, Boulder, and Pioneer Mountain Ranges.

4) Alluvial Deposits - these include unconsolidated river alluvium, glacial deposits, terrace deposits, landslide debris, and young alluvial fans. The alluvium contains coarse, well sorted materials consisting of small gravels, pebbles, sand, and silt.

5) Basalt of the Snake River Group - it consists of fractured and jointed olivine basalt located near the mouth of the valley where it encroaches on the alluvium being deposited.

Eight general soil associations occur within the Big Lost River valley. Soils information for the upper valley above Mackay Reservoir is more complete for agricultural and nonagricultural areas with soil orders, suborders, textural classifications, series name, and soil series descriptions. A Soil Survey Description Legend is on file at the Soil Conservation Service Office, Arco, Idaho.

Brief descriptions of the soil associations are as follows:

1) Challis Volcanics - includes soil types that range in depth from shallow to deep and were derived from old mountain materials which have weathered into stoney clay loams to heavy clays; located at 5,000 to 10,000 feet elevation in the 12 to 30 inch precipitation zone.

2) Limestone Mountains - an undeveloped mountain soil type that is generally a coarse, gravelly loam soil from very shallow to deep at elevations of 4,500 to 9,500 feet in the 9 to 20 inch precipitation zone.

3) Limestone Alluvium - alluvial fans and terraces are comprised of this gravelly and very gravelly loams with minor soil development; elevations range from 5,000 to 7,000 feet

4) Moist Basalt Plain - these types are wind-blown silt loams that are shallow soils deposited over basalt on gentle slopes at elevations of 5,000 to 6,000 feet and 12 to 13 inch precipitation zone.

5) Lower Big Lost River Alluvium - soils that are derived from river materials that consist primarily of loamy soils over deep gravel deposits and that form the flat terraces at elevations of 5,000 to 6,000 feet and 12 to 13 inch precipitation.

6) Metamorphic Mountain Material - this soil consists of cobbly heavy loam of shallow to moderately deep over siltstone bedrock; elevations range from 6,000 to 10,000 feet and precipitation 13 to 20 inches.

7) Dry Basalt Plains and Recent Lava Flows - comprised of shallow to deep silt loams wind-deposited over basalt at elevations of about 5,500 feet and 11 inches precipitation; recent lava flows are thin ashy soils and volcanic cinders that are associated with the Craters of the Moon National Monument.

8) Upper Big Lost River Alluvium - this type is derived from river wash material that consists of very deep gravelly and cobbly loam soils on a series of old river terraces at elevations of 6,000 to 7,000 feet and greater than 12 inches precipitation.

Climate

Regional weather of the Big Lost River is characterized by a cool, semiarid, continental climate. Cold winters and relatively warm, dry summers prevail. Dramatic topographic relief of the area produces highly variable seasonal and daily temperatures, wind direction, wind velocities, and precipitation. Three National Oceanic and Atmospheric Administration National Weather Service Stations are located strategically in the valley at Chilly Barton Flats in the upper basin, Mackay Ranger Station midway, and near the mouth at Arco. The following discussion of data on temperatures and precipitation will pertain to this respective ordering of the stations. Climatological data was taken from monthly summary records for the period 1951 through 1980 (U.S. Department of Commerce 1982). The respective mean annual maximum and minimum temperatures for the three locations are 52° F and 22.4° F, 55.9° F and 27.5° F, and 56.9° F and 26.7° F. The respective average mean annual temperatures are 38.7° F, 41.7° F, and 41.8° F. Highest temperatures generally occur in July and lowest in January. Mean annual precipitation is 8.07, 9.73. and 9.92 inches. Mean annual snowfall. which accumulates

Hydrology

Frequency of flooding of the Big Lost River corresponds to above average snowpack in the higher elevations of the basin and the runoff rate. The high mountain ranges contribute to a late season runoff that typically peaks in mid-June. An earlier report (Bureau of Reclamation 1960) stated that estimates of flood frequencies derived from frequency curve analysis methods resulted in adoption of a plan for flood protection. This plan was based on a flood discharge of 2,000 cubic feet/second (cfs) which was exceeded about once in 50 years.

The Idaho Department of Water Resources (1976) prepared trial flood storage allocation parameter curves for Mackay Reservoir. Historic flood data (1919-1974) were utilized and each flood season runoff data for each year was analyzed to determine the storage requirement necessary to control the runoff to an allowable discharge of 1,500 cfs. Presently, a draft reservoir operation guide for Mackay Reservoir is being developed by the U.S. Soil Conservation Service (1987 draft). This plan states, "Mackay Reservoir outflows should be greater than 50 cfs to maintain fisheries and downstream water rights and less than 1,500 cfs to avoid downstream flooding."

Historic peak flows are presented in Table 1 for the period from 1948 to 1986 (Idaho Department of Water Resources 1976). Flows are those released from Mackay Reservoir. All but one year (1954) had flows exceeding 1,500 cfs. Severe flooding of greater than 2,000 cfs and at least 20 day duration occurred in 1956, 1965, and 1967. Flood damages were greatest during these years. In 1965 estimates surpassed $1 million (Arco Advertiser 1965). In 1967 damages were set at $730,100 (U.S. Army Corps of Engineers 1967). In 1974 estimates for the second highest historic flood on record were $1 million. More recently, the 1986 flood damage to county and state bridges alone exceeded $750,000 (minutes from FAC meeting, Arco, Idaho, 8-21-86).

Mackay Reservoir (adapted from Idaho Department of Water Resources 1976)

Year	Historic Peak Flows (cfs)	No. of Days Flows > 1,500 cfs
1948	1790	5
1951	1790	2
1952	2130	9
1953	1730	8
1954	1140	0
1956	2530	22
1957	2400	10
1958	2520	13
1963	1550	1
1964	1550	1
1965	2640	38
1967	2430	32
1968	1620	2
1969	1540	2
1970	2150	8
1971	2220	8
1974	2770	18
1986	2990	16

A distinctive characteristic of the Big Lost River is the alternate losses and gains of water from the highly permeable alluvial deposits. At two locations along the mainstem, medium and low surface flows percolate into the alluvium and carbonate aquifer system. Flows reemerge 2 to 3 miles downstream. During peak runoff in normal years the main channel contains surface water for about four months. A large portion of the surface loss (average loss is about 120 cfs) occurs in the reach between Chilly and Mackay Reservoir in the area known as the Chilly Sinks. Surface water inflow to Mackay Reservoir is partially supplied from Thousand Springs Creek (average 25 cfs), from ground-water inflow, and from large springs located in the flood plain. Although the total volume of inflow is undiminished, the amount of water lost due to infiltration and the amount of water that contributes to the alluvium ground-water supply is unknown. Surface flow immediately below the reservoir averages 30 cfs more than combined surface flows of surface streams below the Chilly Sinks. Thus, the river gains volume in this reach (Crosthwaite et al. 1970).

Another high infiltration area known as the Darlington Sinks is located in a reach approximately 18 miles below Mackay Dam between Leslie and Moore. A portion of the water lost (average 200 cfs) is returned to the river before reaching the Moore Canal between ground-water and surface water supplies.

Crosthwaite et al. (1970) suggested that because ground-water and surface water resources are so closely interlinked, they should be considered a single system. Changes in water supply in one system will commonly influence capacity of the other. Ground-water storage comes from precipitation and snowmelt that enters the underground aquifers through the consolidated rock and alluvial fill of the basin. Recharge is largely from 1) reaches where the Big Lost River are above the water table, 2) mountain stream tributaries percolating into the alluvial fans, and 3) infiltration of water applied on irrigated lands. Water storage in the deposits from Mackay Narrows to Arco was estimated at 1.3 million acre-feet in the first 100 feet of alluvium and about 2.6 million acre-feet in the upper 200 feet. This relates to storage only and not a continuous usable supply which refers to the annual discharge from the system.

Surface water originates from direct runoff after rainfall, snow-melt, and ground-water discharge springs, or seeps at points where the water table intersects the ground surface. Water yield in terms of the amount perennially available for use (defined as the difference between average annual input and the annual loss through evaporation and evaportranspiration) is dependent on the mean annual precipitation in the basin. Crosthwaite et al. (1970) estimated the average annual water yield of the Big Lost River during the period from 1944 to 1968 was 650 cfs. Of this amount 150 cfs was evapotranspired and 500 cfs entered the Snake River Plain, of which 75 cfs was surface flow and 425 cfs ground-water flow.

The chemical water quality of both surface and ground-water resources is good in the Big Lost River basin (Crosthwaite et al. 1970). The surface water of the watershed below the reservoir to the headwater streams was evaluated by the U.S. Geological Survey and results indicated that water quality is generally excellent. Crosthwaite et al. (1970) analysed chemical constituents from 13 surface water stations and ground water from 12 wells and four springs. Surface water constituents fell within acceptable U.S. Public Health Service standards. Three wells, however, had highly dissolved iron content that was considered nonhazardous to consumers' health and unrepresentative of ground water in the basin. No new information of chemical water quality problems is apparent on the Big Lost River (personal communication, Gordon Hopson, Idaho State Water Resources Bureau).

Erosion, channel change, and sediment transport has been a major concern in the upper basin above Mackay Reservoir (Jensen 1982). Excessive stream bank erosion occurs during high velocity flows. Coarse materials are carried downstream deposited and that the reservoir had lost 22% of its mid-season and late-season capacity (Jensen 1982).

Construction of Mackay Dam was completed in 1917. It is located five miles northwest of the town of Mackay and owned by the Big Lost River Irrigation District. The dam is an earth and rock-filled structure composed of sand, gravel, and cobbles. Length is approximately 1,430 feet, height 70 feet, and crest width at an elevation of 6,076 feet is 15 feet. The reservoir has a present storage capacity of about 45,050 acre-feet at the spillway crest elevation 6,067 feet and a surface area of 1,341 acres. At full pool, maximum depth is 65 feet. The primary operation is for irrigation storage to provide irrigation water for approximately 33,000 acres of land. Irrigation withdrawals nearly empty the reservoir by the end of September in most years. By the end of December it usually fills to about 60% capacity and typically reaches full pool between April 1 and June 31. Seepage occurs beneath the dam and ranges from 40 cfs with 1,000 acre-feet (about 2.2%) storage up to 130 cfs when full. A Federal Court Decree requires a release of 50 cfs from Mackay Reservoir during winter months which is typically met through seepage losses. The only recreational development is located on the east shore of the reservoir and consists of Fish and Game Sportsmen Accesses and a Bureau (Salmon District) campground and boat ramp.

Vegetation

Vegetation within the Big Lost River drainage is variable due to changes in elevation, slope, aspect, soil characteristics, past livestock management practices, and local climate conditions. Four major vegetative associations are conifer, sagebrush-grass, emergent wetland (Cowardin et al. 1979), and riparian. Sagebrush-grass and riparian are the associations most represented in the valley and most likely to be impacted by the proposed projects.

Major vegetation types are the Wyoming big sagebrush (*Artemesia tridentata* ssp. wyomingensis), mountain big sagebrush (*Artemesia tridentata* ssp. vaseyana), low sagebrush (*Artemesia arbuscula*), black sagebrush (*Artemesia nova*), chicken sage (*Tanacetum nuttallii*), and fringed sagebrush (*Artemesia frigida*). Other types include shadscale (*Atripex* spp.), mountain-mahogany (*Cercocarpus ledifolius*), Douglas-fir (*Pseudotsuga menziesii*), juniper (*Juniperus* spp.), and sedges (*Carex* spp.) of the wet meadow association. Several plant communities probably occur within each vegetation type. Scattered throughout the valley are seeded pastures primarily of crested wheatgrass (*Agropyron cristatum*) grown mainly for livestock forage. The dominant agricultural crops are alfalfa (Medicago spp.) and potato.

al. 1979) of the Big Lost valley. The riparian zone that parallels the river consists predominantly of dense hydrophytic vegetation dominated by cottonwoods (Populus spp.) and to a lesser extent aspen (Populus tremuloides). Common plants comprising both associations are listed in Appendix A.

Historic and recent grazing trends in much of the sagebrush steppe and riparian communities has probably led to the removal of plant biomass and changes in native plant community composition (personal observations from on-site inspection). Daubenmire (1970) and others have reported cases of the complete replacement of the widespread native perennial bluebunch wheatgrass (Agropyron spicatum) by the introduced annual cheatgrass brome (Bromus tectorum) in the sagebrush steppe region. Additionally, a similar finding with Kentucky bluegrass (Poa pratensis) excluding Idaho fescue (Festuca idahoensis) on more mesic sites has been reported by Daubenmire (1970). Livestock tend to concentrate in riparian zones due to proximity to drinking water, cool temperatures, and high quality forage provided by the riparian vegetation. Recovery of the riparian forests from grazing in many areas is prevented by livestock (Brinson et al. 1981). Young trees that are heavily browsed may be affected adversely leaving only a decadent riparian forest. Soil compaction from trampling facilitates establishment of shallow-rooted, herbaceous perennials or tap-rooted shrubs. These plants exclude the desirable fibrous-rooted plants which are usually more palatable, nutritious, and dependable on a yearlong basis (Platts 1979). Grazing results in loss of plant biomass which can cause heavy soil losses and contribute to stream channel instability (Brinson et al.1981).

Range land condition for much of the Big Lost River valley has been evaluated by Bureau personnel (Bureau of Land Management 1983). The majority of the upland sites were in fair to good condition. Most of the poor and seeded sites were adjacent to private landholdings that were in or bordering the Big Lost River flood plain. About 10,531 acres or 3% of private and state lands were not surveyed.

In 1980 a survey for threatened and endangered plants was conducted in the Big Lost and Mackay Planning Units for the Bureau (Reese and Henderson 1980). No listed species were located and based on available information none are known to exist in the area at this time (personal communication, Robert Parenti, Service, Boise Field Office). Information on four plants of state or federal importance that occur on or may occur in the project area was provided by the Idaho Natural Heritage Program. Global/State rankings and Federal status of each species is listed in Table 2 followed by a definition of ranks.

Program).

Scientific name Common name	Global/State Rank	Federal Status
Astragulas aquilonius Lemhi milkvetch	G2 / S2	N
Astragalus amnis-amissi Lost River milkvetch	G3 / S3	3C
Astragalus leptaleus Park milkvetch	G4 / S1	N
Silene scaposa var. lobata	G5T4 / S3	3C

Definition of Ranks

Global Element Ranks

G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range, or because of other factors making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4 = Apparently secure globally, though it may be quite rare in parts of this range, especially at the periphery.

G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

State Element Ranks

S1 = Critically imperiled in state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factors(s) making it especially vulnerable to extirpation from the state.

S2 = Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

Federal Element Ranks

3C = Taxa that have been proven to be more abundant and widespread than was previously believed and/or those that are not subject to any identifiable threat at present.

N = Taxa never having been accorded any Federal Status.

* Note that category 3 taxa are no longer being considered for listing as threatened or endangered species (Federal Register, 50 CFR, Part 17, September 27, 1985, pages 39526-39527).

Fish and Wildlife

Fish

Stream quality and fish populations vary from excellent to poor where surface water alternately intersect and perch above the ground-water table or enter irrigation ditches. The Big Lost River, the largest tributary to the Sinks, becomes marginal where it flows into the Snake River Plain due to diversion and freeze out. Lack of ground-water inflow during cold wintertime air temperatures often causes the stream to become icebound and leave its channel. Severe habitat degradation has occurred in several reaches within the valley proper. Current grazing practices inhibit recovery (Moore et al. 1986). Diversions into irrigation canals often dewaters most of lower segments of the river in the main valley before it reaches the Snake River Plain. Complete dewatering of some reaches during the irrigation season results in fish mortality and migration into more suitable habitat.

The fishery in the Big Lost River is characteristically distinct since it is isolated from downstream drainages. The river sinks into the Snake River Aquifer and as a result many nongame fish species that inhabit the upper Snake River drainage are not found in the Big Lost River. Results of electroshocking by the Fish and Game in 1980 carried out in the upper reaches above Mackay Reservoir indicated a fish population mainly of salmonids and sculpins (a small forage fish). Five species inhabit the Big Lost River and its tributaries, rainbow trout (Salmo gairdneri), brook trout (Salvelinus fontinalis), mountain whitefish (Prosopium williamsoni), kokanee salmon (Oncorhynchus nerka), and the shorthead sculpin (Cottus confusus). Of all the sink drainages (Little Lost River, Birch, Camas, Beaver, and Medicine Lodge Creeks), mountain whitefish are found only in the Big Lost River.

a result some bank stabilization and stream habitat improvement has been done. Little is currently known about the status of the fishery in this area. Management is directed toward a wild trout fishery supplemented with hatchery rainbow trout. However, the river segment from the reservoir to Burnt Creek is not stocked since it flows through mostly private land and is dewatered for a significant part of the year (personal communication, William Doerr, Manager, Mackay Fish Hatchery, Fish and Game).

Except for the reach immediately below Mackay Dam, the remaining downstream 55 miles of the Big Lost River has been extensively modified by numerous irrigation diversions and channelization for flood control which has destroyed about 25% of the channel (Moore et al. 1986). Fish from Mackay Reservoir produce an excellent fishery immediately below the dam. The high quality fishery is maintained since dewatering in this section is generally minimal. Species caught includes hatchery and wild rainbow trout, brook trout, and mountain whitefish. Wild trout populations are the major component of the fish biomass downstream from Mackay Dam.

Mackay Reservoir is a widely fluctuating irrigation supply reservoir with a maximum capacity of about 44,500 acre-feet and a minimum pool of 125 acre-feet. Pool levels below 4,600 acre-feet occur about every three years, causing flushing of most trout and kokanee through the outlet structure of the dam into the river. This results in a poor fishery the following year in the reservoir and makes it virtually impossible to manage for a wild trout fishery (Moore et al. 1986). In 1985 and 1986 severe draw-downs have taken place and will again this year. Drawdowns of this nature restrict the fishery to a put-and-take type. Hatchery rainbow comprised the majority of fish caught with some brook trout, kokanee, and wild trout present. Kokanee were originally planted in the early 1960's and periodic plants have occurred since. The last plant in the fall of 1983 was with spawning adults which were introduced upstream in the river just above the reservoir. Kokanee plants will receive low priority in the future (personal communication, William Doerr, Manager, Mackay Fish Hatchery, Fish and Game). From April through September, 1986, 13,450 pounds or 56,220 catchable rainbow trout (6 inch +), 4,150 pounds or 158,350 fingerlings (3-6 inch), and 3 pounds or 2,000 fry (0-3 inch) were planted in Mackay Reservoir (Idaho Department of Fish and Game 1986).

Fishing Pressure and Economic Values

Creel census was conducted on Mackay Reservoir during the general 1983 season and winter 1984 season. Findings indicated an estimated 35,071 angler hours (10,315 angler days) were spent fishing the reservoir with the peak period of use occurring in August (Corsi et al. 1986). Overall catch rate was .36 fish/hour expenditure was estimated at 10,765 hours for a catch rate of .75 fish/hour. Ice anglers averaged 1.9 lines/angler for the winter season which may partially explain the higher catch rate for winter fishing. The composite winter harvest was 82% hatchery rainbow trout, 9% wild rainbow trout, and 9% kokanee.

Census information is lacking for most of the Big Lost River. The reach immediately below Mackay Dam, which has a substantial trout and mountain whitefish fishery, produces estimated catch rates of one fish/hour and future management will be directed at and maintain this catch rate through maintenance of wild trout populations and supplemental plantings of hatchery trout (Moore et al. 1986).

Sorg et al. (1985) calculated a net willingness-to-pay value of $42.93 per trip or $25.55 per day for cold water fishing in Idaho. This value represents a net economic value an angler on a cold water fishing trip is willing to pay above current expenditures (transportation, lodging, food, tackle...) and is based on a weighted average of all fishing sites in Idaho. The estimated net willingness-to-pay value for the Sink drainages (includes the Big Lost River) was $34.17 per trip or $8.76 below average. Willingness-to-pay was greater for increased catch or for increased size.

Wildlife

The riverine habitat in the Big Lost River drainage supports a variety of birds, mammals, reptiles, and amphibians. Riverine habitat, consisting of tall cottonwoods and aspen, adds vertical structure to the vegetation in the valley which is predominantly sagebrush-dominated rangeland interspersed with agricultural crops. A diversity of shrubs, forbs, and grasses in the riparian zone provides forage and cover unavailable in the drier habitats. These zones are a critical source of diversity within arid range lands. Wildlife use riparian zones disproportionately more than any other type of habitat (Thomas et al. 1979). Some species are totally dependent on the riparian area for all life requirements; others live primarily in the adjacent, dry habitats; still others are influenced or are partially dependent on the riparian zone at some time in their daily, seasonal, or life cycle.

Sagebrush dominated range lands support many important vertebrate species either intermittently (e.g. seasonally) or as residents. These communities can provide breeding habitat for various non-game and upland game birds, and the larger tree-like shrubs may be suitable nest sites for some birds of prey. Small mammal populations in these areas furnish a prey base for foraging raptors. Lower elevation sagebrush communities are often

Bureau yielded 74 mammals, 253 birds (includes breeding and migrants), 10 reptiles, and 8 amphibians (Bureau of Land Management 1983). In addition, listed in Appendix B are species and their use-relationships which should afford a comprehensive perspective of wildlife that may use the area. Major species of concern that are likely to be impacted directly by the proposed projects are : pronghorn antelope (Antilocapra americana), mule deer (Odocoileus hemionus), elk (Cervus elaphus), and sage grouse (Centrocercus urophasianus). These species are discussed in some detail since information is available. Information on other species is limited in extent, but this should not deflate their importance.

No mammal species of special concern, as identified by the Fish and Game pertinent to the Big Lost River Valley, are known to occur in the project area at this time based on available information. The Bureau's sensitive species list included the river otter (Lutra canadensis) which may occur in the project area since it is usually seen in or near water in this region, but more often in larger streams that contain numerous slow-moving fish such as the sucker (family Catostomidae).

Mammals

Antelope

Population declines of Big Lost River Valley antelope were noted in the early 70's (Autenreith 1976). Recent levels have stabilized and moderate productivity has occurred (Autenreith and Connelly 1985). Antelope populations in some areas of the Big Lost Valley have been increasing, notably the Thousand Springs Valley and southwest of Arco. Increased depredation complaints from landowners in these areas has prompted Idaho Department of Fish and Game to implement three new hunts (450-4, 450-5, 450-6) in 1986 and double the number of permits in 450-2 in 1987.

Productivity is lower in the Big Lost drainage populations than those inhabiting the Little Lost and Birch Creek drainages. In antelope hunt units which encompasses the project area (450-1, 450-2, and 450-3), population levels, fawn:doe and buck:doe ratios, and harvest have remained stable for the past few years (Table 3 and Table 4). A 1980 aerial survey within the Big Lost - Mackay Grazing EIS area (Bureau of Land Management 1983), estimated a winter population of 2,025 antelope, up from the 1978 estimate of 1,237.

Antelope inhabit portions of the Big Lost River Valley. Habitat is limited because of agricultural development. Lack of winter

BIG LOST

450-1

1973	285	65	153	67	44	42
1974	377	75	228	74	33	33
1975	280	55	185	40	22	30
1976	512	79	294	139	47	27
1977	607	116	368	123	33	32
1978	.551	103	296	152	51	35
1979	389	55	220	114	52	25
1980	579	160	276	143	52	58
1981	675	103	360	212	59	29
1982	598	178	264	156	59	67
Unweighted mean 1973 to 1982:					45	38

450-2

1977	214	59	96	59	61	61
1978	65	11	35	19	54	31
1979	49	18	21	10	--	--
1980	88	13	44	31	70	30
1981	101	15	46	40	87	33
1982	154	35	76	43	57	46
Unweighted mean 1977 to 1982:					66	40

450-3

1973	83	5	48	30	63	10
1974	18	0	10	8	--	--
1975	66	20	37	9	24	54
1976	85	11	49	25	51	22
1977	49	22	20	7	--	--
1978	21	5	6	10	--	--
1979	57	23	19	15	--	--
1980	78	27	34	17	50	80
1981	139	30	76	33	43	39
1982	56	17	27	12	--	--

Allotment	Winter Dates	Winter #'s	Spring-Summer-Fall Dates	Spring-Summer-Fall #'s
Alder Creek	11/01 - 03/31	10	04/01 - 11/30	11
Upper Elbow			04/01 - 12/15	30
Beaverland Pass	07/15 - 03/15	15		
Arco Peak				
King Spring			04/01 - 10/31	10
Serviceberry			04/01 - 10/31	25
Deadman	12/01 - 03/31	100	04/01 - 11/30	40
Blizzard			05/01 - 10/31	9
Dry Fork			05/01 - 10/31	13
Judd Brown	11/01 - 03/31	30	04/01 - 11/01	7
North Lava Craters			05/01 - 10/31	9
Crawford Canyon				
Marsh Canyon	11/01 - 03/31	10	04/01 - 10/31	5
Waddoups-Cherry Creek	11/01 - 03/31	10	04/01 - 10/31	37
Earl Smith	11/01 - 03/31	10	04/01 - 11/30	18
Sheep Mountain	11/01 - 03/31	20	04/01 - 11/30	18
Leslie Buttes	11/01 - 03/31	10	04/01 - 11/30	7
Beck Canyon	11/01 - 04/30	25	05/01 - 10/31	3
Newman Canyon	11/01 - 04/30	25	05/01 - 10/31	19
Sorrenson	11/01 - 04/30	50	05/01 - 10/31	3
Harper Point	11/01 - 04/30	25	05/01 - 10/31	6
Dry Canyon				
Mahogany	11/01 - 04/30	100		
McGee-Berry Canyon			05/01 - 10/31	19
Hammond Canyon			05/01 - 10/31	3
Techick Canyon			05/01 - 10/31	6
Latham Hollow-Timber Mountain Basin			05/01 - 10/31	19
Champagne Creek SW			05/01 - 10/31	5
Chicken Creek			05/01 - 10/31	6
Trail Creek			05/01 - 10/31	19
Goodman Canyon				
Appendicitis Hill			05/01 - 10/30	6
Aikele	11/04 - 04/30	10	05/01 - 10/31	6
George	11/01 - 04/30	10	05/01 - 10/31	6
Nickles	11/01 - 04/30	15	05/01 - 10/31	15
Bliss	11/01 - 04/30	5	05/01 - 10/31	5
Stoddard			05/01 - 10/31	3
Era Flat	11/04 - 04/30	30	05/01 - 10/31	22
Rocky Canyon			04/01 - 10/31	3
Lower Elbow	07/15 - 03/15	35	03/16 - 07/14	10
Champagne Creek NE			05/01 - 10/31	3
Huggins	11/04 - 04/30	25		
Martin			05/01 - 10/31	9
Leslie Buttes				
Arentson Gulch			04/01 - 10/31	50
Dickey	11/01 - 03/31	30	04/01 - 10/31	100
Whiskey Springs	11/01 - 03/31	500	04/01 - 10/31	50
Mackay	11/01 - 03/31	70	04/01 - 10/31	120
Asay			04/01 - 10/31	30
Copper Basin	11/01 - 03/31	600	04/01 - 06/30	200
			07/01 - 10/31	75
Boone Creek	11/01 - 03/31	350	04/01 - 06/30	150
			07/01 - 10/31	75
Wildhorse	11/01 - 03/31	150	04/01 - 10/31	150
Sage Creek			04/01 - 06/30	100
			07/01 - 10/31	25
Thousand Springs			04/01 - 10/31	50

due to past range alteration projects for sheep and cattle (Autenreith and Connelly 1985). Severe weather and water availabilty may occasionally compound these factors.

The highly mobile nature of antelope makes it difficult to predict seasonal distribution. Most antelope winter in the Bureau Mackay Planning Unit in the upper valley basin north of Mackay Reservoir. Summer range is located on Bureau lands and the Challis National Forest. Table 4 indicates antelope seasonal distribution by Bureau cattle allotments for forage allocation. Estimates were based on field observations by Fish and Game and Bureau personnel and represent averages of seasonal use which are likely conservative (Bureau of Land Management 1983). Above Mackay Reservoir concentrated use occurs in the Swenson Butte and Barton Flat area. Although the upper canyon reaches of the Big Lost River Valley provide summer range for an estimated 500-1,000 antelope, small scattered herds use the Chilly-Barton Flat area during this period (personal observation). Fawning areas, which are critical to fawn survival and ultimately production, are* directly related to habitat quality. The abundance of nutritious forage during the spring prior to and following parturition, plus the quality and abundance of security cover are of major importance (Autenreith 1978). Crucial winter ranges and fawning areas vary according to weather conditions. Antelope are highly mobile and some areas outside these boundaries may be used during some years. The map in Appendix C shows locations of known winter and fawning areas.

Riparian zones are key areas for antelope, particularly during summer months. Range lands maintaining high pronghorn numbers have water available every one to four miles (Yoakum 1980). Pronghorns use water from all sources, e.g., springs, streams, lakes, water catchments, metal troughs, and snow. In Oregon, Herrig (1974) reported that distance to water for all summer observations of antelope was less than one mile. When succulent forage is available, one quart of water per day appears sufficient, during dry summers 1 to 1 1/2 gallons a day may be needed (Sunstrom 1968, Beale and Smith 1970).

Antelope are highly dependent on sagebrush communities within the project area. Sagebrush is a key species that provides forage at critical times of the year and security cover for fawns. Sagebrush communities that provide a mix of grasses, forbs, and shrubs are preferred based on food habit studies. Forage preferences are greatest for succulent forbs in the spring and summer and may have a direct bearing on fawn production (Autenreith 1978). Good (1977) reported pronghorn movements from dry rangelands to intermittent lake beds seeking abundant succulent forbs. A similar finding was noted on the U.S.

decrease in fall, and grasses are least important except as spring forage. Utilization of domestic crops is important locally (i.e. alfalfa, wheat), particularly in winter and spring (Cole and Wilkins 1958). Loss of sagebrush communities can severely reduce the potential of an area to support antelope as follows:

* reduction of cover in fawning areas can increase predation of fawns, thus reducing productivity.

* quantity and quality of winter range areas will be reduced by loss of critical winter forage and security cover.

* Elimination of expanses of sagebrush by agricultural or related land use practices can alter or block migration routes.

Antelope Hunting Pressure and Economic Value

A total of 215 permits was issued for the 1986 controlled antelope hunts in units 450-1, 450-2, and 450-3 which encompasses the Big Lost River Valley. Based on telephone surveys of permittees, 210 hunters harvested 190 animals for an average success rate of 86.6% (Nelson 1987). Table 5 summarizes data collected from this survey. Table 6 shows the summary results from previous annual surveys. Antelope that were harvested from the Big Lost Valley were estimated to be about 7.5% of the state-wide estimated harvest and provided approximately 5% of the total estimated days hunted. Harvest will be increased in these units by about 33% through the 1985 - 1990 five year period. The harvest goal by 1990 is 300 animals and 650 hunter days (Autenreith and Connelly 1985). Table 7 outlines the past and present status and 1990 objectives. The 1987 antelope hunting regulations show an increase to 255 permits (area 450-2 increased by 45 permit450-3) issued for the area. The harvest rate will remain low to provide low density, high quality hunts with an opportunity to harvest large bucks. Populations are stable and significant growth is not expected during the planning period. Data collection will be minimal in these units due to light harvest, minimal depredation problems, and budget constraints (Autenreith and Connelly 1985).

Table 5. 1986 antelope harvest information for the Combined Big Lost hunting units (from Nelson 1987).

Harvest	Mean Percent Males	Hunters	Mean Percent Success	Mean Days / Hunter	Total Days
190	83	210	86	1.5	323

Big Lost hunting units (taken from Trent et al. 1986).

Hunt Number	Year	Permit	Total Harvest	Percent Males	Percent Success
450-1	1978-1982 mean	130	115	78	88
	1983	130	118	76	90
	1984	130	108	86	83
	1985	130	125	84	96
	1986	130	119	89	92
450-2	1978-1982 mean	40	33	89	84
	1983	40	33	88	82
	1984	40	34	59	85
	1985	40	39	95	97
	1986	40	32	87	81
450-3	1978-1982 mean	45	35	78	77
	1983	45	41	85	92
	1984	45	37	76	82
	1985	45	42	77	93
	1986	45	39	73	86

Table 7. Past and Present Status and 1990 Objectives for the Big Lost Antelope Hunting Units (adapted from Autenreith and Connelly 1985).

Year	Preseason Population Estimate	Harvest	Hunter Days	Days/Animal
1981 est.	2,400	205	850	4.1
1985 goal	2,675	415	1,700	4.1
1985 est.	2,500	200	500	4.1
1900 goal	2,500	300	650	4.1

The net benefit to society for hunting antelope in Idaho is estimated at $234,000 (Loomis et al. 1985). An average value per hunting permit and per hunting day for Idaho was $73.31 and $38.58, respectively. The net willingness-to-pay for antelope hunting in all three Big Lost hunting units was $104, or $31 over the average net willingness-to-pay per permit. Caution is needed with assigning values on antelope since they refer only to hunting activity. The value per animal may be misleading because the animal provides other benefits beyond just hunting.

Mule deer winter range occurs primarily on public lands throughout the valley. Winter range appears to be the major limiting factor to Big Lost deer production. Agriculture has infringed upon wintering distributions of deer and present range circumscribes the valley bottom where most development exists (see map Appendix D). Early accounts indicate there were many more deer on the east side of the valley prior to settlement in the Mackay to Arco area. During the winter of 1963, 1,000 deer died of malnutrition on Leslie Butte and again in the early 70's. Development has apparently prevented deer from migrating across the valley to the east side where abundant forage and cover are available (personal communication, Russ McFarling, Wildlife Biologist, Bureau of Land Management). Fish and Game identified the following specific issue in their 1986 - 1990 mule deer management plan, "the unusable historical winter range on the northeast side of the Big Lost Valley because the migration route across the valley floor has been disrupted by ranches, farms, fences, and roads." At present mule deer populations in unit 50 appear to be near carrying capacity (about 4,000 deer) due to limited winter range (Trent et al. 1985).

Population estimates for unit 50 in 1981 and 1985 were 3,900 and 4,000, respectively. The Bureau (Bureau of Land Management 1982) reported 1,000 deer winter from Harger Point to Antelope Creek in the Appendicitis Hills and 750 winter on the canyon and ridges surrounding Sheep Mountain. An estimated 100-150 deer continue to winter on Leslie Butte despite poor range condition and mild winters. Another 100 deer may winter on the south side of Antelope Creek in the foothill range east of the proposed damsite in the Appendicitis Hills.

Most deer summer in higher elevations on Bureau and U.S. Forest Service (Forest Service) lands on higher quality range west of the Big Lost River Valley. Some resident (yearlong) deer occur in the valley bottom and are associated with the riparian zone (Trent et al. 1985) and adjacent sagebrush range lands.

The primary use by mule deer in the valley is wintering. Severity of weather determines actual winter numbers. Surveys south of Mackay estimated winter populations of 987 in 1970, 1,876 in 1973, 1,323 in 1979, and 787 for the more normal winter in 1980. Since aerial surveys are subject to many biases, these estimates are probably conservative (Caughley 1974). Crucial winter habitat is extensive in the Big Lost Valley (Appendix C). A general perspective of seasonal use by mule deer can be ascertained by examining relative abundance in Bureau grazing allotments presented in Table 8 (Bureau of Land Management 1983).

Allotment	Winter Dates	Winter #'s	Spring-Summer-Fall Dates	Spring-Summer-Fall #'s
Alder Creek	12/01 - 03/31	75	04/01 - 11/30	25
Upper Elbow	10/01 - 03/31	25		
Beaverland Pass	12/01 - 03/31	30		
Arco Pass	12/01 - 03/31	40	04/01 - 12/15	40
King Springs	12/16 - 03/31	50	04/01 - 12/15	10
Serviceberry	12/16 - 03/31	30	04/01 - 12/15	15
Deadman	12/16 - 03/31	40	04/01 - 12/15	20
Blizzard			04/01 - 11/30	30
Dry Fork			04/01 - 11/30	35
Judd Brown	12/15 - 03/31	100	04/01 - 12/15	10
North Lava Craters			04/01 - 07/31	125
Crawford Canyon	12/15 - 03/31	10		
Marsh Canyon	12/01 - 03/31	150	04/01 - 11/30	15
Waddoups-Cherry Creek	12/01 - 03/31	100	04/01 - 11/30	50
Earl Smith	12/01 - 03/31	50		
Sheep Mountain	12/01 - 03/31	200	04/01 - 11/30	25
Leslie Buttes	12/01 - 03/31	50	04/01 - 11/30	5
Beck Canyon	12/01 - 03/31	5	04/01 - 11/30	5
Newman Canyon	12/15 - 03/31	25		
Sorrenson				
Harger Point	12/15 - 03/31	110	04/01 - 12/14	10
Dry Canyon				
Mahogany	12/15 - 03/31	115	04/01 - 12/14	5
McGee-Berry Canyon	12/15 - 03/31	185	04/01 - 12/14	10
Hammond Canyon			04/01 - 11/30	5
Techick Canyon			04/01 - 11/30	25
Latham Hollow-Timber			04/01 - 11/30	5
Mountain Basin				
Champagne Creek SW			04/01 - 11/30	3
Chicken Creek				
Trail Creek	12/01 - 03/31	10	04/01 - 11/30	10
Goodman Canyon	12/15 - 03/31	150	04/01 - 12/14	15
Appendicitis Hills	12/15 - 03/31	370	04/01 - 12/14	20
Aikele				
George				
Nickles				
Bliss				
Stoddard				
Era Flat				
Rocky Canyon	12/15 - 03/31	25		
Lower Elbow	12/01 - 03/31	5		
Champagne Creek NE				
Huggins	12/01 - 03/31	5	04/01 - 11/30	5
Martin				
Leslie Buttes	12/01 - 03/31	25	04/01 - 11/30	5
Arentson Gulch	12/01 - 03/31	25		
Dickey	12/01 - 03/31	20		
Whiskey Springs	12/01 - 05/31	400		
Mackay	12/01 - 05/31	600		
Asay	12/01 - 04/30	25		
Copper Basin	12/01 - 04/30	400	05/01 - 06/30	200
			07/01 - 09/30	50
			10/01 - 11/31	200
Wildhorse			06/01 - 12/01	50
Sage Creek			06/01 - 12/01	40
Thousand Springs	12/01 - 03/31	75		
Boon Creek	12/01 - 04/30	20	05/01 - 11/31	20

(*Cercocarpus ledifolius*) sites. Sagebrush stands also received use. The 1980 winter transect readings in mountain mahogany stands averaged 19 days per acre and sagebrush two days per acre (Bureau of Land Management 1982). These figures are relative use estimates and do not necessarily reflect habitat preferences.

Fecal analysis results from the Appendicitis Hills area showed higher amounts of mountain mahogany in deer diets, followed by sagebrush and bitterbrush (*Purshia tridentata*) respectively. Browse was the principle forage with forb use contingent on availability. The most frequently occurring forbs were Lupine (*Lupine* spp.) and buckwheat (*Eriogonum* spp.). Grass was negligible in the diet. Sagebrush in the diet increased steadily through the winter as bitterbrush and mountain mahogany became less available. Peterson (1984) examined the literature on the value of sagebrush as forage for mule deer and concluded that it is nutritional and digestible. Furthermore, sagebrush is a key component in providing a nutritional plane sufficient for over-winter survival.

In the Chilly/Barton Flats area of the upper valley, sagebrush is the dominant vegetation type and may receive significant utilization. In addition, extensive tracts of crested wheatgrass (*Agropyron desertorum*) have been planted on the flats which may be an important late winter forage for mule deer, particularly during critical periods (Leckenby 1968, Leckenby and Toweill 1983).

Leckenby et al. (1982) alluded to the importance of riparian zones for mule deer. In arid range lands the only permanent or seasonal water is found in spring areas, along stream courses, or in ephemeral moist areas. They often enclose the most vegetationally productive sites found over long distances and provide a diversity of plant species that are especially valuable for fawn-rearing, summer and winter thermal cover, and late season forage. Sheehy (1978) found that riparian vegetation was contained within every home range of fawns he observed. In southeastern Oregon mule deer, livestock, and people compete for resources in riparian zones more than any types of communities (Leckenby 1982).

Migratory movements between summer and winter ranges are often characteristic of mule deer herds (Zalunardo 1965, Robinette et al. 1977). Timing of migration and the area used by adults may be traditional and vary widely between individuals (Mackie and Knowles 1982). Griffith (1983) reported mid-summer migrations of Craters of the Moon mule deer were related to water availabilty and possibly other factors. In late July some of these deer migrated north of the highway into the Timbered Dome and Appendicitis Hills area south of Antelope Creek. Migratory routes the Big Lost River corridor towards Chilly Buttes and onto the foothills of the Lost River Range below Borah Peak.

* northerly movement from Copper Basin and the White Knob Mountains over Barton Flats crossing the Big Lost River near Chilly and onto the foothill range of the east valley.

* northeasterly movements from the White Knob Mountains crossing the valley immediately above Mackay Reservoir onto the Cedar Creek Bar.

* northeasterly migration from the White Knob Mountains crossing just below the Mackay Reservoir Dam at Mackay Narrows and onto the Cedar Creek Bar.

Migration routes to the east side are blocked in the remaining lower valley due to various land uses related to agricultural development. Deer winter range extends from Cherry Creek to Alder Creek with heaviest concentrations occurring in the Marah Canyon to Leslie Butte area. Deer movements have been observed crossing Antelope Creek in a north-south direction in the vicinity of the proposed damsite. Deer then disperse onto the perimeter foothill range of Appendicitis Hills (personal communication, Terry Williams, Conservation Officer, Fish and Game). Other than some tagging studies completed in the early 1970's, little research has been done with regard to deer movements in the region.

Mule Deer Hunting Pressure and Economic Value

Nelson (1987) reported the 1986 general deer season hunt in unit 50 resulted in a harvest of 899 deer (95% mule deer), 75% were bucks. An estimated 1,863 hunters were afield for approximately 8,006 days for a success rate of 48%. Days per hunter averaged 4.3 and animals seen per day 6.5.

In the mid-70's estimates of average expenditures, excluding licenses and the value of the meat, were $100 - $300 per year for equipment, supplies, food, and other services (Prenzlow et al. 1974, Ross et al. 1975). Donnelly and Nelson (1986) investigated the net economic value of deer hunting in Idaho. This value was considered to be the value to the hunter and to society and to be interpreted as the amount an average hunter is willing to pay above actual expenditures to continue to have these sites available for deer hunting in Idaho. Average net willingness-to-pay in 1982 was estimated at $50.23 per trip. For hunting unit 50 this value equalled $39.91 or a total net willingness-to-pay of $1,669.26 for all hunting trips. Actual cost estimates, which are probably more accurate for the unit, were $45.48 and $1,931.28, Elk populations in the Big Lost River Valley have increased significantly in the last 15 years. Fish and Game 1970 winter trend counts estimated 50 elk in unit 50 and by 1982 this number reached 578. Variance may be due to severity of weather during the winter periods. Population estimates in 1985 were 500 animals and is expected to increase in unit 50 to 600 by 1990 (Toweill et al. 1985).

Elk that may be impacted by the proposed projects winter in the foothill range of the Appendicitis Hills south of Antelope Creek. This area overlaps with mule winter range (see map Appendix E). Aerial survey estimates of elk in the area were 64, 104, and 137 for 1978, 1980, and 1982, respectively (Bureau of Land Management 1982). Elk use the open slopes from Rocky Canyon to Antelope Creek. Elk have been observed migrating from Copper Basin southeast across Antelope Creek into the Appendicitis Hills (personal communication, Terry Williams, Conservation Officer, Fish and Game). Vegetative sites utilized by elk include mountain mahogany and sagebrush-grass stands. Fecal analysis to determine elk food habits showed that diets consisted of 11% shrubs, 72% forbs, and 17% grass for the month of December. The winter range conditions at present are sufficient to maintain elk production despite pressure on forage supplies from deer and livestock. However, winter range could become a limiting factor to elk.

Data on Big Lost elk is lacking. More information is needed with respect to population size and recruitment, habitat use, migration routes, and seasonal distributions. Carrying capacity of the winter ranges should be determined in order to tailor harvest strategies for control of population levels.

Elk Hunting Pressure and Economic Value

Regulated hunts have been in effect since the early 70's. The number of permits issued for unit 50 has increased from the 1973 level of 60 to 175 in 1985. Average success was 47% for the 13 year period. The total number of elk harvested from unit 50 was 620 and most were bulls (83%). In 1986 175 permits were issued and 168 hunters harvested 101 elk, 73% were bulls. This was the highest number of elk taken from this unit. Success rate was 58%. Hunter days totaled 938 or 5.6 days per hunter (Nelson 1986).

The economic impact of elk hunting in Idaho is that of a major industry (Toweill et al. 1985). Sorg and Nelson (1986) estimated a Wildlife and Fish User Day in 1982 at $100. There were 77,073 elk hunters that hunted 386,221 days and spent an estimated $10 million or more in Idaho in 1982. Most of this money was distributed in small communities throughout the state (Toweill et. al. 1985). The average total cost per hunter trip for unit 50 was $295. Using 1986 data, an estimated $50,000 was spent to hunt

Historically, bighorn sheep inhabited the Lost River Range, but were believed to have been eliminated in the early 1900's. Bighorn sheep populations have been reestablished through a trapping-transplanting program. The Borah Peak herd began with transplants in 1969 and 1970. It ranges in units 37, 50, and 51. A total of 31 sheep were released and presently numbers approximately 300 animals (Parker and Scott 1985). This herd summers north of Doublesprings Road, but there is no indication of having become reestablished in the north portions of the Big Lost River range (Trent and Naderman 1986a). Incidental observations of sheep occurred in the upper valley near the Chilly/ Barton Flats area (personal communication, Terry Williams, Conservation Officer, Fish and Game) and on Bureau lands near Jaggles Canyon during the winter. Forty-five bighorn sheep were released in Elbow and Jaggles Canyons in 1978 and 1980, respectively. As the population increases in the Lost River Range, it's likely bighorn sheep will expand their range and may eventually establish seasonal movements across the valley to the west side or come down to foothill areas to winter. Further development in the valley may discourage this expansion or the potential use of lower elevation winter range.

Other Mammals

The Big Lost Valley, although not adequately inventoried for wildlife species, provides habitats for a variety of mammals. Major mammalian predators are coyotes (Canis latrans), skunks [spotted skunk (Spilogale putorius) and striped skunk (Mephitis mephitis)], weasels (Mustela frenata but more commonly Mustela ermines), badger (Taxidea taxus), bobcat (Felix rufus), mountain lion (Felis concolor), and possibly red fox (Vulpes vulpes) (Fichter and Williams 1967). Species that inhabit wetlands and riparian strips are muskrat (Ondatra zibethica), beaver (Castor canadensis), deer mice (Peromyscus spp.), voles (Microtus spp.), and (Eutamias spp.) tree squirrels (Sciurus spp., Tamiasciurus hudsonius, and Glaucomys sabrinus). Other less common, but aquatic dependent species are the water shrew (Sorex palustris), mink (Mustela vison), and river otter. Mammals of sagebrush steppe habitats consist of sagebrush voles (Lagurus curtatus), bats [eg. pallid bat (Antrozous pallidus) and Myotis spp.], pocket mice (Perognathus spp.), deer mice, ground squirrels (Spermophilus spp.), and rabbits [eg. pygmy rabbit (Brachylagus idahoensis), nuttal's cottontail (Sylvilagus nuttalli), and black-tailed jackrabbit (Lepus californicus)].

Sage Grouse

Call (1979) reported that "no other bird is so habitat specific to one particular plant type in meeting its annual life requirements." Sage grouse is, and will continue to be, inseparably associated with sagebrush-grassland plant communities. More than 90% of all sage grouse nests are located under or adjacent to sagebrush plants; they feed almost exclusively on sagebrush leaves during winter (Call 1979) and use big sage cover for loafing and security (Autenreith 1981).

Sage grouse range throughout the Big Lost Valley (see map Appendix F). In 1980 15 documented active leks were located within the Big Lost-Mackay Grazing Environmental Impact Statement project area (310,962 acres of public lands encompassing the Big Lost River Valley) by Bureau personnel, but more leks probably exist (Bureau of Land Management 1983) (see Appendix F). Roadless areas could not be covered adequately during lek searches. Sage grouse densities in Antelope Creek indicated strutting was probably occurring but leks were not observed. Open areas of low vegetation or disturbed sites (i.e. burned areas, dry lake beds, cleared roadsides ...) are typical breeding habitats, and are often located near water (Call 1979).

Winter habitat for sage grouse is closely tied to strutting grounds. Limited observations suggest low sagebrush is preferred until snow is too deep, then sites containing mountain big sagebrush receive more use (Bureau of Land Management 1982). Sage grouse wintering and nesting habitat in the Big Lost Valley may be limited as a result of range conversion to seeded crops (i.e. crested wheatgrass). Further conversions of native habitat may be detrimental to the quality of sage grouse habitat (Bureau of Land Management 1982).

Nesting habitat for sage grouse is directly related to the characteristics of sagebrush. Concealment is the basic requirement of nesting cover. In Montana nests that were located in greater than average canopy coverage and height were more successful (Wallestad and Pyrah 1974). Nest sites are typically located within two miles of a strutting ground (Call 1979). Autenreith (1981) found that with good nesting cover available near the nest, the nesting radius (distance to nearest lek) tended to be less than when cover was sparse. The optimum nest bush would be an older aged plant with an umbrella growth form.

Autenreith (1981) reported that sage grouse in Idaho begin moving from watering areas to their traditional strutting grounds in occurred in the first two weeks of June (Trent and Naderman 1986b). Brood movements varied, some went long distances to higher elevations, while others moved shorter distances to wet meadows and irrigated alfalfa fields. Nonmigratory broods that remained on lower elevation xeric ranges depend on springs and stream meadows throughout the summer. Riparian zones are key components for these birds since the only source of succulent vegetation is found there.

Some data on brood movement in the valley is available, but generally limited. Broods have been observed moving out of the Chilly-Barton Flat area and into the western foothill ranges (personal communication, Terry Williams, Conservation Officer, Fish and Game). Autenreith (1981) monitored three broods near Barton Flats and reported average daily moves of .3 miles. Movements appeared random. Two hens shifted slightly to higher elevations while a third hen showed no elevation change and used the brood rearing habitat along a canal meadow for the summer. Longer movements took place as the broods grew older. Traditional use of certain areas was noted; arrival time varied since it was closely tied to forb and insect availability.

Sage grouse is the most important game bird in the Upper Snake. The region shares similar management problems with other parts of the state. Since 1981 regional data collected from lek counts indicated a declining population from the ten year average (Table 9). Production appears low and may be related to weather conditions during the brood period since this estimate is highly variable year to year (Table 9). Harvests in recent hunts are about 27% below the ten year mean (Table 9).

Table 9. Comparison of sage grouse harvest index, population index, and production index for the Upper Snake Region, 1976-1985 (adapted from Trent and Naderman 1986c).

Year	Harvest Index	Population Index	Production
1976	4,623	2,194	362
1977	4,028	2,428	193
1978	6,671	2,252	327
1979	6,403	2,224	229
1980	3,222	2,122	139
1981	3,932	1,461	227
1982	2,580	759	152
1983	1,512	688	341
1984	994	1,089	216
1985	2,669	1,297	254

In 1979, 32,124 hunters spent 80,944 days hunting sage grouse for a statewide record harvest of 92,600 birds. In 1985 Idaho sage grouse hunters had a success rate of 2.2 birds/hunter and spent approximately 16,000 hunter days afield. In Region 6 hunter opportunity and harvests have fluctuated with population levels (Table 9). The success rate (birds/hunter) goal for the five year period 1986-1990 set by Fish and Game equalled 1985's, the hunter day goal is approximately 60,000 days, and the harvest goal is 65,000 birds (Rybarczyk et al. 1985). Fish and Game estimated that sage grouse hunters spend over $1 million annually during opening weekend of sage grouse season (Rybarczyk et al. 1985).

Mourning Doves (Zenaidura macroura)

Doves occupy nearly all habitats in Idaho, but riparian areas are especially important since the highest densities of nest sites tend to occur in dense vegetation near water. Production is high in Butte and Custer Counties and high densities are common, particularly in late summer, when migrants join resident populations. The 1979 preseason population for Region 6 was estimated at 375,000 doves. The long term trend counts for doves nationwide is declining, presumably due to habitat loss. The only habitat issue identified in Idaho by Fish and Game (Rybarczyk et. al. 1985) for this species was specifically the loss of riparian and other nesting habitats because of land clearing and other activities. As a result management direction in the future will be toward maintaining existing habitats and creating additional habitat, especially nesting sites.

Dove hunters in Region 6 enjoy a high success rate of about 15 birds/day. Dove hunting near Arco is popular. Butte County reported the 1980 and 1981 harvest estimate at 5,008 and 13,004, respectively. Hunter harvests appear directly related to hunters afield, but, in general, statewide harvests are low since most doves migrate south prior to opening of the season (Rybarczyk et al. 1985). The Service establishes harvest seasons within which states may impose more restrictive hunts. Idaho will continue to adopt a liberalized season (daily bags of 15 birds/hunter) to provide more opportunity to harvest doves that have not migrated from the state (Rybarczyk et al. 1985).

Upland Game Economic Value

An economic study on the value of upland game hunting in Idaho determined an average net value of $28.50 per day above expenditures (Rybarczyk et al. 1985). The total net value in 1983 was almost $24 million and in 1984 $18 million. As bird populations fluctuate, the total economic contribution from upland game hunting fluctuates. In years of high populations, numbers of hunters increase sharply. The high year of 1981 produced over

Populations of waterfowl inhabiting the Big Lost River have not been adequately inventoried. Available information suggests the river and tributaries (Antelope Creek and Alder Creek) provide nesting and rearing habitat for a significant number of waterfowl (Bureau of Land Management 1982). Thousands of waterfowl migrate through the area seasonally. Most wetlands occur on private land and are limited in extent. Consequently, protection of wetland habitat is vital to production of local waterfowl and for resting and feeding of migrants. Mallards (_Anus platyrhynchos_), teal (_Anus_ spp.), gadwal (_Anus strepera_), and goldeneye (_Bucephala_ spp.) are produced on the Big Lost River (Bureau of Land Management 1982). Large populations of Canada geese (_Branta canadensis_) migrate through the valley annually while a smaller number reside yearlong in the wetlands near Arco. Goose production also occurs in the privately owned wetland habitat above Mackay Reservoir (personal communication, Terry Williams, Conservation Officer, Fish and Game).

An area rich in waterfowl, Thousand Springs Valley, occupies the uppermost portion of the Big Lost basin immediately north of the Big Lost River near Chilly (see figure 2). Thousand Springs Creek drains this upper watershed and feeds into the Big Lost River entering at the southern boundary of the valley. About 6,000 acres of highly valued wetland-riparian habitat is contained within the valley. Bird species total 113, of which 62 are waterfowl and shorebirds. A proposed reintroduction site for the reestablishing peregrine falcons (_Falco peregrinus_), a federally listed endangered species (listed under the Endangered Species Act), in Idaho is proposed for Thousand Springs Valley (personal communication, Rich Howard, Service, Boise Field Office). Trumpeter swans (_Olor buccinator_), sandhill cranes (_Grus canadensis_), bald eagles (_Haliaeetus leucocephalus_) (Federally listed as endangered under the Endangered Species Act), and nesting long-billed curlews (_Numenius americanus_) (a Federal candidate species) frequent the area at various times of the year. The value of this wetland complex cannot be underestimated. An estimated 157 fish and wildlife species utilize this valley.

Since the valley is integral to the Big Lost River drainage system, potential exists for wildlife inhabiting this zone to overlap into other parts of the basin. This would be particularly true for highly mobile species such as birds. Should waterfowl concentrations increase and breeding habitat diminish, many species may disperse to areas along the Big Lost River corridor, particularly to extensive wetland habitats like that found above Mackay Reservoir. Potential exists for waterfowl populations to expand, especially in the upper Big Lost River region, provided the existing wetlands are protected or new wetlands created.

At least 33 species of birds of prey, and the turkey vulture (*Cathartes aura*) are found in Idaho (Groves and Marks 1985). Raptors inhabit most habitats throughout the state. Many species range over large areas of the Big Lost Valley (see Appendix B). Territory size varies according to species and may be as small as one square mile for an accipiter or as large as 50 square miles for an eagle. Prey distribution, available nest sites, and interference competition between rival species or individuals determine territory size (Eyre and Paul 1973). Investigations are needed to inventory raptor species, nest sites, abundance, territories, and hunting areas.

Representative raptors known to be in the project area at least seasonally include, bald eagles, redtailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), rough-legged hawk (*Buteo lagopus*), Swainson's hawk (*Buteo swainsonii*), ferruginous hawk (*Buteo regalis*), American kestrel (*Falco sparverius*), merlin (*Falco columbaris*), gyrfalcon (*Falco rusticolus*), great horned owls (*Bubo virginianus*), long-eared owl (*Asio otus*), short-eared owl (*Asio flammeus*), and burrowing owl (*Athene cunicularia*). Prairie falcons and golden eagles use the cliffs of the Lost River Range for hunting and nesting (Bureau of Land Management 1982). The valley and desert provide habitats for small mammals which supply a prey base for wintering rough-legged hawks. Wintering bald eagles have been increasing in the valley in recent years (personal communication, Terry Williams, Conservation Officer, Fish and Game). Their winter diet probably consists of carrion, ducks, and rabbits (personal communication, Charles Trost, Dept. of Biological Sciences, Idaho State Univ.).

The riparian zone is highly valuable for many raptor inhabitants along the Big Lost River. The tall cottonwood trees provide the most important vertical diversity and structure for raptors found in the valley. Nesting American kestrels utilize cavities in these trees (personal observation). Great horned owls are common in this zone (personal communication, Terry Williams, Conservation Officer, Fish and Game) and the large trees may provide good nesting habitat for merlins (personal communication, Rich Howard, Service, Boise Field Office). In addition, tall cottonwoods may be good potential nest locations for bald eagles and can serve as perch sites or roost trees for many raptors.

The bald eagle and peregrine falcon are classified as Endangered Species under the Endangered Species Act. The merlin and ferruginous hawk are State Species of Special Concern that likely occur in the project area. Sensitive species that may use the area and are listed under a master memorandum of understanding between the state and Bureau, include Swainson's hawk, ferruginous hawk, gyrfalcon, merlin, and burrowing owl.

communication, James Gore, Service, Boise Field Office).

Water Birds

These birds are associated with water, marshes, wet meadows, and shoreline habitats. Between 90-100 species are distributed throughout Idaho. Most are migratory. They include the following major groups: herons, egrets, ibis, bitterns, cranes, rails, curlews, swans, loons, grebes, pelicans, cormorants, gulls, terns, and kingfishers. The dipper (Cinclus mexicanus) can also be considered in this category. Water birds are extremely valuable for aesthetics, observation, and education. All are protected under the Migratory Bird Treaty Act and Idaho State Law.

Passerine and Other Birds

The variety of plant communities within the riparian areas, sage brush-steppe, and mountain mahogany-juniper vegetation types found in the Big Lost Valley support numerous passerine and other nongame birds. Excellent habitat occurs in the Darlington area for the yellow-billed cuckoo, a rare nesting species in Idaho (Groves and Marks) and Federal candidate species (September 18, 1985, Federal Register, 50 CFR Part 17). To determine if the species was present, a preliminary survey using voice recordings was conducted and resulted in no findings at that time (personal communication, Charles Trost, Dept. of Biological Sciences, Idaho State Univ.). Preferences for certain riparian vegetation types are most prevalent among passerine (perching) birds (Brinson et al. 1981). A total of 115 breeding passerine birds inhabit Idaho (Morache et al. 1985). Representative species include the flycatchers (family Tyannidae), swallows (family Hirundinidae), jays (family Corvidae), larks (family Alaudidae), blackbirds (family Icteridae), warblers (family Parulidae), wrens (family Troglodytidae), sparrows (family Emberizidae), and blue-birds (family Muscicapidae). Additional species are listed in Appendix B. All species, except the European starling (Sturnus vulgaris), house sparrow (Passer domesticus), and rock dove (Columba livia), are protected by the Migratory Bird Treaty Act and/or state law.

Amphibians and Reptiles

Fifteen species of amphibians, 11 species of snakes, 10 lizards, and 1 turtle have been reported in Idaho (Groves and Marks 1985). Species which occur in the Big Lost Valley are listed in Appendix B. The night shade snake (Hypsiglena torquata) is classified a state Species of Special Concern and has been observed near Arco, Idaho (Morache et al. 1985). Relatively little is known regarding this wildlife group. The group has aesthetic,

Future Without Project

Natural processes and man-made alterations have played a direct role in the dynamics of the Big Lost River system. Man-made structures have altered the natural equilibrium of river and groundwater resources by diverting river water for irrigation and pumping groundwater from wells. Increased demands from agricultural interests can be expected in the future. The sinks are a unique feature that affect the availabilty of surface water in the river for a major part of the year. It is reasonable to expect that these processes will continue to affect water in the same way in the future.

Fish and wildlife habitat on, or associated with, private land ownership is expected to change little in the Big Lost River Valley. Nearly all the valley bottom flood plain is privately owned. If significant habitat alterations occur, wildlife populations could be impacted. Ranching operations, residential development, and conversion to agricultural cropland destroys habitats which provides life support requirements for an abundance of species. Grazing has been widespread in the river bottom and contributes to accelerated erosion in the Big Lost River drainage (Jensen 1982). It is reasonable to assume that livestock grazing in the riparian zone will continue. Residential development, although not a rapid growth, is likely to persist as human populations expand, particularly around the small towns located throughout the valley. Agricultural development may expand in parts of the valley, provided more water becomes available for nonirrigated lands. Historically, agricultural expansion has adversely affected wildlife and fish habitats through direct habitat losses by conversion of land uses, diversion of river/stream flows, and barriers to migrating large mammals. Under present conditions, the existing water resources are over-extended. During years of low runoff some irrigated land does not receive a full supply. Riparian zones are productive growing sites that contain available water. Consequently, agricultural expansion into these areas is profitable and was a feature that attracted the first settlers to the region. Conversion of riparian areas into farmland results in direct losses of wildlife habitats, and has had a greater impact on wildlife species than any other land use practice in the Big Lost River Valley. Management of water resources will likely continue to be an important issue for the local economy.

Flooding will continue in those years that have above normal snowpack and sudden runoff. Operations at Mackay Reservoir will offer limited control of downstream flooding since its primary purpose of irrigation storage is likely to remain unchanged. The reaches that typically overflow during floods may be modified by abundance of wildlife species decreases significantly in these areas. Further impacts causing loss of habitat quality can be significant for those species inhabiting this zone. Fish habitat may also undergo periodic changes that result from erosion and channelization. Aggradation and degradation of riverine habitat will affect the quality of available fish habitat. Presently, high quality fish habitat is in short supply and because accelerated bank erosion is anticipated, further reduction can be expected.

Degradation of water quality, because of erosion, persevere in the upper reaches of the Big Lost River above Mackay Reservoir. Gabions installed on a high sluffing bank in 1981 were washed out by spring of 1987 (personal observation). Erosion will continue to increase sedimentation in Mackay Reservoir.

Management directions for fisheries on sections of the Big Lost River are reported in the Fish and Game Fisheries Management Plan 1986-1990 (Moore et al. 1986). Wild populations of rainbow and brook trout will be maintained in upstream reaches from Chilly. In heavy use areas fish populations will be supplemented with hatchery rainbow trout to maintain catch rates of 1.0 fish/hour. A similar strategy is planned for the reach from Mackay Dam to Moore; a put-and-take fishery in areas of intense effort and poor habitat in order to maintain catch rates of 1.0 fish/hour. Reaches from Moore to the INEL boundary will continue to be a put-and-take fishery for rainbow trout due to dewatering. The catch rate goal is .5 fish/hour. Additionally, a brown trout (Salmo trutta) fishery is planned through introduction of fingerlings. A put-and-take rainbow trout fishery will be maintained in Mackay Reservoir with planned catch rates directed toward 11" fish at .6 fish/hour. Stocked catchable trout are intended to offset years of fingerling loss due to drawdown. Since the vast majority (93%) of Idaho anglers prefer coldwater fisheries and supply 82% of the fishermen days expended, Fish and Game has set as their highest priority over the next five years, the preservation of stream habitat and management of stream fisheries. Future programs identified by Fish and Game addressing specific problems in the Big Lost River system include:

* Creel census and fish population surveys to determine angler use, harvest, fish abundance, and fish distribution.

* Identify overgrazed areas and damaged riparian habitat and develop programs, along with appropriate federal agencies, to halt the trend in habitat losses.

* Determine the need to change the yearlong fishery season to a closed fishery during February through May to prevent overharvest of mature spawning rainbow trout; and, identify

in the Big Lost River Valley. The Bureau states that the preferred alternative identified in the Big Lost-Mackay Final Grazing Environmental Impact Statement (Bureau of Land Management 1983) is designed to maintain or improve wildlife habitat quality or to mitigate adverse impacts to an acceptable level. However, important environmental consequences under this plan would have to be studied in order to determine the benefits to wildlife inhabiting the project area.

The Appendicitis Hills and White Knob Mountains have been evaluated for designation as wilderness areas, partial wilderness, or nonwilderness (Bureau of Land Management 1986). Both units encompass important winter range for big game wintering in the Antelope Creek drainage. Changes in habitat quality of this range are contingent on which alternative Congress accepts, since habitat management practices would be affected on these lands. Livestock grazing, which is recognized by Congress as an acceptable activity within wilderness areas, would likely continue under existing plans or under the Bureau's preferred alternative design.

In antelope habitat Fish and Game intends to urge the Bureau to inter-seed forbs and shrubs in some old seedings and include forb and shrub seeds in new seedings (Autenreith and Connelly 1985). Harvest will be increased in these units by about 33% through the 1985-1990 five year period. The harvest goal by 1990 is 300 animals and 650 hunter days (Autenreith and Connelly 1985). Table 7 outlines the past and present status and 1990 objectives. The 1987 antelope hunting regulations show an increase to 255 permits (area 450-2 increased by 45 permits) issued for the area. The harvest rate will remain low to provide low density, high quality hunts with an opportunity to harvest large bucks. Populations are stable and significant growth is not expected during the planning period. Data collection will be minimal in these units due to light harvest, minimal depredation problems, and budget constraints (Autenreith and Connelly 1985).

Because mule deer winter range is limited in unit 50 and populations are near carrying capacity, Fish and Game management strategy will be to encourage federal agencies administering these lands to minimize the impacts of late fall grazing and improve the quality of existing deer winter range. Harvest goals for 1990 are 600 deer and 9,000 hunter days or 15 hunter days/ mule deer (Trent et al. 1985). The population is expected to remain at 4,000 deer. Seasons will be designed to maintain a minimum post-season count of 15 bucks / 100 does and/or 65% yearlings in the male harvest. The general season will be 26 days long for antlered deer only and five days long for antlerless deer.

Fish and Game harvest goals by 1990 are 80 elk and 900 hunter days or 11 days per elk . Hunting seasons will continue to be controlled hunts due to the high vulnerability as evidenced by last year's harvest which exceeded the 1990 harvest goal by 21 elk. Management direction will be to increase hunter opportunity for antlerless elk and maintain a post-season bull:cow ratio at or about 20:100, and a minimum 20% harvest of mature bulls (six points on at least one side) (Toweill et al. 1985).

The bighorn sheep population for unit 50 is expected to increase to 400 by 1990 (Parker and Scott 1985). Management efforts will be directed toward population assessments, inventoring of new release sites for transplanted sheep, and, if feasible, increasing hunting permits to about 30 by 1990 (Parker and Scott 1985).

Future statewide Fish and Game goals for sage grouse management in Idaho are: 1) slow the rate of habitat loss, 2) encourage land managers to protect and enhance habitats, 3) maintain populations, and 4) increase harvest to provide more recreational opportunity (Trent and Naderman 1986). Management in Region 6 will be directed toward determining the factors influencing production and the resulting effects in population trends (Trent and Naderman 1986b). Several biological and habitat issues were identified by Fish and Game concerning sage grouse in Region 6 (Rybarczyk et al. 1985). Those issues that directly relate to the proposed projects in the Big Lost are as follows:

* Migration routes can be blocked by changes in land use.

* Loss of sagebrush through land treatment projects is detrimental to sage grouse.

* Lack of water, especially during seasonal drought periods, limits distribution and possibly abundance of sage grouse.

* Sage grouse use traditional leks and nesting areas, and loss of associated nesting habitat is detrimental to this species.

* Not all sage grouse breeding areas have been identified and some change over time, therefore, it is difficult to assist land management agencies in protecting sage grouse habitats.

Little change is expected in the short term for other wildlife populations and habitats if conditions continue as they are at present. Long term effects could occur as a result of the persistent downward trend in range conditions in upland and riparian areas. Impacts to terrestrial wildlife and wildlife habitats from continued water quality degradation due to erosion

Site specific data for the alternatives being considered is limited for most fish and wildlife species. Information concerning sage grouse leks, antelope fawning and wintering areas, mule deer habitats, elk wintering areas, and migration routes for these key species can be considered preliminary. Most wildlife species are mobile, some use transient areas, others move randomly following availability of food sources. Relationships of nonsedentary wildlife habitat use patterns on microhabitats is often unknown and difficult to ascertain (especially on a seasonal basis or for shorter periods). Moreover, difficulty arises with the determination of long term cumulative effects from project development. Intensive pre and post studies (i.e., long term monitoring) would be needed to satisfactorily evaluate project impacts. The costs and benefits to fish and wildlife will vary depending on which project(s) are accepted.

Evaluation of Project Alternatives

Alternative 1: Construct a diversion dam and canal system to divert flood flows from the Big Lost River into Chilly Sinks/ Barton Flats area.

* May prevent or control flood damage to river bottom property, roads, and bridges. Agricultural areas, residential developments, and other structures that were historically flooded could be protected through control of high water flows, thus reducing or eliminating flood damage expenditures.

* May diminish downstream erosion, channel change, and sediment transport. The rapid spring runoff could be moderated which would decrease undercutting of low banks, channel scouring, and high bank erosion. Transport of loose substrate, large rocks, and other submerged obstructions may be reduced. In addition, debris (dead snags, branches and twigs lodged in the stream channel) accumulation which could cause blockage and subsequent channel movement may be avoided. Moreover, deposition of sand, gravel, and cobbles, as well as sediment volume, may also decrease. Overall channel stability could improve. Streamside vegetation and associated wildlife habitats for water dependent species may be protected. The effects on fish habitat is less clear since freshet flows are important for cleansing existing spawning gravels, creating new spawning gravels, and providing cover such as undercut banks. The positive and negative values from increased channel stability on fish and wildlife resources is difficult to determine with existing information.

* May decrease sedimentation of Mackay Reservoir. The increased volume of silts and fine gravels as a result of flushing and turbulence during spring could be neutralized, thus slowing

Water velocity exerts considerable control on fish (and benthic invertebrates) and may direct movement at the dam headworks toward the opening of the canal diversion.

* Direct and indirect losses of riparian vegetation could occur. Direct immediate losses are due to construction of the dam headworks and canal structures. This would affect cottonwood-willow habitat, however, the extent of this loss is unknown. Long term effects could be adverse for cottonwood (and possibly other riparian plants) regeneration. The absence of high volume flows would inundate less of the flood plain and may preclude the creation of moist substrates on alluvial seedbeds that are required for seed germination (Fenner et al. 1985).

* Open discharge of flood flows into sagebrush-grassland habitats may reduce or eliminate sagebrush and/or associated flora. Wyoming and mountain big sagebrush species are intolerant of high moisture levels (particularly for extended periods) and can be eliminated on these sites (personal communication, Alan Beetle, Professor Emeritus of Range Management, Univ. of Wyoming). The extent of sagebrush-grassland habitat lost is undetermined, but would depend on the size of the area flooded and duration of water retention. This, in turn, relates to the volume and length of time of the spring runoff that is being diverted.

* Loss of sagebrush-grassland habitats for numerous passerine birds, non-raptorial birds, small mammals, and reptiles inhabiting the sagebrush proper would be destroyed. Losses of unknown populations of these species could occur locally. Available prey for raptors could also be impacted locally.

* Antelope, mule deer, sage grouse, and other migratory species may be adversely affected by the canal structure. The canal may pose a barrier to these species during spring, particularly if the timing of migration coincides with diverted flows at or near full capacity. Drowning of young or weakened animals could occur as well as adults that become stressed trying to negotiate a crossing. Movements of sage grouse broods that are following the development of green forage to higher elevations may be impeded. Information on migratory movements of various species using the area is seriously limited. Timing of construction of the canal may have negative impacts on migratory species if it occurs concurrently with migration.

* Potential loss of crucial sage grouse and antelope winter range can be anticipated. Potential losses may occur to crucial antelope fawning habitat and mule deer winter range. Antelope does use traditional fawning areas annually because these sites

overlaps pre or post parturition periods, negative impacts could result from stress (i.e., fetal absorption, abortion, abandonment).

Site specific habitat use data for antelope and mule deer is lacking. Potential effects on populations of these species are not possible to determine with existing information.

* Sage grouse nesting habitat, wintering habitat, and strutting grounds (leks) could be lost. Quality of these habitats may be altered due to changes in vegetative features. Brood rearing habitat may or may not be affected. Klebenow (1969), working in Idaho, observed the majority of brood locations were in sagebrush types in early summer. Brood movements to irrigated or foothill meadows have been reported (Autenreith 1981). Wet meadow strips paralleling earth embankment canals can be a source of forbs for broods in late summer. The canal may also retain enough water for use by broods. However, water availability and development of meadow vegetation along the canal system is indeterminate at present. Further, Autenreith (personal communication, phone conversation on 7-11-87) suggests that discharged flood flows would occur too late in the season (mid-June to early July) to be beneficial for sage grouse. The key time for water availability and forage production would have passed. The canal system, as a water source, may be unreliable on an annual basis. Traditional known sage grouse leks occur in the Barton Flats area (Autenreith 1981, Bureau of Land Management files, Salmon Falls District). Construction of the canal could cause abandonment of these sites and nearby nest locations, particularly during the construction phase. Autenreith (personal communication, phone conversation on 7-11-87) believes this disruption may decimate the area for nesting because of the traditional nature of sage grouse nest site selection.

* May interfere with natural hydrologic processes which occur in downstream reaches of the Big Lost River. Downstream effects could be lack of ground water recharge of springs in the flood plain, decreased flows for channel maintenance and continued stream bed integrity, and reduced extent and depth of the water table in the riparian zone.

Alternative 2 : Enlarge Mackay Reservoir storage capacity to 57,500 acre-feet by raising the dam in conjunction with increasing the spillway capacity to maintain control of the probable maximum flood inflow volume.

* May prevent or control flood damage to river bottom property, roads, and bridges. Agricultural areas, residential developments, and other structures that were historically flooded could be protected through control of high water flows, thus

ment transport. Rapid spring runoff could be moderated which would decrease undercutting of low banks, channel scouring, and high bank erosion. Transport of loose substrate, large rocks, and other submerged obstructions may be reduced. In addition, debris (dead snags, branches and twigs lodged in the stream channel) accumulation which could cause blockage and subsequent channel movement may be avoided. Moreover, deposition of sand, gravel, and cobbles, as well as sediment volume, may also decrease. Overall channel stability could improve. Stream side vegetation and associated wildlife habitats for water dependent species may be protected. The effects on fish habitat are less clear since freshet flows are important for cleansing existing spawning gravels, creating new spawning gravels, and providing cover such as undercut banks. The positive and negative values from increased channel stability on fish and wildlife resources are difficult to determine with existing information.

* Riparian zones and wetlands provide key, productive habitats in an otherwise arid environment. Loss of wetland/riparian vegetation would decrease both plant and animal species diversity. Small mammals, numerous passerine birds, and amphibians dependent on the moisture and dense cover found in riparian areas would be negatively impacted. Adverse impacts could occur to predatory species higher in the food chain (i.e., coyotes, raptors, bobcats) because of a depressed prey base as a result of losing these productive habitats. The effects on predatory species may be insignificant for some species (i.e. coyotes), but for others (i.e., wintering bald eagles) may be more substantial. Approximately 330 acres of wetland habitat would be inundated at the upper perimeter of Mackay Reservoir. This area contains communities of forested wetlands, scrub-shrub wetlands, and emergent wetlands (Cowardin et al. 1979) important for waterfowl. Nesting and refuge areas for geese and ducks would be lost. Migrating or transient species that use these habitats for resting and foraging could also be adversely affected. Over the long term, additional wetlands may develop along the reservoir perimeter at the new level, but the extent, type of wetland habitats, and intermediate effects on fish and wildlife are unknown.

* Bald eagle wintering habitat around the open water at the upper boundary of Mackay Reservoir may be adversely impacted, provided hunting perches (i.e., large cottonwood trees) and prey species are detrimentally affected. Exact numbers of bald eagles that would be affected are unknown. Utilization of the area by eagles may also be deterred. More information is needed concerning use of the site by bald eagles.

* Increased size of the reservoir may interfere with mule deer that migrate across the upper boundary of Mackay Reservoir

Increased fish habitat may occur at the upper end of the reservoir where the greatest inundation of aquatic macrophytes exist. This location would provide more cover than surrounding flooded shoreline habitat. Affects from these changes on fish populations is unknown.

Alternative 3: Enlarge the emergency spillway on Mackay Dam to accommodate the probable maximum flood inflow volume and protect the dam from overtopping.

* May prevent or control flood damage to river bottom property, roads, and bridges. Agricultural areas, residential developments, and other structures that were historically flooded could be protected through control of highwater flows, thus reducing or eliminating flood damage expenditures.

* May diminish downstream erosion, channel change, and sediment transport. The rapid spring runoff could be moderated which would decrease undercutting of low banks, channel scouring, and high bank erosion. Transport of loose substrate, large rocks, and other submerged obstructions may be reduced. In addition, debris (dead snags, branches and twigs lodged in the stream channel) accumulation which could cause blockage and subsequent channel movement may be avoided. Moreover, deposition of sand, gravel, and cobbles as well as sediment volume may also decrease. Overall channel stability could improve. Stream side vegetation and associated wildlife habitats for water dependent species may be protected. The effects on fish habitat are less clear since freshet flows are important for cleansing existing spawning gravels, creating new spawning gravels, and providing cover such as undercut banks. The positive and negative values from increased channel stability on fish and wildlife resources are difficult to determine with existing information.

* Timing of the construction phase may interfere with spring or fall mule deer migration below the dam if the construction activities overlap periods of seasonal movements.

Alternative 4: Replace the old existing U/C dam headworks, enlarge the entire canal system to increase capacity, and build a new extension of the canal into the lava beds south of highway 20/26 for diversion of flood flows.

* May prevent or control flood damage of river bottom property, roads, and bridges in downstream reaches from the diversion location. Flooding that occurs upstream, particularly around the town of Mackay, would be unaffected. Agricultural areas, residential developments, and other structures below the diversion that were historically flooded could be protected through control of high water flows, thus reducing or eliminating

ment transport. Rapid spring runoff could be moderated which would decrease undercutting of low banks, channel scouring, and high bank erosion. Transport of loose substrate, large rocks, and other submerged obstructions may be reduced. In addition, debris (dead snags, branches and twigs lodged in the stream channel) accumulation which could cause blockage and subsequent channel movement may be avoided. Moreover, deposition of sand, gravel, and cobbles as well as sediment volume, may also decrease. Overall channel stability could improve. Upstream reaches from the diversion would be unaffected. Stream side vegetation and associated wildlife habitats for water dependent species may be protected. The effects on fish habitat are less clear since freshet flows are important for cleansing existing spawning gravels, creating new spawning gravels, and providing cover such as undercut banks. The positive and negative values from increased channel stability on fish and wildlife resources are difficult to determine with existing information.

* Direct losses could result from flushing of fish through the canal system and out the open discharge into the lava beds. Water velocity exerts considerable control on fish (and benthic invertebrates) and may direct movement at the dam headworks toward the opening of the canal diversion.

* Direct and indirect losses of riparian vegetation could occur. Direct immediate losses are due to construction of the dam headworks and canal structures. This would affect cottonwood-willow habitat, however, the extent of this loss is unknown. Long term effects could be adverse for cottonwood (and possibly other riparian plants) regeneration. Absence of high volume flows would inundate less of the flood plain and may preclude the creation of moist substrates on alluvial seedbeds that are required for seed germination (Fenner et al. 1985).

* Open discharge of flood flows into sagebrush-grassland habitats may reduce or eliminate sagebrush and/or associated flora. Wyoming and mountain big sagebrush species are intolerant of high moisture levels (particularly for extended periods) and can be eliminated on these sites (personal communication, Alan Beetle, Professor Emeritus of Range Management, Univ. of Wyoming). Extent of sagebrush-grassland habitat lost is undetermined, but would depend on the size of the area flooded and duration of water retention. This, in turn, relates to the volume and length of time of the spring runoff that is being diverted.

* Loss of sagebrush-grassland habitats for numerous passerine birds, non-raptorial birds, small mammals, and reptiles inhabiting the sagebrush proper would be destroyed. Losses of unknown populations of these species could occur locally. Available prey for raptors could also be impacted locally.

young or weakened animals could occur as well as adults that become stressed trying to negotiate a crossing. Movements of sage grouse broods following the development of green forage to higher elevations may be impeded. Information on migratory movements of various species using the area is seriously limited. Timing of construction of the canal may have negative impacts on migratory species if it occurs concurrently with migration.

* Potential loss of crucial sage grouse and antelope winter range can be anticipated. Potential losses may occur to crucial antelope fawning habitat and mule deer winter range. Antelope does use traditional fawning areas annually because they meet the requirements of security, concealment, and other important factors. Autenreith (personal communication, phone conversation on 7-11-87) proposed that periodic flooding could disrupt the traditional use of these areas by sage grouse. In addition, vegetative characteristics may change and cause a decrease in the quality of antelope fawning habitat. If the construction phase overlaps pre or post parturition periods, negative impacts could result from stress (i.e., fetal absorption, abortion, abandonment). Site specific habitat use data for antelope and mule deer is lacking. Potential effects on populations of these species are not possible to determine with existing information.

* Sage grouse nesting habitat, wintering habitat, and strutting grounds (leks) could be lost. The quality of these habitats may be altered due to changes in vegetative features. Brood rearing habitat may or may not be affected. Klebenow (1969), working in Idaho, observed the majority of brood locations were in sagebrush types in early summer. However, brood movements to irrigated or foothill meadows have been reported (Autenreith 1981). Wet meadow strips paralleling earth embankment canals can be a source of forbs for broods in late summer. The canal may also retain enough water for use by broods. However, water availability and the development of meadow vegetation along the canal system is indeterminate at present. Further, Autenreith (personal communication, phone conversation on 7-11-87) suggests the discharged flood flows would occur too late in the season mid-June to early July) to be beneficial for sage grouse. The key time for water availability and forage production would have passed. The canal system, as a water source, may be unreliable on an annual basis. Traditional known sage grouse leks occur near the proposed project site (Bureau of Land Management files, Salmon Falls District). Construction of the canal could cause abandonment of these sites and nearby nest locations, particularly during the construction phase. Autenreith (personal communication, phone conversation on 7-11-87) believes this disruption may decimate the area for nesting because of the traditional nature of sage grouse nest site selection.

water table in the riparian zone.

* The existing environmental features of lava formations possess a strong, unique, wilderness character (Bureau of Land Management 1980). Extension of the canal into the lava beds may undermine this sense of wilderness for visitors to the vicinity.

Alternative 5: Construct a dam on Antelope Creek, a major tributary of the Big Lost River, for storage of flood flows and small hydropower generation.

* May prevent or control flood damage to river bottom property, roads, and bridges in downstream reaches on the Big Lost River from the mouth of Antelope Creek. Upstream reaches would be unaffected. Agricultural areas, residential developments, and other structures may be protected from overbank flooding in reaches downstream from the town of Darlington, thus reducing flood damage expenditures.

* May diminish downstream erosion, channel change, and sediment transport on the Big Lost River below the town of Darlington and from the mouth of Antelope Creek to the Dam. Rapid spring runoff could be moderated which would decrease undercutting of low banks, channel scouring, and high bank erosion. Transport of loose substrate, large rocks, and other submerged obstructions may be reduced. In addition, debris (dead snags, branches and twigs lodged in the stream channel) accumulation which could cause blockage and subsequent channel movement may be avoided. Moreover, deposition of sand, gravel, and cobbles, as well as sediment volume, may also decrease. Overall channel stability could improve. Upstream reaches from the mouth of Antelope Creek would be unaffected. Stream side vegetation and associated wildlife habitats for water dependent species may be protected. The effects on fish habitat are less clear since freshet flows are important for cleansing existing spawning gravels, creating new spawning gravels, and providing cover such as undercut banks. The positive and negative values from increased channel stability on fish and wildlife resources are difficult to determine with existing information.

* At maximum reservoir forebay elevation of 5,950 feet, approximately 1,032 acres would be flooded. This area is predominantly upland sagebrush-grassland range. Existing riparian vegetation occupies a narrow zone along a small, well-defined channel about halfway through the proposed area of inundation. The remainder of the channel meanders through a broader flood plain area consisting of willow-redosier scrub-shrubland wetland habitat. No overstory tree species occur in either reach. Extensive grazing has occurred along the riparian

raptors and other predators. The individual species, their abundance, and distributions are unknown.

* The reservoir would inundate an undetermined amount of rainbow and brook trout spawning and rearing habitat. Impacts may be significant because of loss of a portion of the wild trout fishery. Abundance of trout species in the reaches that would be inundated is unknown. Reduced flows in the immediate reaches below the proposed dam on Antelope Creek could have an adverse affect on trout populations.

* Loss of sagebrush-grassland range may have potential negative effects on sage grouse that inhabit the area. It's likely sage grouse use the area since similar sites in nearby Antelope Valley are occupied, however, abundance of sage grouse and other site specific information is seriously lacking.

* Migration of antelope, mule deer, and elk to foothill ranges in lower portions of the Antelope Creek drainage may be impeded or blocked. Elk and mule deer that migrate from summer areas north of the drainage have been observed crossing the valley near the proposed dam site. Negative impacts could result to these wintering animals if the proposed reservoir acts to interfere with their traditional travel corridors. The relocated road and powerline system in conjunction with other reservoir associated developments may, cumulatively, act as a barrier. Winter range in Appendicitis foothills would be unavailable. Mule deer and antelope that winter along the south facing slopes of Antelope Creek and on Leslie Butte may also be affected in the same manner since many of these animals use the drainage as a travel route. Wintering populations of big game may shift present distributions, possibly causing increased depredations in agricultural areas, or accelerating downward trends in range conditions on already poor range. However, effects are unknown and need to be investigated.

* Some sagebrush-grassland and mountain mahogany big game winter range will be flooded. Less winter forage would be available and may increase utilization pressure on the remaining wintering areas. Amount of winter range lost and the effect on wintering animals needs to be studied.

* A new reservoir can have potential benefits to fish and wildlife. Benefits acquired are dependent, to a large extent, on reservoir operations (i.e., drawdowns). Some of these potential benefits could include:

1) Potential for an additional fishery.
2) Potential for shorebird habitat development.
3) Potential for waterfowl habitat development.

water dependent species.

7) Potential for a continuous water supply for wildlife in an arid environment.

* Large reservoirs often have some type of recreational development associated with them which could have negative impacts on wildlife species. Type of development, amount of disturbance, frequency of use, and other related factors would determine the degree of impact on wildlife inhabiting the area. Human activities and development nearly always precludes wildlife species from utilizing the area.

* A small portion of the Appendicitis Hills proposed Wilderness Study Area (Bureau of Land Management 1986) may be flooded by the proposed reservoir. Some wilderness values could be lost. Potential impact of these losses are unknown.

* Adverse impacts to fish and wildlife may result during the construction phase. Disruption of fish and wildlife use in the area would result from the amount and duration of construction activities of building a dam, roads, powerline corridors, etc.. The long and short term effects to fish and wildlife species are unknown at this time.

Alternative 6: Regulation of Mackay Dam through operational planning for flood control.

* May prevent or control flood damage to river bottom property, roads, and bridges below Mackay Dam. Agricultural areas, residential developments, and other structures that were historically flooded could be protected through control of high water flows, thus reducing or eliminating flood damage expenditures.

* May diminish downstream erosion, channel change, and sediment transport below Mackay Dam. Rapid spring runoff could be moderated which would decrease undercutting of low banks, channel scouring, and high bank erosion. Transport of loose substrate, large rocks, and other submerged obstructions may be reduced. In addition, debris (dead snags, branches and twigs lodged in the stream channel) accumulation which could cause blockage and subsequent channel movement may be avoided. Moreover, deposition of sand, gravel, and cobbles as well as sediment volume may also decrease. Overall channel stability could improve. Stream side vegetation and associated wildlife habitats for water dependent species may be protected. The effects on fish habitat are less clear since freshet flows are important for cleansing existing spawning gravels, creating new spawning gravels, and providing cover such as undercut banks. The positive and negative values from increased channel stability on fish and wildlife resources

conditional on the program design which would regulate reservoir water levels. It is likely drawdowns would occur and the timing of these drawdowns may be significant for species utilizing the reservoir on a seasonal basis. If winter drawdowns were to occur, wintering bald eagle habitat, waterfowl habitat, and the reservoir fishery might be adversely affected.

Currently, the cumulative impacts associated with the proposed projects are unknown. Adequate baseline data for fish and wildlife species is limited. In accordance with the public trust in areas of natural resources and in the public's best interest, a thorough evaluation of the short and long term impacts from the proposed projects is prudent. Because of the many unknowns, the Service recommends that information contained in this report be used as a framework for more conclusive Fish and Wildlife Coordination Act investigations.

POTENTIAL MITIGATION AND ENHANCEMENT

It is the policy of the Service to seek to mitigate losses of fish, wildlife, their habitats, and uses thereof from resource developments. The approach to mitigation for project-related impacts includes: 1) avoiding, 2) minimizing, 3) rectifying, 4) reducing or eliminating over time, and 5) compensating for impacts (Federal Register 1981). If highly valued, unique and irreplaceable habitats on a national or ecoregion basis for evaluation species are to be impacted, the mitigation goal is no loss of existing habitat value. If the impacted habitat is of high value and relatively scarce or becoming scarce on a national or ecoregion basis, the mitigation goal is no net loss of in-kind habitat value. The Service will recommend ways to alleviate impacts should losses occur. At the reconnaissance level of this project investigation, the Service cannot adequately quantify project-related losses, discriminate between mitigation and enhancement, or designate habitat values without further habitat evaluation analyses.

Opportunities exist for mitigation and enhancement relative to the project alternatives on the Big Lost River. Mitigation will be required for any loss of fish and wildlife habitat values due to project development.

Potential on-site mitigation for the proposed diversion dam and canal system alternatives include:

* Installation of a self-cleaning, low maintenance structure with fish screens at the water diversion site. Debris and

a self-cleaning structure is needed. Fish screens would prevent direct losses of fish that would enter the canal system.

* Provide fish passage for upstream migrants at the diversion dam and periodic maintenance of the passage as related to sediment loading.

* Allow periodic flushing flows in spring for channel maintenance, ground-water recharge, cleansing of spawning gravels, maintenance of riparian vegetation integrity and regeneration (i.e., cottonwoods).

* Plan construction activities to avoid concurrent timing with antelope fawning, sage grouse nesting and strutting, and migration of antelope, mule deer, and sage grouse.

* Provide permanent water storage at the end of the canal for wildlife inhabiting the region.

* Design the canals to facilitate animal crossing and, if feasible, keep alignments and extension lengths as short as possible.

Potential on-site mitigation for the enlargement of Mackay Reservoir and emergency spillway alternatives include:

* Determine instream maintenance flows and maintain them to sustain or enhance fisheries below the dam. The Service recommends an instream flow incremental methodology analysis (Bovee 1982) for this determination.

* Determine and maintain minimum pool requirements to sustain or enhance fisheries in the reservoir.

* Relocate and improve existing recreational facilities on the east side of the reservoir.

* Increase annual stocking of fish to accommodate the desirable catch rates for the winter and general recreation fishing seasons. Additionally, increased stocking levels will provide more forage fish for wintering bald eagles.

* Allow periodic flushing flows during spring for channel maintenance, ground-water recharge, cleansing of spawning gravels, and maintenance of riparian vegetation and regeneration (i.e., cottonwoods).

* Develop and manage subimpoundments at the upper perimeter of the reservoir to regulate water level fluctuations. Nest islands should be designed and positioned for the benefit of

vegetation in and adjacent to subimpoundments. A desirable mix of cover and forage species should be established and maintained. An active management program may be required.

* Maintain the integrity of large cottonwood trees at the upper boundary of the reservoir to provide perch sites for wintering bald eagles. These sites should be protected from livestock grazing by fencing and from other disturbances that could deteriorate the riparian zone.

* Timing of the construction phase of the dam rehabilitation should be scheduled to avoid mule deer migration.

Wetlands are considered to be of high value to a variety of fish and wildlife species. To mitigate for these wetlands the Service's policy requests no net loss of in-kind habitat value. In order to determine what actions are necessary for in-kind replacement of habitat values flooded at the upper end of the reservoir, the Service recommends using the Habitat Evaluation Procedures (U.S. Fish and Wildlife Service 1980). The in-kind habitat values destroyed and the replacement-loss ratios need to be determined.

Potential for on-site mitigation for the proposed Antelope Creek Dam and Reservoir alternative include:

* Determine and maintain instream maintenance flows in Antelope Creek and the Big Lost River downstream to Arco. This will maintain and possibly enhance fisheries in these reaches. An instream flow incremental analysis (Bovee 1982) should be accomplished for this determination.

* Allow periodic flushing flows during spring for channel maintenance, ground-water recharge, cleansing of spawning gravels, and maintenance of riparian vegetation and regeneration (i.e., cottonwoods).

* Plan construction activities to avoid concurrent timing with migration of big game species to and from winter range in the Appendicitis Hills and Leslie Butte foothills.

* Create a protected wetland for waterfowl at the upper boundary in the willow-redosier habitats. Develop and manage subimpoundments at the upper perimeter of the reservoir to regulate water level fluctuations. Nest islands should be designed and positioned for the benefit of nesting waterfowl. During nesting the area should be free from disturbance. Fences should be constructed to exclude cattle. Purchase of private lands may be necessary as well as an active management program.

native cover and forage species should be established and maintained. An active management program may be required.

* Design and position transmission poles and lines to minimize raptor and waterfowl electrocution and collision.

Wetlands are considered to be of high value to a variety of fish and wildlife species. To mitigate for these wetlands the Service's policy requests no net loss of in-kind habitat value. In order to determine what actions are necessary for in-kind replacement of habitat values for the wetland/riparian areas lost, the Service recommends using the Habitat Evaluation Procedures (U.S. Fish and Wildlife Service 1980). The in-kind habitat values destroyed and the replacement-loss ratios need to be determined.

Potential on-site mitigation for the proposed regulation of Mackay Dam and Reservoir for flood control alternative:

This alternative has no project development associated with it and, therefore, is a no-impact alternative. Operational programming of the dam for flood control may influence utilization of the reservoir by fish and wildlife and, therefore, enhancement possibilities. Without specifications of program design, impacts to fish and wildlife are indeterminate.

Potential off-site mitigation/enhancement could include:

* Conservation easements or purchases of private land-holdings of wetland/riparian habitat in the Thousand Springs Valley north of Chilly, Idaho. An estimated 6,000 acres of wetland/riparian habitat occupies the valley. Approximately 430 acres are in public ownership on four separate tracts of Bureau land. Protection and management of this public wetland complex is difficult because the tracts are surrounded by private lands. Pursuit of wildlife easements or purchases with private land-owners to block up public lands would help ensure protection of wetland values. Management would be more efficient and habitat improvement projects could be implemented. The U.S. Bureau of Land Management (Salmon District) has expressed a willingness to work with all concerned agencies and private industry to implement this mitigation measure. Further, they indicate that the size of the various projects, effects on fish and wildlife, and the potential for wetland improvement would determine the adequacy of this measure to mitigate in-kind losses.

* Establishment and maintenance of a brook trout fishery in Spring Creek, a tributary of the Big Lost River. A brook trout fishery existed in the creek prior to demands on water resources by agricultural development in the valley. Surface water is

Steve Elle, Fishery Biologist, Fish and Game).

DATA GAPS AND INFORMATION NEEDS

To adequately evaluate the proposed projects for the Big Lost River and Antelope Creek, a variety of environmental surveys and studies should be considered. Information needs concerning the project alternatives follows.

Diversion Dam and Canal System Alternatives

1. A vegetation survey and study of local flora and plant communities needs to be conducted to thoroughly inventory existing vegetation and evaluate pre and post project vegetative responses. A cover type map should be developed. Attention should be given to the possible presence of rare and sensitive plants, particularly on unique sites such as the lava flows. The canals are designed as open ended systems that divert flood flows onto porous soils occupied by sagebrush-grassland plant communities. The study should focus on what will happen to the water and the effect it will have on the area. It should consider the extent of the area to be flooded which relates to the discharge velocities, capacity, and flood frequency. Further considerations are the rate of infiltration, duration of water retention, water volume retained, topography as it relates to containment, ground-water recharge, delay time before reappearing as surface flows (Chilly canal diversion only), and other elements that affect land/water relationships. The study should investigate present vegetation on infiltration areas before development and, through long term monitoring, determine post-vegetative changes. This information would aid in predictions of changes in sagebrush-grassland habitats relative to future diversion of flood flows into these plant communities.

2. An intensive survey of all vertebrate species utilizing the project site should be conducted to determine the abundance and diversity of species inhabiting the sagebrush-grassland zone that would be impacted. Special emphasis should be directed toward the presence of rare, sensitive, and endangered species.

3. More site specific information is needed on sage grouse and antelope use patterns. Intensive searches for sage grouse leks, nest sites, migration routes, and wintering areas need to be done. Antelope fawning areas need to be searched and documented. This information is needed to thoroughly document abundance of both species and determine the effects on habitat use patterns within the project area.

Barton Flats area. The study should be designed to determine project-related effects on migration patterns and wintering distributions.

5. A habitat based evaluation should be done to assess the value of the sagebrush-grassland habitats in the infiltration area for sage grouse and antelope. The evaluation should explore the changes in habitats and the potential positive and negative values that result from those modifications for sage grouse and antelope. For both species it should consider such elements as seasonal shifts in habitat use, affects on migration patterns, changes in forage quality and quantity, affects on productivity, and predator response.

6. A general survey of fish populations in the Big Lost River reaches between Mackay Reservoir and the Barton Point Road bridge should be conducted to determine fish densities and assess fish habitat values.

7. An investigation of the value and determination of spring flushing flows for channel maintenance, cleansing of spawning gravels, and maintenance and regeneration of riparian vegetation should be done. This study should address the change in stream morphology related to freshet flows since the project may reduce the duration and amount of spring discharge in the mainstem.

Mackay Dam Rehabilitation Alternatives

1. A Habitat Evaluation Procedure should be conducted to evaluate wetland habitat values that would be lost at the upper boundary of the reservoir. The analysis will determine what actions are necessary for in-kind replacement of wetland habitat values.

2. A study to determine instream maintenance flows on the Big Lost River below the dam should be conducted using the instream flow incremental methodology analysis (Bovee 1982).

3. More information is needed on seasonal movements of mule deer above the reservoir and below the dam. Presently, the importance of these travel corridors to mule deer is unknown. Access to available winter range in the east valley may be impaired which could have an adverse impact on wintering populations.

4. An intensive survey of plant communities and vertebrate species inhabiting habitats around the existing perimeter of the reservoir, including the cottonwood-willow wetland zone at the upper end, should be conducted. Data on flora and fauna

5. An investigation of the value and determination of spring freshet flows for channel maintenance, cleansing of spawning gravels, and maintenance and regeneration of riparian vegetation should be done.

6. A winter survey of bald eagles, perch sites, and foraging habits should be conducted to determine the value of this area for wintering eagles.

Antelope Creek Dam Alternative

1. A vegetation and plant community survey of the project area should be conducted. Special effort should be directed toward rare, sensitive, and endangered plant species. Wetland plant community classification should follow Cowardin et al. (1979).

2. A study to determine instream maintenance flows on Antelope Creek and downstream reaches of the Big Lost River below the dam should be conducted using the instream flow incremental methodology (Bovee 1982) analysis.

3. A survey of fish populations, fish habitats, and fishermen should be conducted on Antelope Creek to determine fishery values. Trout spawning and rearing areas should be identified in the inventory.

4. A study is needed to determine a conservation pool in the proposed reservoir to sustain a fishery.

5. An investigation of the value and determination of spring freshet flows for channel maintenance, cleansing of spawning gravels, and maintenance and regeneration of riparian vegetation should be done.

6. An intensive survey of all residential and seasonal vertebrate species should be performed to determine the abundance and diversity of species that use the project area.

7. A study is needed to evaluate the effects the proposed reservoir would have on migratory big game species. Mule deer, elk, and antelope often use traditional migration routes. Seasonal movements, wintering areas, abundance, and herd composition should be determined for each species. Considerations should be given to the effects of animals trying to cross ice on the reservoir in winter and becoming trapped. Changes in winter distributions and possible effects on range conditions should also be considered.

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Table A1. A list of common plants within the sagebrush-grass and riparian plant associations in the Big Lost River drainage (Bureau of Land Management 1982).

SAGEBRUSH-GRASS ASSOCIATION

Shrubs
1. Wyoming big sagebrush (_Artemesia tridentata_ ssp. wyomingensis)
2. Basin big sagebrush (_Artemesia tridentata_ ssp. tridentata)
3. Low sagebrush (_Artemesia arbuscula_)
4. Rabbit-brush (_Chrysothamnus_ spp.)

Grasses
1. Bluebunch wheatgrass (_Agropyron spicatum_)
2. Sandberg bluegrass (_Poa sandbergii_)
3. Idaho fescue (_Festuca idahoensis_)
4. Squirreltail (_Sitanion hystrix_)
5. Cheatgrass brome (_Bromus tectorum_)
6. Needlegrass (_Stipa_ spp.)

Forbs
1. Phlox (_Phlox_ spp.)
2. Lupine (_Lupinus_ spp.)
3. Wild buchwheat (_Eriogonum_ spp.)
4. Milk-vetch (_Astragalus_ spp.)
5. Balsamroot (_Balsamorhiza_ spp.)

RIPARIAN ASSOCIATION

Trees and Shrubs
1. Cottonwood (_Populus_ spp.)
2. Aspen (_Populus_ spp.)
3. Willow (_Salix_ spp,)
4. Red-osier dogwood (_Cornus stolonifera_)
5. Basin big sagebrush (_Artemesia tridentata_ ssp. tridentata)

Grasses, Sedges, and Grass-likes
1. Sedges (_Carex_ spp.)
2. Basin wildrye (_Elymus_ ssp.)
3. Kentucky bluegrass (_Poa pratensis_)
4. Hairgrass (_Aira_ spp.)

Forbs
1. Geranium (_Geranium_ spp.)
2. Cinquefoil (_Potentilla_ spp.)
3. Wild iris (_Iris_ spp.)
4. Clover (_Trifolium_ spp.)

LIST LEGEND

F = species occurs in the area depicted during fall migrations

Sp = species occurs in area depicted during spring migrations

M = species occurs in area depicted during fall and spring migrations

S = species occurs in area depicted during the summer

W = species occurs in area depicted during the winter

YL = species occurs in area depicted year-long

COMMON NAME	SCIENTIFIC BINOMIAL	TIME OF YEAR
Masked Shrew	Sorex cinereus	YL
Merriam Shrew	Sorex merriami	YL
Dusky Shrew	Sorex obscurus	YL
Vagrant Shrew	Sorex vagrans	YL
Northern Water Shrew	Sorex palustris	YL
Little Brown Bat	Myotis lucifugus	M-S
Long-Eared Bat	Myotis evotis	M-S
Calfornia Bat	Myotis californicus	M-S
Fringed Myotis	Myotis thysanodes	M-S
Yuma Bat	Myotis yumanensis	M-S
Long-Legged Bat	Myotis volans	M-S
Small Footed Bat	Myotis subulatus	M-S
Silver Haired Bat	Lasionycteris noctivagans	M-S
Big Brown Bat	Eptesicus fuscus	M-S
Hoary Bat	Lasiurus cinereus	M-S
Spotted Bat	Euderma maculata	M-S
Western Big Eared Bat	Plecotus townsendi	M-S
Black Bear	Ursus americanus	YL
Raccoon	Procyon lotor	YL
Marten	Martes americana	YL
Longtail Weasel	Mustela frenata	YL
Shorttail Weasel(ermine)	Mustela erminea	YL
Mink	Mustela vison	YL
River Otter	Lutra canadensis	YL
Badger	Taxidea taxus	YL
Spotted Skunk	Spilogale putorius	YL
Striped Skunk	Mephitis mephitis	YL
Coyote	Canis latrans	YL
Red Fox	Vulpes fulva	YL
Mountain Lion	Felis concolor	YL
Bobcat	Lynx rufus	YL
Yellowbelly Marmot	Marmota flaviventris	YL
Townsend Ground Squirrel	Citellus townsendi	YL
Richardson Ground Squirrel	Citellus richardsoni	YL
Columbian Ground Squirrel	Citellus columbianus	YL
Golden Mantled Ground Squirrel	Citellus lateralis	YL
Least Chipmunk	Eutamias minimus	YL

Red Squirrel	Tamiasciurus hudsonicus	[illegible]
Townsend Pocket Gopher	Thomomys townsend	YL
Northern Pocket Gopher	Thomomys talpoides	YL
Great Basin Pocket Mouse	Perognathus parvus	YL
Ord Kangaroo Rat	Dipodomys ordi	YL
Beaver	Castor canadensis	YL
Western Harvest Mouse	Reithrodontomys megalotis	YL
Deer Mouse	Peromyscus maniculatus	YL
Northern Grasshopper Mouse	Onychomys leucogaster	YL
Meadow Vole	Microtus pennsylvanicus	YL
Longtail Vole	Microtus longicaudus	YL
Boreal Redback Vole	Clethrionomys gapperi	YL
Mountain Vole	Microtus montanus	YL
Richardson Vole	Microtus richardsoni	YL
Sagebrush Vole	Lagurus curtatus	YL
Mountain Phenacomys	Phenacomys intermedius	YL
Muskrat	Ondatra zibethica	YL
Bushy Tailed Wood Rat	Neotoma cinerea	YL
Norway Rat	Rattus norvegicus	YL
House Mouse	Mus musculus	YL
Western Jumping Mouse	Zapus princeps	YL
Porcupine	Erethizon dorsatum	YL
Pika	Ochotona princeps	YL
White Tailed Jackrabbit	Lepus townsendi	YL
Snowshoe Hare	Lepus americanus	YL
Black Tail Jackrabbit	Lepus californicus	YL
Mountain Cottontail	Sylvilagus nuttalli	YL
Pygmy Rabbit	Sylvilagus idahoensis	YL
Elk	Cervus canadensis	YL
Mule Deer	Odocoileus hemionus	YL
Whitetail Deer	Odocoileus virginianus	YL
Moose	Alces alces	W-SP
Pronghorn	Antelocapra americana	YL
Mountain Goat	Oreamnos americanus	YL
Bighorn Sheep	Ovis canadensis canadensis	W

Common Loon	Gavia immer	[illegible]
Horned Grebe	Podiceps auritus	M
Eared Grebe	Podiceps caspicus	YL
Western Grebe	Aechmophorus occidentalis	M-S
Pied-Billed Grebe	Podilymbus podiceps	YL
Great Blue Heron	Ardea herodias	M-S
Snowy Egret	Leuocophoyx thula	M-S
Black-Crowned Night Heron	Nycticorax nycticorax	M-S
American Bittern	Botaurus lentiginosus	M-S
Whistling Swan	Olor columbianus	M-S
Trumpeter Swan	Olor buccinator	M
Canada Goose	Branta canadensis	YL
Snow-Blue Goose	Chen caerulescens	M
Ross' Goose	Chen rossii	M
Mallard	Anas platyrhynchos	YL
Gadwall	Anas strepera	YL
Pintail	Anas acuta	YL
Green-Winged Teal	Anas carolinensis	YL
Blue-Winged Teal	Anas discors	M-S
Cinnamon Teal	Anas cyanoptera	M-S
American Widgeon	Mareca americana	YL
Shoveler	Spatula clypeata	YL
Wood Duck	Aix sponsa	M
Red Head	Aythya americana	YL
Ringnecked Duck	Aythya collaris	M-W
Canvasback	Aythya valisineria	M-W
Greater Scaup	Aythya marila	M
Lesser Scaup	Aythya affinis	YL
Common Goldeneye	Bucephala clangula	M-W
Barrows Goldeneye	Bucephala islandica	M
Buffelhead	Bucephala albeola	YL
Oldsquaw	Clangula hyemalis	M-W
Ruddy Duck	Oxyura jamaicensis	M
Hooded Merganser	Lophodytes cucullatus	M-W
Common Merganser	Mergus merganser	M-W
Red-Breasted Merganser	Mergus serrator	M-W
Turkey Vulture	Cathartes aura	M-S
Goshawk	Accipiter gentilis	YL
Cooper's Hawk	Accipiter cooperii	YL
Sharp-Skinned Hawk	Accipiter striatus	M-S
Red-Tailed Hawk	Buteo jamaicensis	YL
Swainson's Hawk	Buteo swainsoni	M-S

Golden Eagle	Aquila chrysaetos	YL
Bald Eagle	Haliaeetus leucocephalus	M-W
Marsh Hawk	Circus cyaneus	YL
Osprey	Pandion haliaetus	M-S
Prairie Falcon	Falco mexicanus	YL
Peregrine Falcon	Falco peregrinus	YL
Merlin	Falco columbarius	M-W
American Kestrel	Falco sparverius	YL
Gyrfalcon	Falco rusticolus	M-W
Blue Grouse	Dendragapus obsurus	YL
Ruffed Grouse	Bonasa umbellus	YL
Sage Grouse	Centrocercus urophasianus	YL
Gambel's Quail	Lophortyx gambelii	YL
Chukar	Alectoris graeca	YL
Hungarian Partridge	Perdix perdix	YL
Pheasant	Phasianus colchicus	YL
Sandhill Crane	Grus canadensis	M
Sora	Porzana carolina	M-S
Virginia Rail	Rallus limicola	M-S
American Coot	Fulica americana	YL
Semipalmated Plover	Charadrius semipalmatus	M
Dunlin	Erolia alpina	M
Killdeer	Charadrius vociferus	M-S
Mountain Plover	Eupoda montana	M
American Golden Plover	Pulvialis dominica	M
Black-Bellied Plover	Squatarola squatarola	M
Common Snipe	Capella gallinago	M-S
Long-Billed Curlew	Numenius americanus	M-S
Spotted Sandpiper	Actitis macularia	M-S
Solitary Sandpiper	Tringa solitaria	M
Willit	Catoptrophorus semipalmatus	M-S
Greater Yellowlegs	Totanus melanoleucus	M
Lesser Yellowlegs	Totanus flavipes	M
Pectoral Sandpiper	Erolia melanotos	F
Baird's Sandpiper	Erolia bairdii	M
Least Sandpiper	Erolia minutilla	M
Short-Billed Dowitcher	Limnodromus griseus	M
Stilt Sandpiper	Micropalama himantopus	M
Semipalmated Sandpiper	Ereunetes pusillus	M

Hairy Woodpecker	*Dendrocopos villosus*	
Downy Woodpecker	*Dendrocopos pubescens*	YL
Eastern Kingbird	*Tyrannus tyrannus*	M-S
Western Kingbird	*Tyrannus verticalis*	M-S
Say's Phoebe	*Sayornis saya*	S
Willow Flycatcher	*Empidonax traillii*	M-S
Ash-Throated Flycatcher	*Myiarchus cinerascens*	S
Hammond's Flycatcher	*Empidonax hammondii*	M-S
Dusky Flycatcher	*Empidonax oberholseri*	M-S
Western Flyatcher	*Empidonax difficilis*	M-S
Western Wood Pewee	*Contopus sordilulus*	M-S
Olive-Sided Flycatcher	*Nuttallornis borealis*	M-S
Horned Lark	*Eremophila alpestris*	YL
Violet-Green Swallow	*Tachycineta thalassina*	M-S
Tree Swallow	*Iredoprocne bicolor*	M-S
Bank Swallow	*Riparia riparia*	M-S
Barn Swallow	*Hirundo rustica*	M-S
Cliff Swallow	*Petrochelidon pyrrhonota*	M-S
Rough-Winged Swallow	*Stelgidopteryx ruficollis*	M-S
Gray Jay	*Perisoreus canadensis*	YL
Stellar's Jay	*Cyanocitta stelleri*	YL
Black-Billed Magpie	*Pica pica*	YL
Common Raven	*Corvus corax*	YL
Common Crow	*Corvus brachyrhnchos*	YL
Clark's Nutcracker	*Nicifraga columbiana*	YL
Pinon Jay	*Gymnorhinus rganocephalus*	YL
Black-Capped Chickadee	*Parus atricapillus*	YL
Mountain Chickadee	*Parus gambeli*	YL
Plain Titmouse	*Parus inornatus*	YL
Bushtit	*Psaltriparus minimus*	YL
White-Breasted Nuthatch	*Sitta carolinensis*	YL
Red-Breasted Nuthatch	*Sitta canadensis*	YL
Pygmy Nuthatch	*Sitta pygmaea*	YL
Brown Creeper	*Certhea familiaris*	YL
Dipper	*Cinclus mexicanus*	YL
House Wren	*Troglodytes aedon*	M-S
Winter Wren	*Troglodytes troglodytes*	YL
Long-Billed Marsh Wren	*Telmatodytes palustris*	YL
Canyon Wren	*Catherpes mexicanus*	YL

Sage Thrasher	Oreoscoptes montanus	M-S
Robin	Turdus migratorius	YL
Hermit Thrush	Hylocichla guttata	M-S
Varied Thrush	Ixoreus naevius	M
Swainson's Thrush	Hylocichla ustulata	M-S
Verry	Hylocichla fuscenscens	M
Western Bluebird	Sialia mexicana	M
Mountain Bluebird	Sialia currucoides	M-S
Townsend's Solitaire	Myadestes townsendii	YL
Golden-Crowned Kinglet	Regulus satrapa	YL
Ruby-Crowned Kinglket	Regulus calendula	M-S
Blue-Gray Gnatcatcher	Polioptila caerulea	M-S
Water Pipit	Anthus spinoletta	M-S
Bohemian Waxwing	Bombycilla garrula	YL
Cedar Waxwing	Bombycilla cedrorum	YL
Northern shrike	Lanius excubitor	W
Loggerhead Shrike	Lanius ludovicianus	M-S
Starling	Sturnis vulgaris	YL
Solitary Vireo	Vireo solitarius	M-S
Red-Eyed Vireo	Vireo olivaceus	M-S
Warbling Vireo	Vireo gilvus	M-S
Orange Crowned Warbler	Vermivora celata	M-S
Nashville Warbler	Vermivora ruficapilla	M
Yellow Warbler	Dendroica petechia	M-S
Black & White Warbler	Mniotilta xaria	M
Yellow-Rumped Warbler	Dendroica audoboni	M-S
Townsend's Warbler	Dendroica townsendi	M-S
MacGillivray's Warbler	Oporornis tolmiei	M-S
Yellowthroat	Geothlypis trichas	M-S
Yellow-Breasted Chat	Icteria virens	M-S
Wilson's Warbler	Wilsonia pasilla	M-S
Virginia's Warbler	Vermivora virginiae	M-S
American Redstart	Stetophaga ruticilla	M-S
Northern Waterthrush	Seiurus noveboracensis	M
Black-Throated Gray Warbler	Dendroica nigrescens	M-S
House Sparrow	Passer domesticus	YL
Bobolink	Dolichonyx oryzivorous	M-S
Western Meadowlark	Sturnella neglecta	M-S

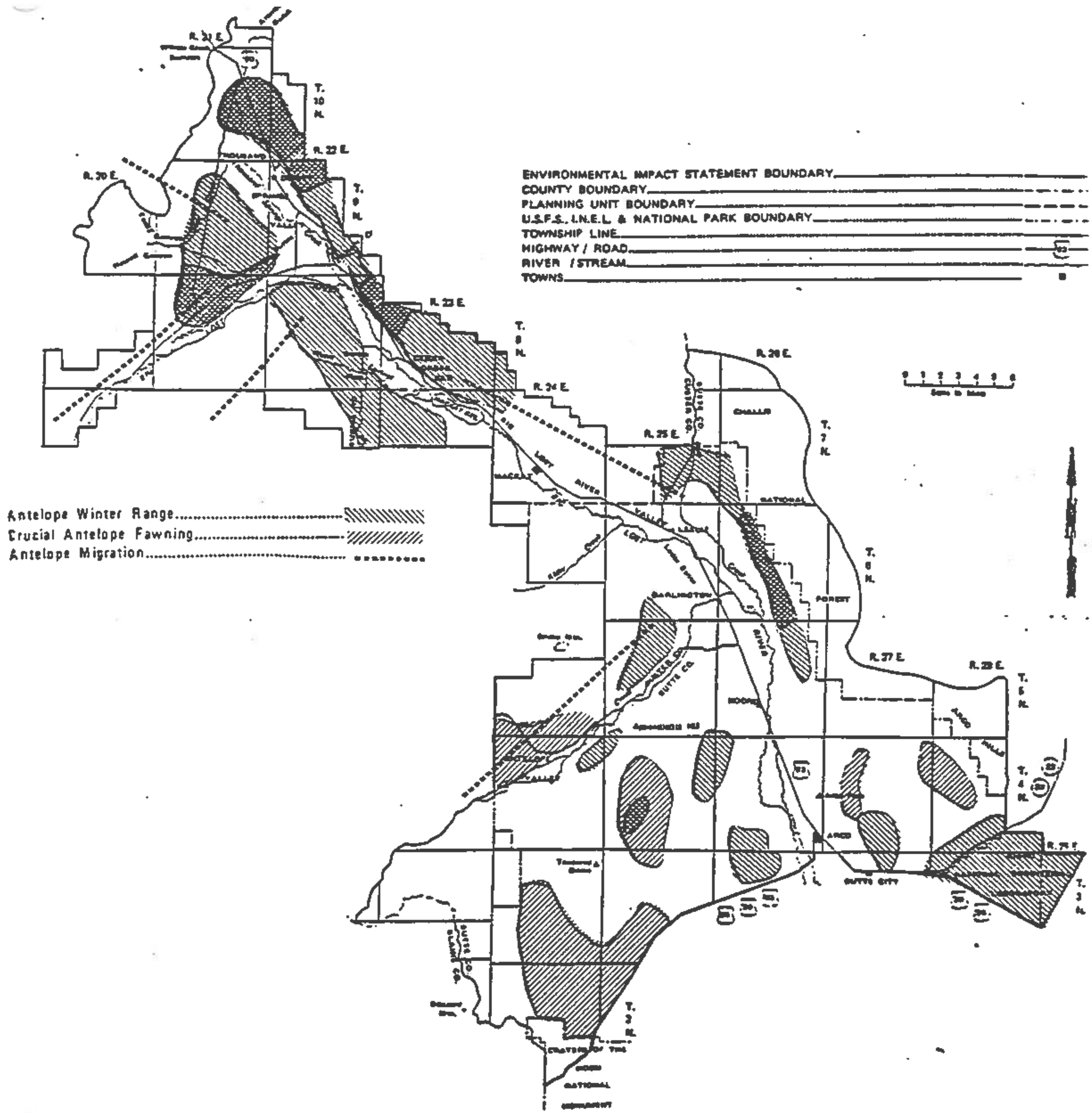
Northern Oriole	[illegible]	
Brewer's Blackbird	Euphagus cyanocephalus	M-S
Brown-Headed Cowbird	Molothrus ater	Sp-S
Common Grackle	Quiscalus quiscula	M
Western Tanager	Piranga ludoviciana	M-S
Rose-Breasted Grosbeak	Pheucticus ludovicianus	M
Blue Grosbeak	Guiraca caerulea	M-S
Black-Headed Grosbeak	Pheucticus melanocephalus	M-S
Evening Grosbeak	Hesperiphonia vespertina	YL
Pine Grosbeak	Pinicola enucleator	YL
Lark Bunting	Calamospiza melanocorys	M-S
Lazuli Bunting	Passerina amoena	M-S
Snow Bunting	Plectrophenax nivalis	W
Cassin's Finch	Cartpodacus cassinii	YL
House Finch	Carpodacus mexicanas	YL
Gray-Crowned Rosy Finch	Leucosticte tephrocotis	YL
Black Rosy Finch	Leucosticte atrata	W
Common Redpoll	Acanthis flammea	M-W
Pine Siskin	Spinus pinus	YL
American Goldfinch	Spinus tristis	M-S
Lesser Goldfinch	Spinus psaltria	M
Red Crossbill	Loxia curvirostra	YL
White Winged Crossbill	Loxia leucoptera	W
Green-Tailed Towhee	Chlorura chlorura	M-S
Rufous-Sided Towhee	Pipilo erythrophthalmus	M-S
Dark-eyed Junco	Junco oreganus	YL
Grey-Headed Junco	Junco caniceps	M-S
Savannah Sparrow	Passerculus sandwichensis	Sp-S
Grasshopper Sparrow	Ammodramus savannarum	M
Vesper Sparrow	Pooecetes gramineus	M-S
Lark Sparrow	Chondestes grammacus	M-S
Black-Throated Sparrow	Amphispiza bilineata	M-S
Sage Sparrow	Amphispiza belli	M-S
Tree Sparrow	Spizella arborea	W
Chipping Sparrow	Spizella passerina	M-S
Brewer's Sparrow	Spizella breweri	M-S
Harris' Sparrow	Zonotrichia querula	W-Sp
White Crowned Sparrow	Zonotrichia leucophrys	M-S
White-Throated Sparrow	Zonotrichia albicollis	M
Fox Sparrow	Passerella iliaca	M-S
Lincoln's Sparrow	Melospiza lincolnii	M-S

Wilson's Phalarope	Steganipus tricolor	M-S
Northern Phalarope	Lobipes lobatus	M
Pomarine Jaeger	Stercorarius pomarinus	M
American Avocet	Recurvirostra americana	M-S
Black-necked Stilt	Himantopus mexicanus	M-S
Long-billed Dowitcher	Limnodromus scolopaceus	M-S
Marbled Godwit	Limosa fedora	M
Herring Gull	Larus argentatus	M
California Gull	Larus californicus	M-S
Ring-Billed Gull	Larus delawarensis	YL
Franklin's Gull	Larus pipixcan	M
Bonaparte's Gull	Larus philadelphia	M
Forster's Tern	Sterna forsteri	M-S
Common Tern	Sterna hirundo	M
Rock Dove	Columba livia	YL
Mourning Dove	Zenaidura macroura	M-S
Yellow-Billed Cuckoo	Coccyzus americanus	M-S
Barn Owl	Tyto alba	M-S
Great Horned Owl	Bubo virginianus	YL
Screech Owl	Otus asio	YL
Snowy Owl	Nyctea scandiaca	W
Pygmy Owl	Glaucidium gnoma	YL
Western Burrowing Owl	Speotyto cunicularia	M-S
Great Grey Owl	Strix nebulosa	YL
Long-Eared Owl	Asio otus	YL
Flammulated Owl	Otus flammeolus	M-S
Short-Eared Owl	Asio flammeus	YL
Saw-Whet Owl	Aegolius acadicus	YL
Poor-Will	Phalaenoptilus nuttallii	M-S
Common Nighthawk	Chordeiles minor	M-S
White-Throated Swift	Aeronautes saxatalis	M-S
Black-Chinned Hummingbird	Archilochus alexandri	M-S
Broad-Tailed Hummingbird	Selasphorus platycercus	M-S
Rufous Hummingbird	Selasphorus rufus	M-S
Calliope Hummingbird	Stellula calliope	M-S
Belted Kingfisher	Megaceryle alcyon	M-S
Common Flicker	Colaptes auratus	YL
Pileated Woodpecker	Dryocupus pileatus	YL
Lewis' Woodpecker	Asyndesmus lewis	YL
Northern Three-Toed Woodpecker	Picoides tridactylos	YL
Yellow-Bellied Sapsucker	Sphyrapicus varius	M-S

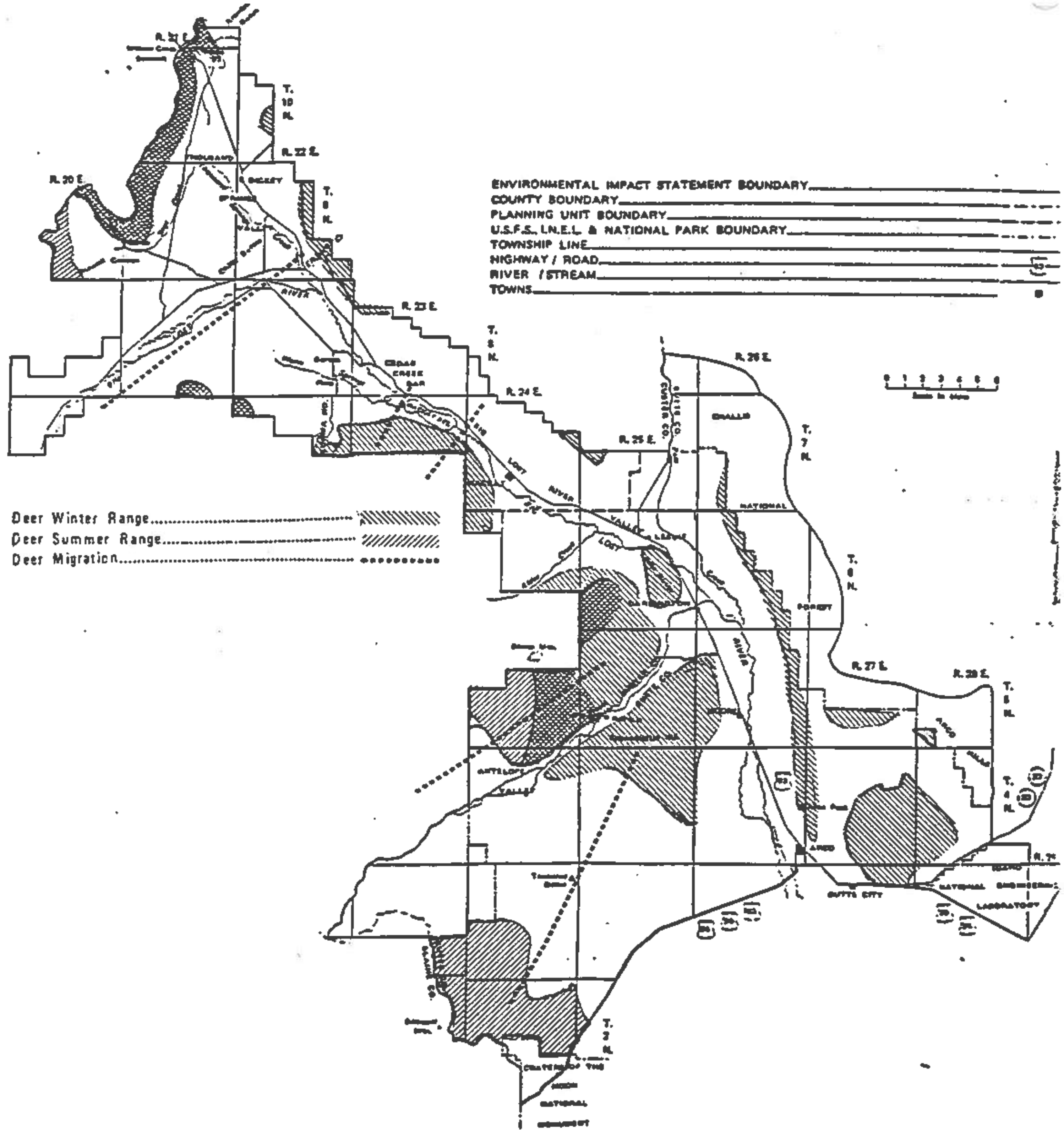
REPTILE AMPHIBIANS

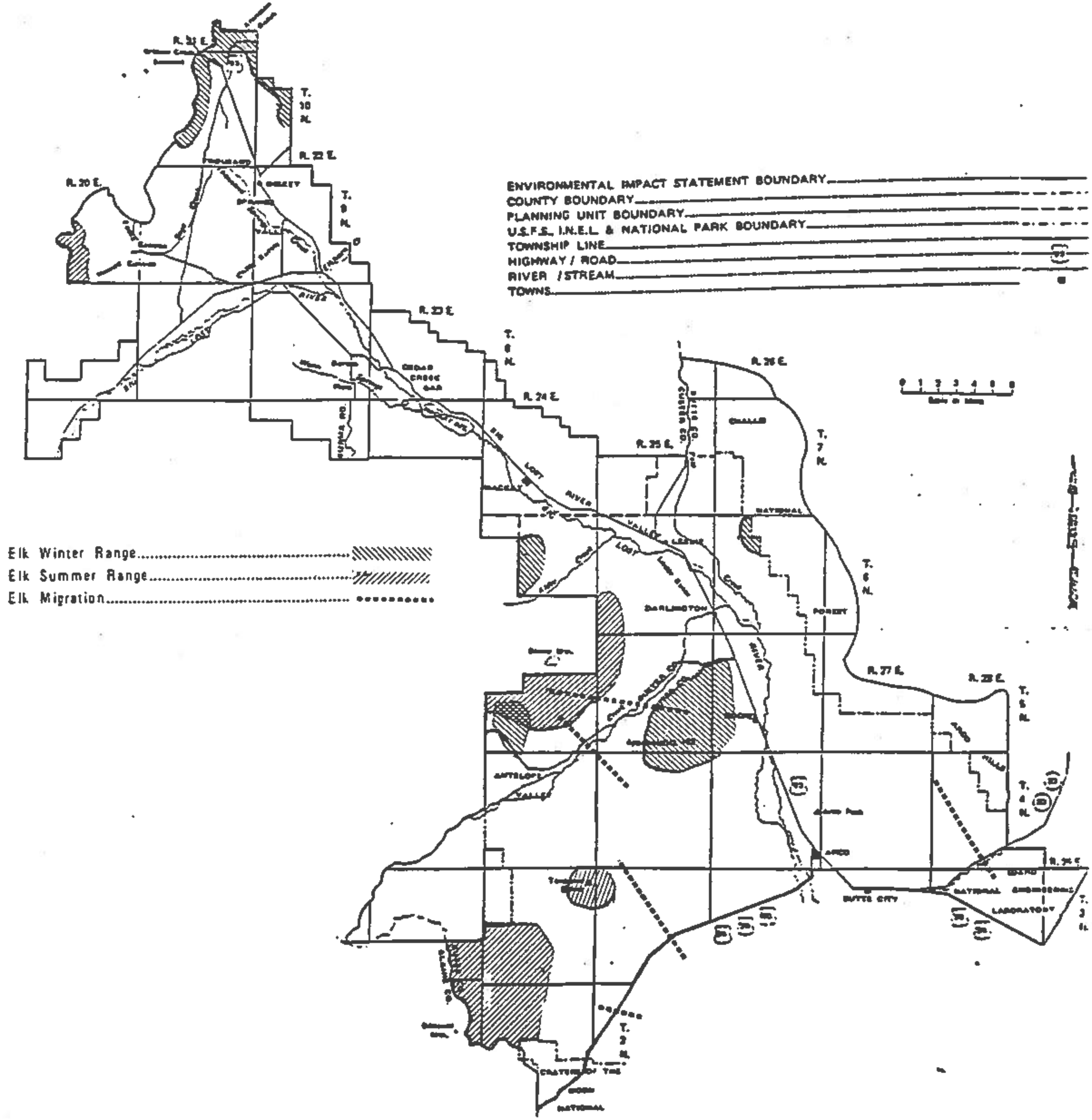
COMMON NAME	SCIENTIFIC BINOMIAL	TIME OF YEAR
Long-Toed Salamander	Ambystoma macrodactylum	YL
Tiger Salamander	Ambystoma tigrinum	YL
Great Basin Spadfefoot Toad	Scaphiopus intermontanus	YL
Western Toad	Bufo boreas	YL
Woodhouse's Toad	Bufo woodhousei	YL
Chorus Frog	Pseudacris triseriata	YL
Spotted Frog	Rana pretiosa	YL
Leopard Frog	Rana pipiens	YL
Leopard Lizard	Crotaphytus wislizenii	YL
Sagebrush Lizard	Sceloporus graciosus	YL
Short-Horned Lizard (Horny Toad)	Phrynosoma douglassi	YL
Western Skink	Eumeces skiltonianus	YL
Rubber Boa	Charina bottae	YL
Gopher or Bull Snake	Pituophis melanoleucus	YL
Common Garter Snake	Thamnophis sirtalis	YL
Western Terrestrial Garter Snake	Thamnophis elegans	YL
Western Rattlesnake	Cortalus viridus	YL
Western Yellow-Bellied Racer	Coluber constrictor mormon	YL
Night Snake	Hypsiglena torquata	?

trout (Salvelinus fontinalis Mitchill), kokanee salmon (Oncorhynchus nerka Walboum), and short head sculpin, (Cottus confusus).



ENVIRONMENTAL IMPACT STATEMENT BOUNDARY
COUNTY BOUNDARY
PLANNING UNIT BOUNDARY
U.S.F.S., I.N.E.L. & NATIONAL PARK BOUNDARY
TOWNSHIP LINE
HIGHWAY / ROAD
RIVER / STREAM
TOWNS
Antelope Winter Range
Crucial Antelope Fawning
Antelope Migration
R. 20 E.
R. 22 E.
R. 23 E.
R. 24 E.
R. 25 E.
R. 26 E.
R. 27 E.
R. 28 E.
T. 10 N.
T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
CHALLIS
FOREST
NATIONAL
BUTTE CO.
CUSTER CO.
LOST RIVER VALLEY
DARLINGTON
MOORE
ARCO
BUTTE CITY
CRATERS OF THE MOON NATIONAL MONUMENT


ENVIRONMENTAL IMPACT STATEMENT BOUNDARY
COUNTY BOUNDARY
PLANNING UNIT BOUNDARY
U.S.F.S., I.N.E.L. & NATIONAL PARK BOUNDARY
TOWNSHIP LINE
HIGHWAY / ROAD
RIVER / STREAM
TOWNS
Deer Winter Range
Deer Summer Range
Deer Migration
R. 20 E.
R. 22 E.
R. 23 E.
R. 24 E.
R. 25 E.
R. 26 E.
R. 27 E.
R. 28 E.
T. 10 N.
T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
RIVER
CEDAR CREEK BAR
LOST RIVER
VALLEY
CHALLIS
NATIONAL
FOREST
BUTTE CO.
CUSTER CO.
ANTELOPE
VALLEY
ARCO
BUTTE CITY
NATIONAL
LABORATORY
BLAINE CO.
NATIONAL
MONUMENT


ENVIRONMENTAL IMPACT STATEMENT BOUNDARY
COUNTY BOUNDARY
PLANNING UNIT BOUNDARY
U.S.F.S., I.N.E.L. & NATIONAL PARK BOUNDARY
TOWNSHIP LINE
HIGHWAY / ROAD
RIVER / STREAM
TOWNS
Elk Winter Range
Elk Summer Range
Elk Migration
R. 20 E.
R. 21 E.
R. 22 E.
R. 23 E.
R. 24 E.
R. 25 E.
R. 26 E.
R. 27 E.
R. 28 E.
R. 24 E.
T. 10 N.
T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
CEDAR CREEK GAP
LOST RIVER
VALLEY
DARLINGTON
MACKAY
CHALLIS
NATIONAL
FOREST
ANTELOPE VALLEY
ARCO
BUTTE CITY
IDAHO
NATIONAL ENGINEERING
LABORATORY
CRATERS OF THE
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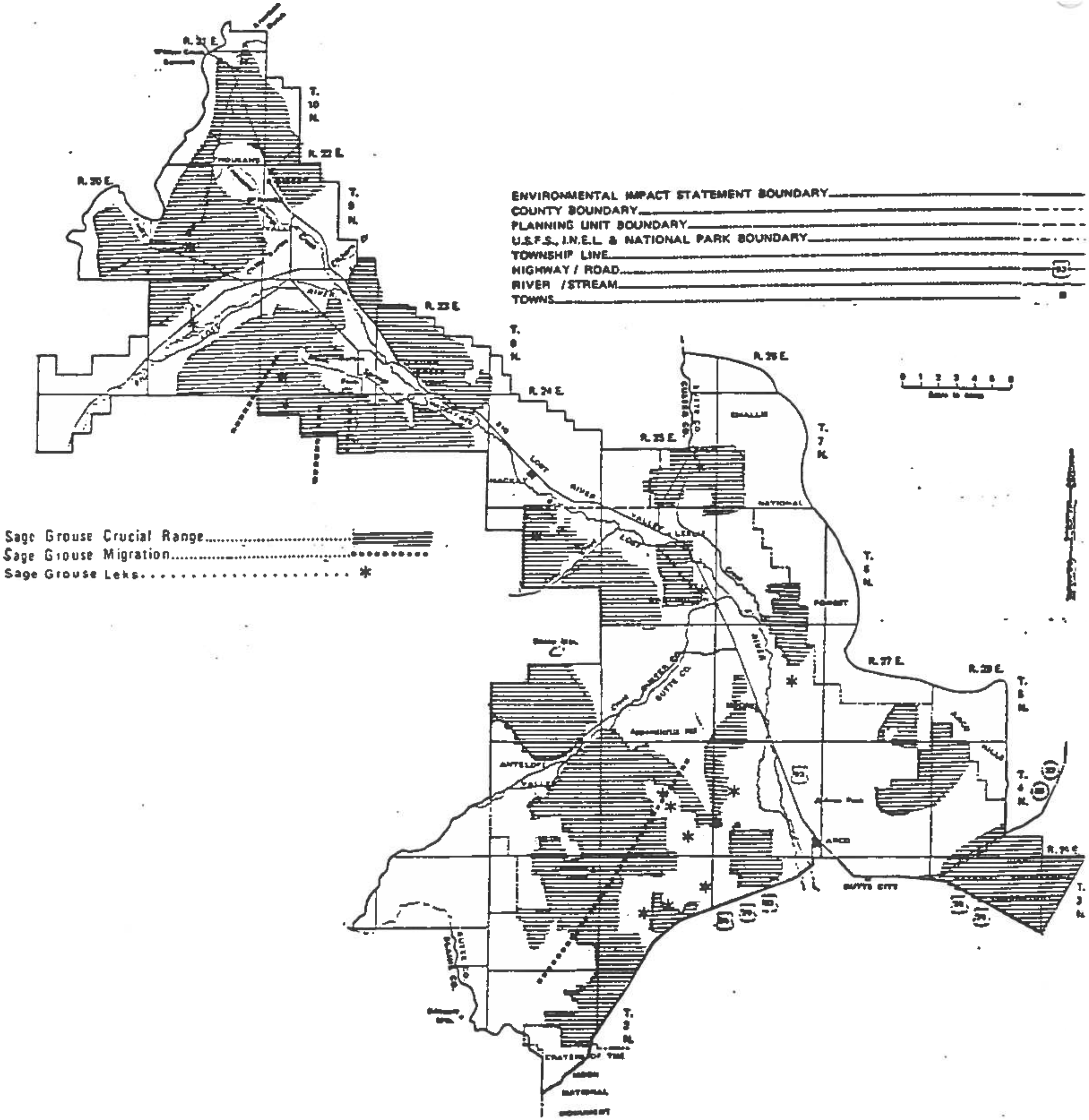
ENVIRONMENTAL IMPACT STATEMENT BOUNDARY
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PLANNING UNIT BOUNDARY
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HIGHWAY / ROAD
RIVER / STREAM
TOWNS
Sage Grouse Crucial Range
Sage Grouse Migration
Sage Grouse Leks
R. 21 E.
R. 22 E.
R. 20 E.
R. 23 E.
R. 24 E.
R. 25 E.
R. 26 E.
R. 27 E.
R. 28 E.
T. 10 N.
T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
RIVER
LOST
LOST RIVER
BIG LOST RIVER
VALLEY
CHALLIS
NATIONAL
FOREST
BUTTE CO.
CUSTER CO.
BLAINE CO.
ANTELOPE
ARCO
BUTTE CITY
CRATERS OF THE MOON NATIONAL MONUMENT

APPENDIX H

Cost Estimates

BIG LOST RIVER BASIN, 500 CFS
BARTON FLATS, ARCO, IDAHO
DATE PREPARED: 11/27/90 3:27:44 PM OCTOBER 1, 1990 PRICE LEVE

Prepared By: CENPW-EN-CB
Reviewed & Approved By: LARRY CHENEY

ACCOUNT CODE	ITEM DESCRIPTION		ESTIMATED COST	CONTINGENCY	TOTAL COST
15.0.-.-	FLOODWAY/DIVERSION STRUCTURES:				
15.0.A.-	MOB / DEMOB & PREP WORK:	(CONTRACT A)	$108,812	$27,188	$136,000
15.0.B -	CARE & DIVERSION OF WATER:	(CONTRACT A)	$184,117	$40,483	$224,600
15.0.1.-	OVERFLOW STRUCTURES:	(CONTRACT A)	$953,082	$238,318	$1,191,400
15.0.D.-	EARTHWORK, EMBANKMENT AND CANAL:	(CONTRACT A)	$1,145,146	$286,354	$1,431,500
15.0.J.-	BARTLETT POINT ROAD BRIDGE:	(CONTRACT A)	$133,692	$33,408	$167,100
15.0.2.N	BAFFLED APRON DROP STRUCTURE:	(CONTRACT A)	$163,603	$40,897	$204,500
15.0.D.-	EARTHWORK, INFILTION BASIN	(CONTRACT A)	$2,186,076	$546,524	$2,732,600
	SUBTOTAL CONSTRUCTION COSTS: WITH 25 % CONTINGENCY		$4,874,528	$1,213,172	$6,087,700
01.-.-.-	LANDS AND DAMAGES:		$28,600	$1,700	$30,300
30.-.-.-	PLANNING, ENGINEERING AND DESIGN:	(CONTRACT A)	$735,410	$183,890	$919,300
31.-.-.-	CONSTRUCTION MANAGEMENT:	(CONTRACT A)	$465,760	$116,440	$582,200
	TOTAL PROJECT COST: WITH 25 % CONTINGENCY		$6,104,298	$1,515,202	$7,619,500

**** TOTAL PROJECT COST SUMMARY ****

;T RIVER BASIN, 500 CFS
FLATS, ARCO, IDAHO
:EPARED: 11/27/90 3:27:44 PM

OCTOBER 1, 1990 PRICE LEVEL

Prepared By: CENPW-EN-C
Reviewed & Approved By: LARRY CHEN

CONTRACT NUMBER	ITEM DESCRIPTION:	ESTIMATED COST: 1 OCT 90	CONTINGENCY AMOUNT ($)	TOTAL EST. COST 1 OCT 90	MID-POINT CONSTRUCTION DATE (MO-YR)	OMB INFLATION FACTOR (%)	INFLATION TOTAL AMOUNT ($)
A	FLOODWAY/DIVERSION STRUCTURES:	$4,874,528	$1,213,172	$6,087,700	2 QTR 95	18.0%	$1,095,300
	TOTAL CONSTRUCTION COST =====>	$4,874,528	$1,213,172	$6,087,700			$1,095,300
	LANDS AND DAMAGES:	$28,600	$1,700	$30,300	1 QTR 93	9.4%	$2,700
A	PLANNING, ENGINEERING AND DESIGN:	$735,410	$183,890	$919,300	4 QTR 93	12.4%	$113,700
A	CONSTRUCTION MANAGEMENT:	$465,760	$116,440	$582,200	2 QTR 95	18.0%	$104,800
	TOTAL PROJECT COSTS =======>	$6,104,298	$1,515,202	$7,619,500			$1,316,500

.OST RIVER BASIN, 500 CFS
ON FLATS, ARCO, IDAHO
PREPARED: 11/27/90 3:27:44 PM

OCTOBER 1, 1990 PRICE LEVEL

Prepared By: CENPW-EN-C
Reviewed & Approved By: LARRY CHENE

IT R	ITEM DESCRIPTION:	ESTIMATED COST: 1 OCT 90	CONTINGENCY AMOUNT ($)	TOTAL EST. COST 1 OCT 90	MID-POINT CONSTRUCTION DATE (MO-YR)	OMB INFLATION FACTOR (%)	INFLATION TOTAL AMOUNT ($)	CU FULL
.-	FLOODWAY/DIVERSION STRUCTURES:	$4,874,528	$1,213,172	$6,087,700	1 QTR 91	18.0%	$1,095,300	$7
	TOTAL CONSTRUCTION COST =====>	$4,874,528	$1,213,172	$6,087,700			$1,095,300	$7
.-	LANDS AND DAMAGES:	$28,600	$1,700	$30,300	1 QTR 91	8.9%	$2,700	
.-	PLANNING, ENGINEERING AND DESIGN:	$735,410	$183,890	$919,300	1 QTR 91	12.4%	$113,700	$1
.-	CONSTRUCTION MANAGEMENT:	$465,760	$116,440	$582,200	1 QTR 91	18.0%	$104,800	
	TOTAL PROJECT COSTS =======>	$6,104,298	$1,515,202	$7,619,500			$1,316,500	$8

BIG LOST RIVER BASIN, 500 CFS
BARTON FLATS, ARCO, IDAHO
DATE PREPARED: 11/19/90 1:12:4 PM

OCTOBER 1, 1990 PRICE LEVEL

Prepared By: CENPW-EN-CB
Reviewed & Approved By: LARRY CHENEY

M-CACES BDIF	ACCOUNT CODE / ITEM	QUANTITY UNIT	UNIT PRICE	AMOUNT	CONTINGENCY AMOUNT	TOTAL AMOUNT	CONTINGENCY PERCENT
1	15.0.-.- FLOODWAY/DIVERSION STRUCTURES:						
2	15.0.A.- MOB / DEMOB & PREP WORK:	(CONTRACT A)					
2AA	.0.A.A MOB / DEMOB & PREP WORK	1 EA	108,812	108,812	27,188	136,000	25%
	SUBTOTAL, CONSTRUCTION COSTS:			108,812			
	15.0.Z.- CONTINGENCIES @ +/- 25.0 %				27,188		
	15.0.A.- MOB / DEMOB & PREP WORK:	(CONTRACT A) TOTAL:				136,000	
3	15.0.B - CARE & DIVERSION OF WATER:	(CONTRACT A)					
3AA	.0.B.B SITE PREPARATION	1 LS	14,135	14,135	3,565	17,700	25%
3BA	.0.B.B DIVERSION AND CARE OF WATER	1 LS	169,982	169,982	42,518	212,500	25%
	SUBTOTAL, CONSTRUCTION COSTS:			184,117			
	15.0.Z.- CONTINGENCIES @ +/- 25.0 %				46,083		
	15.0.B - CARE & DIVERSION OF WATER:	(CONTRACT A) TOTAL:				230,200	
4	15.0.1.- OVERFLOW STRUCTURES:	(CONTRACT A)					
4AA	.0.1.C SPILLWAY	1 LS	704,683	704,683	176,217	880,900	25%
4BA	.0.1.C CHILLY CANEL HEADWORKS	1 LS	20,198	20,198	5,002	25,200	25%
4CA	.0.1.C DIVERSION CANNEL HEADWORK	1 LS	228,201	228,201	57,099	285,300	25%
	SUBTOTAL, CONSTRUCTION COSTS:			953,082			
	15.0.Z.- CONTINGENCIES @ +/- 25.0 %				238,318		
	15.0.1.- OVERFLOW STRUCTURES:	(CONTRACT A) TOTAL:				1,191,400	
5	15.0.D.- EARTHWORK, EMBANKMENT AND CANAL:	(CONTRACT A)					
5AA	.0.D.B DAM, TIE-IN EMBANKMENT	1 LS	261,174	261,174	65,326	326,500	25%
5BA	.0.D.B DIVERSION CANAL	1 LF	883,972	883,972	221,028	1,105,000	25%
	SUBTOTAL, CONSTRUCTION COSTS:			1,145,146			
	15.0.Z.- CONTINGENCIES @ +/- 25.0 %				286,354		
	15.0.D.- EARTHWORK, EMBANKMENT AND CANAL:	(CONTRACT A) TOTAL:				1,431,500	

OCTOBER 1, 1990 PRICE LEVEL

Prepared By: CENPW-EN-CB
Reviewed & Approved By: LARRY CHENEY

M-CACES BDIF	ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY AMOUNT	TOTAL AMOUNT	CONTINGENCY PERCENT
6	15.0.J.-	BARTLETT POINT ROAD BRIDGE:	(CONTRACT A)						
6AA	.0.J.B	SITE WORK	1	LS	10,552	10,552	2,648	13,200	25%
6BA	.0.J.C	CONCRETE WORK	1	CY	119,343	119,343	29,857	149,200	25%
6CA	.0.J.E	GUARD RAIL ASSEMBLY	1	LF	3,993	3,993	1,007	5,000	25%
6DA	.0.J.B	BRIDGE SURFACING	1	SY	28,011	28,011	6,989	35,000	25%
		SUBTOTAL, CONSTRUCTION COSTS:				161,899			
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %					40,501		
	15.0.J.-	BARTLETT POINT ROAD BRIDGE:	(CONTRACT A) TOTAL:					202,400	
7	15.0.2.N	BAFFLED APRON DROP STRUCTURE:	(CONTRACT A)						
7AA	.0.2.B	SITE WORK	1	LS	26,499	26,499	6,601	33,100	25%
7BA	.0.2.C	CONCRETE WORK	1	CY	137,104	137,104	34,296	171,400	25%
		SUBTOTAL, CONSTRUCTION COSTS:				163,603			
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %					40,897		
	15.0.2.N	BAFFLED APRON DROP STRUCTURE:	(CONTRACT A) TOTAL:					204,500	
8	15.0.D.-	EARTHWORK, INFILTION BASIN	(CONTRACT A)						
8AA	.0.2.B	SITE WORK	1	LS	2,186,076	2,186,076	546,524	2,732,600	25%
		SUBTOTAL, CONSTRUCTION COSTS:				2,186,076			
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %					546,524		
	15.0.D.-	EARTHWORK, INFILTION BASIN	(CONTRACT A) TOTAL:					2,732,600	

BIG LOST RIVER BASIN, 500 CFS — Prepared By: CENPW-EN-CB
BARTON FLATS, ARCO, IDAHO
DATE PREPARED: 11/19/90 1:12:4 PM — OCTOBER 1, 1990 PRICE LEVEL — Reviewed & Approved By: LARRY CHENEY

M-CACES BDIF	ACCOUNT CODE	ITEM	CONTINGENCY PERCENT	CONTINGENCY EXPLANATION
1	15.0.-.-	FLOODWAY/DIVERSION STRUCTURES:		
2	15.0.A.-	MOB / DEMOB & PREP WORK:		(CONTRACT A)
2AA	.0.A.A	MOB / DEMOB & PREP WORK	25%	Mob/demob based on list of equipment thought needed for the job.
		SUBTOTAL, CONSTRUCTION COSTS:		
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %		
3	15.0.B -	CARE & DIVERSION OF WATER:		(CONTRACT A)
3AA	.0.B.B	SITE PREPARATION	22%	Preliminary design, quantities furnished by the designer.
3BA	.0.B.B	DIVERSION AND CARE OF WATER	22%	Preliminary design, quantities furnished by the designer.
		SUBTOTAL, CONSTRUCTION COSTS:		
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %		
4	15.0.1.-	OVERFLOW STRUCTURES:		(CONTRACT A)
4AA	.0.1.C	SPILLWAY	25%	Preliminary design, quantities furnished by the designer.
4BA	.0.1.C	CHILLY CANEL HEADWORKS	25%	Preliminary design, quantities furnished by the designer.
4CA	.0.1.C	DIVERSION CANNEL HEADWORK	20%	Preliminary design, quotes based on quantities given.
		SUBTOTAL, CONSTRUCTION COSTS:		
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %		
5	15.0.D.-	EARTHWORK, EMBANKMENT AND CANAL:		(CONTRACT A)
5AA	.0.D.B	DAM, TIE-IN EMBANKMENT	25%	Preliminary design, quantities furnished by the designer.
5BA	.0.D.B	DIVERSION CANAL	25%	Preliminary design, quantities furnished by the designer.
		SUBTOTAL, CONSTRUCTION COSTS:		
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %		

CONTINGENCY EXPLANATION SUMMARY

BIG LOST RIVER BASIN, 500 CFS — Prepared By: CENPW-EN-CB
BARTON FLATS, ARCO, IDAHO
DATE PREPARED: 11/19/90 1:12:4 PM — OCTOBER 1, 1990 PRICE LEVEL — Reviewed & Approved By: LARRY CHENEY

M-CACES BDIF	ACCOUNT CODE	ITEM	CONTINGENCY PERCENT	CONTINGENCY EXPLANATION
6	15.0.J.-	BARTLETT POINT ROAD BRIDGE:		(CONTRACT A)
6AA	.0.J.B	SITE WORK	25%	Preliminary design, quantities furnished by the designer.
6BA	.0.J.C	CONCRETE WORK	22%	Preliminary design, quotes based on quantities given.
6CA	.0.J.E	GUARD RAIL ASSEMBLY	20%	Preliminary design, quotes based on quantities given.
6DA	.0.J.B	BRIDGE SURFACING	25%	Preliminary design, quantities furnished by the designer.
		SUBTOTAL, CONSTRUCTION COSTS:		
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %		
7	15.0.2.N	BAFFLED APRON DROP STRUCTURE:		(CONTRACT A)
7AA	.0.2.B	SITE WORK	25%	Preliminary design, quantities furnished by the designer.
7BA	.0.2.C	CONCRETE WORK	25%	Preliminary design, quantities furnished by the designer.
		SUBTOTAL, CONSTRUCTION COSTS:		
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %		
8	15.0.D.-	EARTHWORK, INFILTION BASIN		(CONTRACT A)
8AA	.0.2.B	SITE WORK	25%	Preliminary design, quantities furnished by the designer.
		SUBTOTAL, CONSTRUCTION COSTS:		
	15.0.Z.-	CONTINGENCIES @ +/- 25.0 %		

APPENDIX I

Pertinent Correspondence and Letters of Support

P.O. BOX 737
ARCO, IDAHO 83213

JANUARY 8, 1990

JAW 10 Jan '90

Lieutenant Colonel James A. Walter
District Engineer
Department of the Army
Walla Walla District
Corps of Engineers
Walla Walla, Washington 99362-9265

Dear Lieutenant Colonel Walter:

This is in response to your request regarding sponsorship of a potential flood control project in the Big Lost River Basin. Butte County agrees to act as sponsor for a project if the feasibility study results in a project plan that the county wishes to participate in.

Assuming a favorable and acceptable project, the County would enter into a Local Cooperation Agreement (LCA) with the Corps of Engineers to implement the project. By signing the LCA, Butte County would be subject to the Department of Army's policies for cost sharing and project financing as set forth in the LCA.

BUTTE COUNTY BOARD OF COMMISSIONERS

James O. Andreason, Chairman

Herman Aikele, Member

Seth Beal, Member

cc: Jack Jensen
Butte Soil & Water Conservation District
P. O. Box 819
Arco, Idaho 83213

December 15, 1989

Cliff Fitzsimmons
Army Corp of Engineers
Building 602, City-County Airport
Walla Walla, Washington 99362-9265

Dear Cliff:

As we discussed on the telephone the Butte Soil and Water Conservation District is planning on a series of public information meetings. The board has selected January 16 and 17, 1990 as the dates. There will be two meetings per day. An afternoon meeting at 1:30 is scheduled in Moore and an evening meeting at 7:00 in Arco on the 16th. On the 17th an afternoon meeting will be above the Mackay reservoir and in Mackay for the evening meeting.

We appreciate your willingness to participate in these meetings. If you have any questions please contact me at (208) 527-8557 or Jack Jensen at (208) 527-3179.

Sincerely,

Dan Holden

Dan Holden, District Conservationist

cc: Jerry Nicholescu, SCC
Robert Zinszer, SCS

October 30, 1989

Cliff Fitzsimmons
US Army Corps of Engineers
Walla Walla District
Building 603
City-County Airport
Walla Walla, Washington 99362-9265

Dear Sir:

This letter is to inform you of recent events regarding the formation of a watershed improvement district. An election was held on October 5, 1989.

The referendum to form a watershed improvement district was defeated. The Butte Soil and Water Conservation District board of supervisors wishes to try one more time after having a series of local public meetings.

If you have any questions feel free to contact us at the Arco Field Office - 208-527-8557.

Sincerely,

Jack Jensen, Supervisor
Butte Soil and Water Conservation District

August 28, 1989

Cliff Fitzsimmons
Army Corps of Engineers
Building 602, City-County Airport
Walla Walla, WN 99362-9265

Dear Sir:

The Army Corps of Engineers is currently conducting a feasibility study for flood control on the Big Lost River. The control project entails diverting peak runoff into a canal and sinking the excess water in trenches in the Barton Flat area. The Corps would like to meet with local landowners who may be directly involved with any construction on their property and also to answer questions and take comments on the project. A meeting has been scheduled for 2:00 p.m. September 13, 1989 at the Forest Service Lost River Ranger Station in Mackay. A map that shows the approximate alignment of the structures is included for your information. If you have any questions about the meeting please call me at (208) 527-8557.

Dan Holden

Dan Holden
District Conservationist

Enclosure

APPENDIX B

Geotechnical Considerations

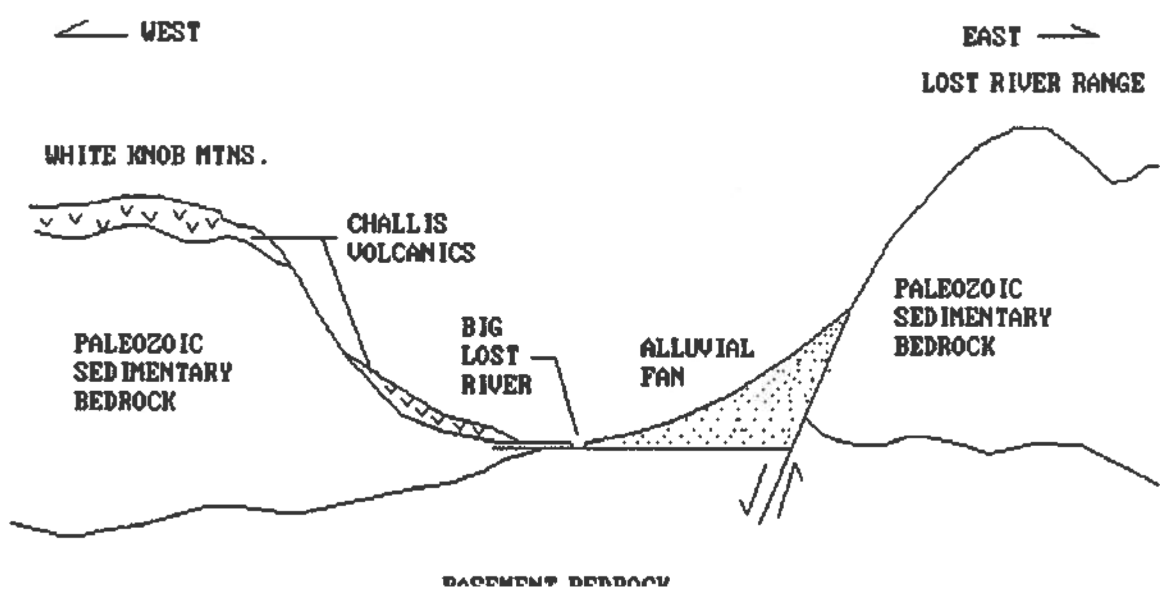
GEOTECHNICAL CONSIDERATIONS

1. INTRODUCTION.

Four exploratory holes were drilled in the vicinity of Chilly Buttes, Idaho, to study the subsurface hydrogeological characteristics of the area. In addition, eight test trenches were excavated with a small backhoe to permit detailed examination and classification of the near surface foundation materials (see plates 5 through 7 for Plan of Exploration and Logs of Explorations). By classifying the materials removed from the holes and by performing infiltration tests, the subsurface stratigraphy was found to consist of strata that was either porous and permeable or tight and much less permeable.

2. GENERAL GEOLOGY.

The study area is located in southeast Idaho in an area characterized by long, narrow, subparallel, northwest-southeast trending mountain ranges separated by broad intermontane valleys (figure 1). The ranges and valleys were produced when northeast-southwest extension of the earth's crust caused mountains to rise and valleys to subside. This type of mountain building, known as basin and range tectonics, began approximately 17 million years ago and continues today. The present landscape is a product of basin and range tectonics and Pleistocene glaciation. In the Thousand Springs Valley, glacial deposits merge with the recent alluvium and are virtually indistinguishable (Ross, 1947).



The southwestern flank of the Lost River Range is bordered by alluvial fans along its entire length. These alluvial fans result from rapid erosion in the high mountains with relatively high annual precipitation. The abundant erosional debris are deposited, forming the alluvial fan, as the mountains streams emerge on the gentle slopes of the bordering semiarid valleys. Few streams from the mountains maintain channels across the fans, with their flows entering the subsurface. Groundwater entering the subsurface at the valley margins is channeled into porous strata known as aquifers. In the study area the aquifers are confined by less permeable strata.

4. METHODS OF INVESTIGATION.

Four exploratory holes were drilled using a Bucyrus Erie 20W churn drill. The driller used a 6-inch chopping bit and drove 6-inch steel casing. An attempt was made to recover samples using a continuous sampling tool, but the attempt proved fruitless due to the coarse grained nature of the materials. Falling head infiltration tests were performed at 10-foot intervals. Each test was performed by drilling approximately 1 foot ahead of the casing, removing the drill tools from the hole, and filling the casing with water to ground level. The water level in the casing was then measured every 5 minutes for a period of 1 hour (the results of the falling head tests are listed on the summary logs, attached). When the holes reached their designed depth, with the materials classified and falling head tests performed, the wells were completed by installing 2.5 inch PVC piezometers and pulling the steel casing.

5. INTERPRETATION.

The stratigraphy of Barton Flats consists of alternating layers of contrasting permeabilities and is assumed to be the result of alternating basal moraine and outwash. This stratigraphy is typical of that found in glaciated areas. According to Ross (1947) who performed much of the original geologic mapping in southeast Idaho, glacial deposits are abundant in the vicinity of Chilly Buttes.

6. DESCRIPTION OF FOUNDATION MATERIALS.

The stratigraphy consisting of 100 plus feet stratified and unstratified alluvium overlying bedrock. Drill holes D-1, D-3, and D-4 were drilled 50 feet into the alluvium and did not reach groundwater or bedrock. D-2, drilled to 126 feet, encountered water at the alluvium-rock contact at 103 feet. After water was encountered in D-2 the water level in the casing rose to 86 feet. The rise in water level implies that the aquifer is confined by an overlying impermeable layer of alluvium.

clay matrix (SC), and clay (CL) (see summary logs, attached). Each of the different material types encountered exhibit different hydrogeological properties. The clean sands and gravels are porous and permeable and exhibit the ability to hold and transmit water. Conversely the gravel with clay and sand matrix, sands with clay, and clay layers tend not to hold water and more importantly tend to restrict the vertical movement of water in the subsurface. The contacts between the permeable and less permeable layers are sharp and not gradational. The vertical distribution of the less permeable versus the permeable layers is summarized in plate 1. Infiltration rates determined by falling head tests were higher in the permeable zones and lower in the less permeable. Summary logs are attached that list the materials encountered and the results of each infiltration test.

7. QUARRY INVESTIGATIONS.

Two quarry sites were identified in the vicinity of the study area. Site No. 1 is located in the E 1/2 sec. 15, T. 8 N., R. 21 E. at a location known locally as Bartlett Point. There is an existing quarry at this site. The rock is white (fresh) to yellow-brown (weathered) fine- to coarse-grained quartzite belonging to the Pennsylvanian aged Wood River Formation. Fractures in the rock are spaced from 6 inches to 3 feet and are generally open. Usable riprap size rock at this site exceed 500,000 cubic yards (cy), assuming 50 percent recovery. Site No. 2 is located in the SW 1/2 sec. 23, T. 8N., R. 21 E. Site No. 2 is also an outcropping of the Wood River Formation that lies to the southeast of Bartlett Point. The rock type, as at site No. 2 is white (fresh), very hard, moderately-fractured quartzite. Riprap size rock at this site also exceed 500,000 cy assuming 50 percent recovery.

8. CONSTRUCTION MATERIALS.

Gravel fill materials for embankment construction and backfill material can be selected from required excavation or from existing borrow areas in the vicinity. Riprap may be obtained from quarrys as noted in paragraph 7, Quarry Investigations.

9. EMBANKMENT DESIGN CONSIDERATIONS.

a. Embankment Tie from Diversion Structure to Riverbank.

(1) General.

The embankment, extending from the diversion structure and

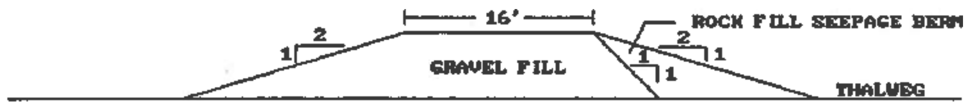


Figure 2. TYPICAL EMBANKMENT SECTION

The analysis utilized a flow net construction to determine head drop at the toe of the embankment.

(2) <u>Flow Net Construction</u>.

The upper flow line through the embankment was constructed using Casagrade's method (EM 1110-2-1901, figure 6-2), and assumed the following:

* The embankment and foundation are both gravel material and have similar permeabilities.
* The worst condition occurs during irrigation diversion.
* The assumed geometry and flow net is shown in plate 2.

The computation of variables used in flow net construction is shown below.

$a = S_o - v[S_o^2-(h^2/sin^2a)]$ (from EM 1110-2-1901, figure 6-2)

Where:

$S_o = v(d^2+h^2)$

Using values shown in plate 2:

$S_o = v(42^2+5^2) = 42.30$

$a = 42.30-v[42.30^2 - (5^2/sin^245)] = 0.60$

(3) <u>Determination of Critical Gradient (Piping) Factor of Safety</u>.

The critical gradient factor of safety, at the downstream toe of the seepage berm, was computed to evaluate the piping potential and required length of the seepage berm. The factor of safety was based upon the exit gradient, computed from the head loss over the length of the flow net square at the edge of the seepage berm as follows:

head drop = total head/number of head drops = 5/6 = 0.83

Exit gradient = h_{ex} = head drop/length of flow net square
$h_{ex} = 0.83/15 = 0.06$

FS against critical gradient = $h_{crit.}/h_{ex}$
FS = 1/0.06 = 18

The factor of safety indicates a very conservative design as a factor of safety of 4 to 5 is generally recommended. The required thickness of the seepage berm to resist heaving was judged to be minimal based upon inspection of head values on the downstream side of the embankment.

(4) Riprap.

The upstream slopes of the embankment will be armored with riprap to prevent wave erosion. River velocities against the embankment are assumed to be minimal and not a factor in the design. The ponded area behind the diversion structure is relatively well protected from wind and a minimal layer thickness of 24 inches of riprap is considered to be appropriate. The riprap toe will be placed to a depth of 5 feet below the thalweg.

b. Infiltration Basin Embankment.

The embankment on the downstream end of the infiltration basin was not analyzed for stability or seepage conditions, but will be conservatively design to preclude any problems with stability and piping. Excess material from required excavation, which will consist of gravelly sands or sandy gravels, will be placed on the outside toe of the slope to buttress the embankment an lengthen the seepage path.

10. DIVERSION STRUCTURE SEEPAGE CONSIDERATIONS.

a. General.

The proposed diversion structure was analyzed to determine uplift pressures and the factor of safety against piping. The analysis was performed using the method of fragment (EM 1110-2-1901, Seepage Analysis and Control for Dams--appendix B, Approximate Methods of Analysis of Flow Problems) which should provide a reasonably accurate answer for this level of study. A more detailed analysis will be performed in later studies.

The following assumptions were used in the analysis:

- K = coefficient of permeability = 0.7 ft/min (for gravel riverbed material)
- Critical Condition occurs during irrigation diversion (tailwater is at its lowest)
- Fragment types used are:
  Region 1 & 3 = Type II (EM 1110-2-1901, figure B-4)
  Region 2 = Type VI
- Geometry used in the analysis is shown in figure 3:

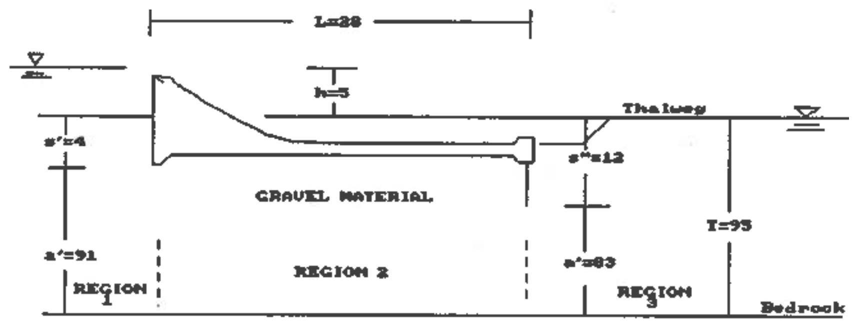


Figure 3. ASSUMED GEOMETRY USED IN ANALYSIS

c. <u>Determination of Form Factor (ϕ)</u>.

The form factor (ϕ) is used in the analysis to determine the head loss over the length of the structure. The determination of ϕ follows:

For Region 1:

$1/(2*\phi)$ is determined from EM 1110-2-1901 figure B-7
$1/(2*\phi) = 1.3$ for $s'/T = 4/95 = 0.04$ and $b/T = 0$

Therefore

$\phi_1 = 1/(2*1.3) = 0.38$

$\Phi = \ln[(1+(b'/a'))(1+(b''/a''))]$ from EM 1110-2-1901 figure B-4.

Where

$b' = (L+(s'-s''))/2$
$b'' = (L-(s'-s''))/2$

Therefore

$b' = (28+(4-12))/2 = 10$
$b'' = (28-(4-12))/2 = 18$

$\Phi_2 = \ln[(1+(10/91))(1+(18/83))] = 0.30$

For Region 3:

$1/(2*\Phi)$ is determined from EM 1110-2-1901 figure B-7
$1/(2*\Phi) = 1.03$ for $s''/T = 12/95 = 0.13$ and $b/T = 0$

Therefore

$\Phi_3 = 1/(2*1.03) = 0.49$

$$E\Phi = \Phi_1+\Phi_2+\Phi_3 = 0.38+0.30+0.49 = 1.17$$

d. Determination of Seepage Quantity.

The approximate quantity of seepage was estimated using EM 1110-2-1902 equation B-3 as follows:

$Q = k(h/E\Phi) = 0.7(5/1.17) = 2.99$ cf/min

e. Determination of Head Loss and Uplift Pressures.

The head loss was determined for each of the three regions to provide the uplift pressure across the diversion structure. The head loss for each region was computed using EM 1110-2-1901, Equation B-4 as follows:

$h_n = (h*\Phi_n)/E\Phi$

$h_1 = (5*0.38)/1.17 = 1.62$ ft
$h_2 = (5*0.30)/1.17 = 1.28$ ft

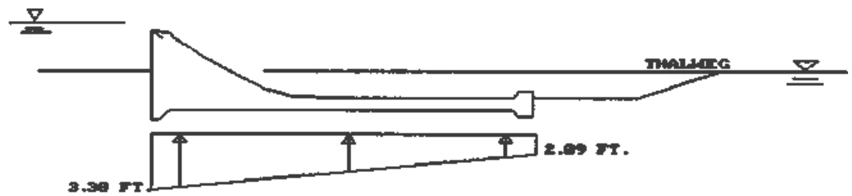


Figure 4. . UPLIFT PRESSURE ON BOTTOM OF STRUCTURE

The head losses were computed with respect to the thalweg elevation, consequently the uplift pressure does not consider the counteracting weight of the water over the spilling basin.

f. <u>Factor of Safety Against Critical Gradient (Piping)</u>.

The factor of safety against a critical gradient condition developing at the downstream end of the diversion structure was computed to evaluate the piping potential. The factor of safety was based upon the exit gradient computed from the head loss over the length of the seepage path in the last region as follows:

$$\text{Exit gradient} = h_{ex} = h_3/\text{length} = 2.09/10 = 0.209$$

The factor of safety was computed based upon the critical gradient for initiation of piping and the exit gradient as follows:

$$FS = i_{ct}/h_{ex} = 1/0.209 = 4.78$$

The factor of safety of 4.78 indicates the proposed structure is adequately designed against piping failure.

11. <u>INFILTRATION RATE DETERMINATION</u>.

The infiltration rates used for design of the infiltration basin were determined based upon the following considerations:

* Infiltration testing conducted by the Soil Conservation Service (SCS) in a geologically similar area as reported in the report "Little Lost River Flood Control Measure Plan and Environmental Impact Statement" (June 1985).

based upon measured canal widths and water depths.

* Infiltration testing was conducted at two locations in the project area. The foundation materials in the first test location area are typical of most near-surface materials in the project area. The second test location was adjacent to the Neilson canal. The foundation materials in the area of the Neilson canal (and the second test location) are finer (associated with slope wash from the adjacent hill sides) than the materials elsewhere at the project.

* Falling head tests were conducted during drilling of the churn drill holes, infiltration rates were computed based upon the open hole area exposed below the drill casing, and the average height of water in the casing during the test (tests were conducted for 60 minutes).

The results of the various infiltration measurements are shown on plates 3 and 4. Plate 3 is a smaller scale chart, and does not include the churn drill falling head tests. Plate 4 is a larger scale chart, and includes the churn drill tests. The infiltration rate curve used in the design of the infiltration basin was conservatively selected and falls to the lower rate side of the tests shown on plate 3, and towards the median range of the results of the churn drill falling head tests shown on plate 4. A more detailed analysis, utilizing a large scale infiltration test, will be conducted during later studies.

12. REFERENCES.

Alt, David D. 1972. Roadside Geology of the Northern Rockies, Mountain Press Pub. Co., Missoula, MT.

Ross, Clyde P. 1947. Geology of the Borah Peak Quadrangle, Idaho, Geol. Soc. America Bull., Vol. 58, pp. 1085-1160.

NOTE: Depths are in feet below ground surface.

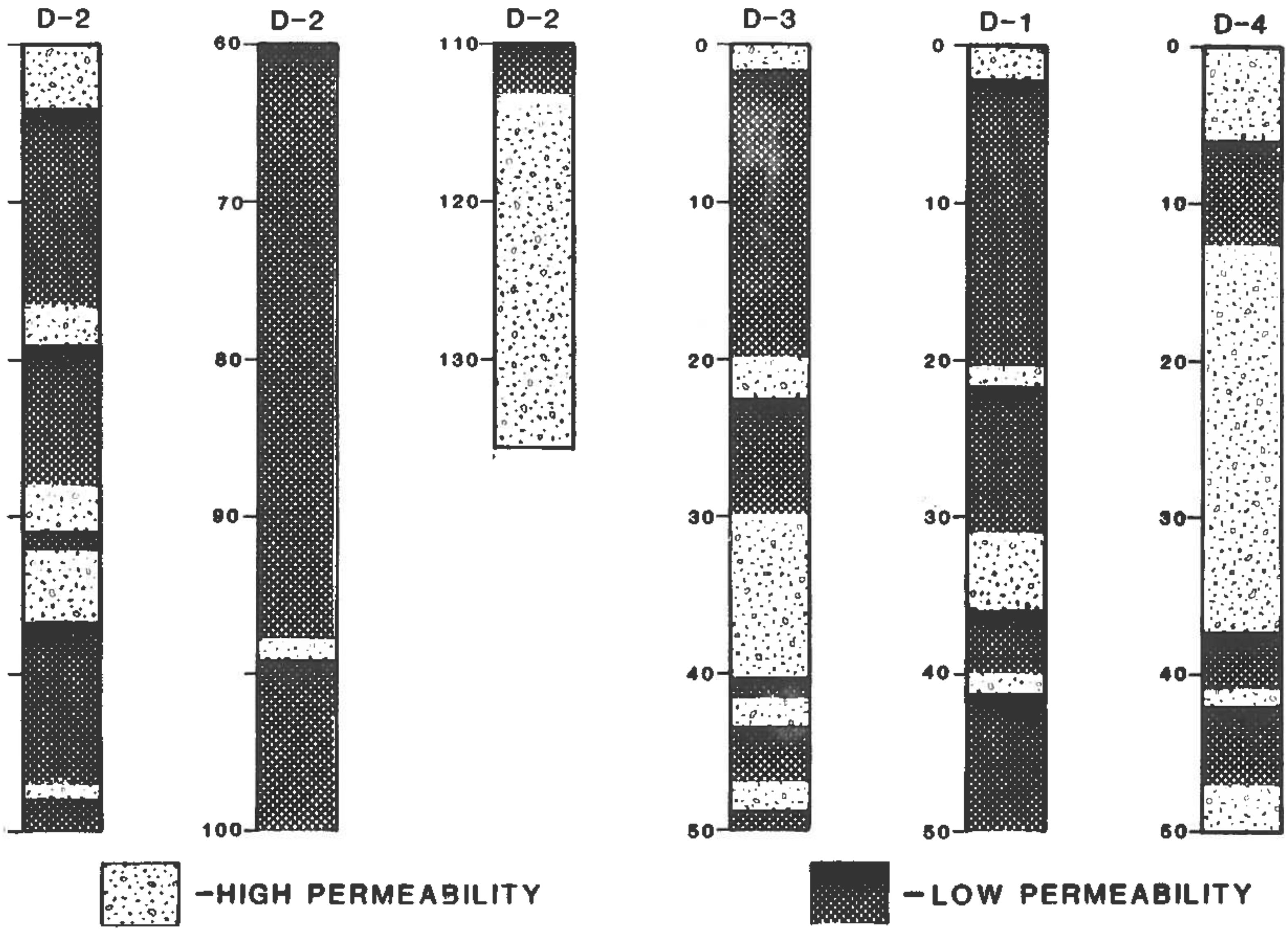


PLATE 1 Summary of permeability vs. depth.

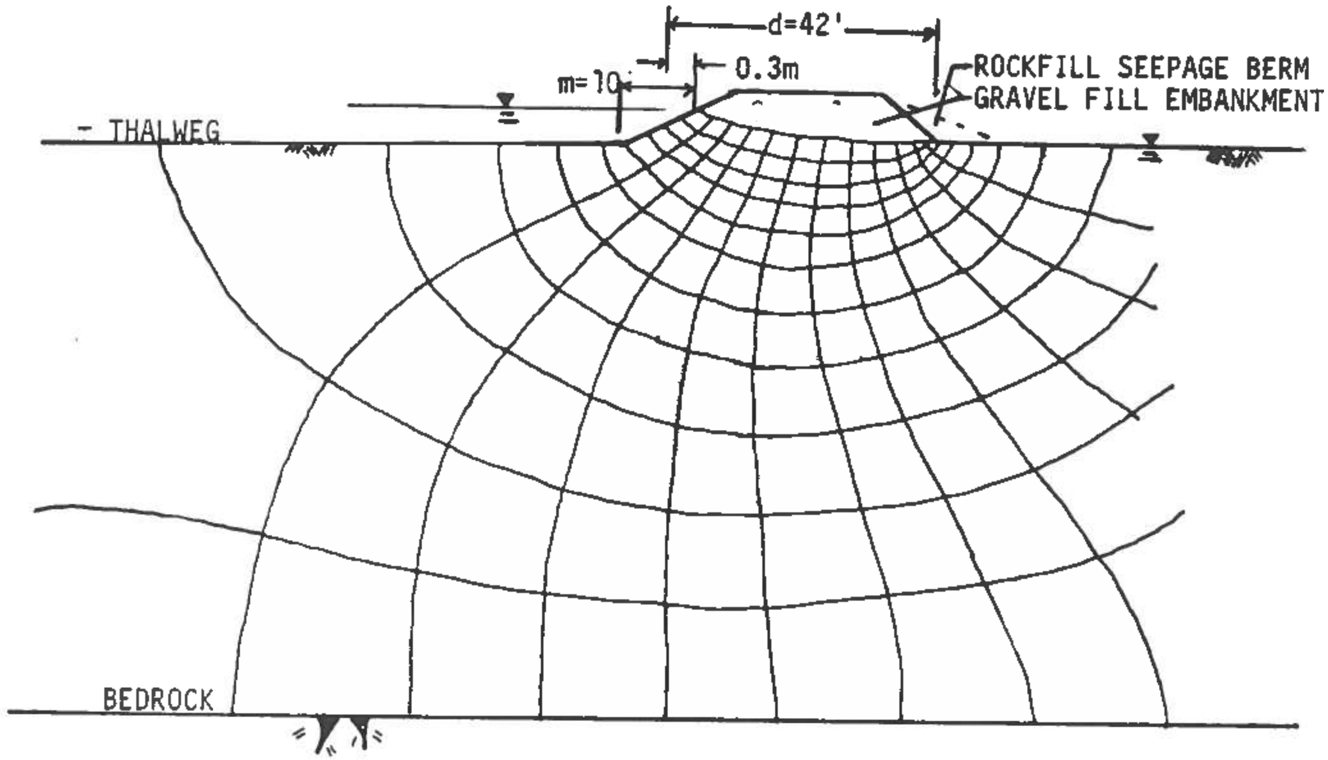
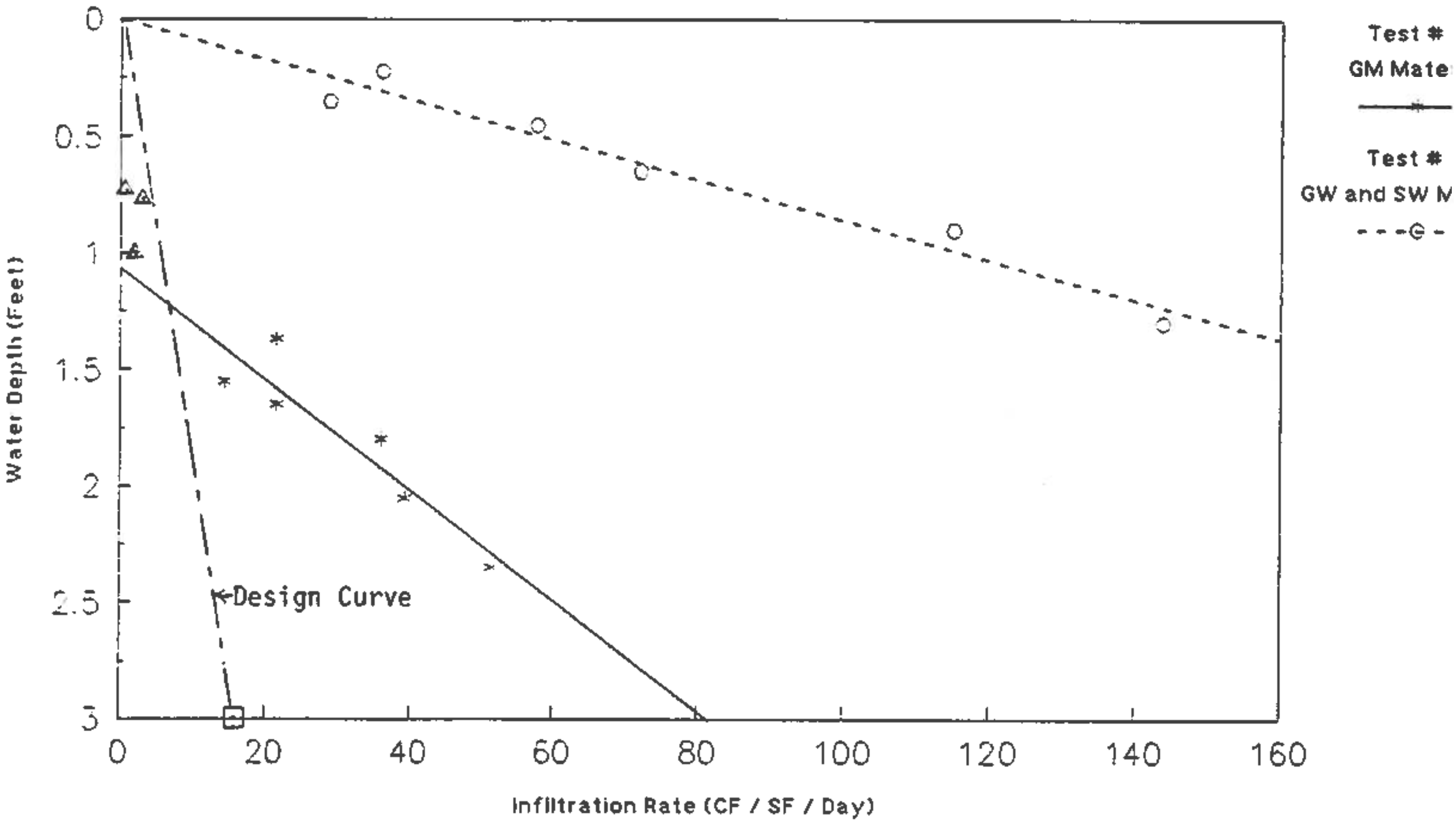


Plate 2. Assumed Geometry and Flow Net

BIG LOST RIVER FLOOD CONTROL PROJECT

Near MaCkay, Idaho

Summary of Infiltration Testing

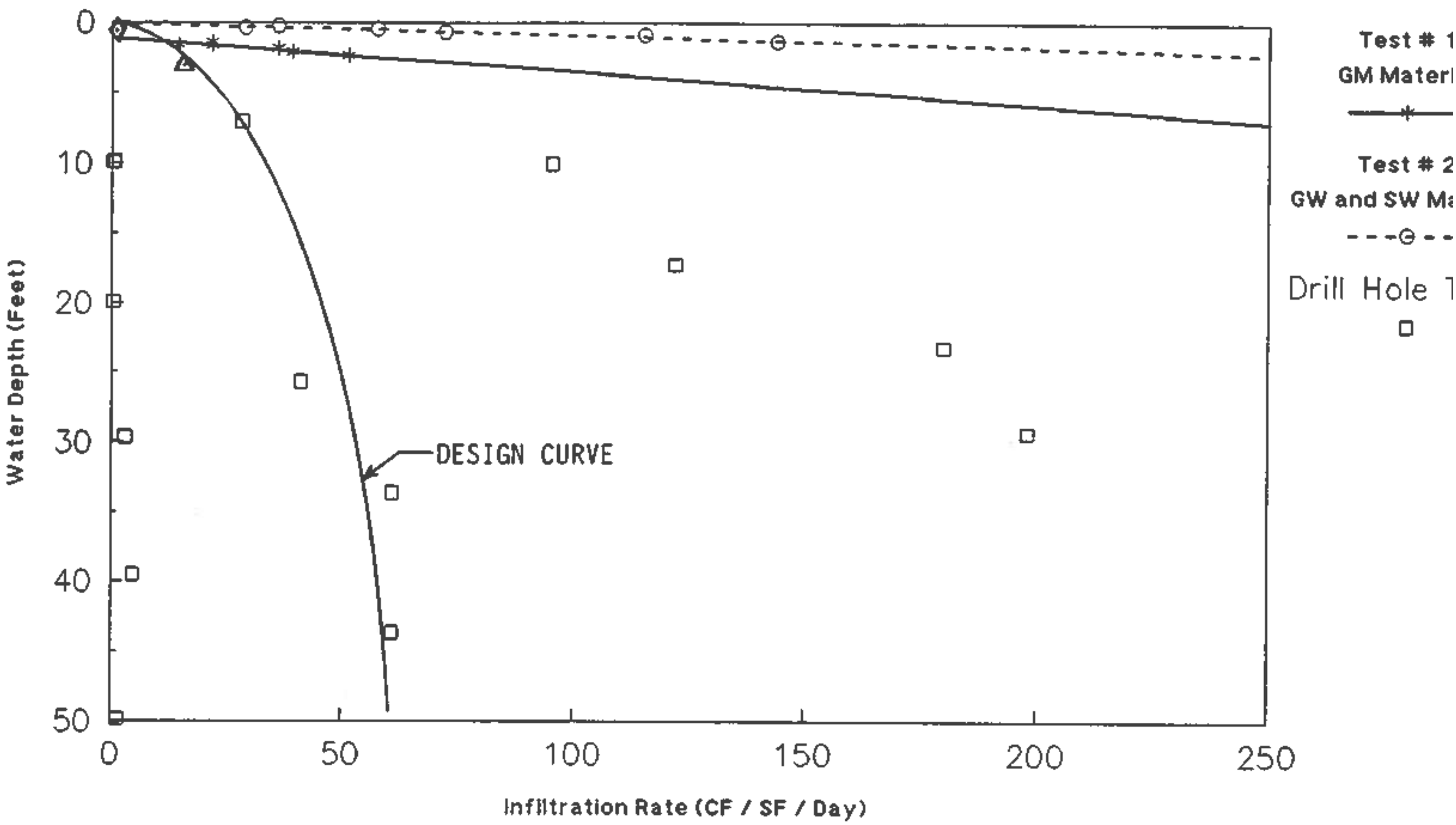


om of Test #1 Trench at 3.8 ft., Location: @ TP 2
om of Test #2 Trench at 4.5 ft., Location: Between TP2 & Neilson canal

Infil. rate for L. Lost R. b
Infil. rates for Neilson

Plate 3. Infiltration Rate Curve I

BIG LOST RIVER FLOOD CONTROL PROJECT
Near MaCkay, Idaho
Summary of Infiltration Testing



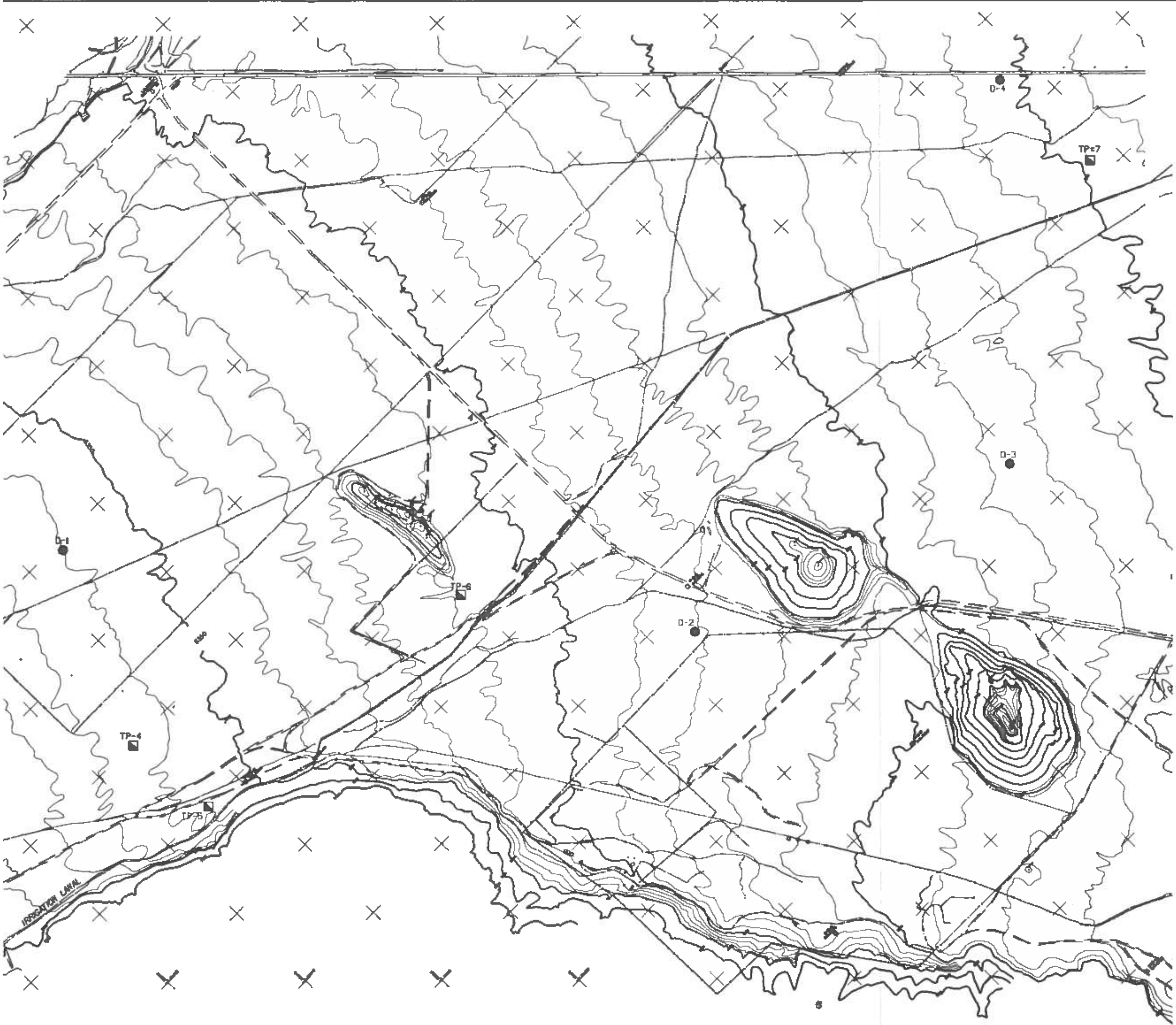
›m of Test #1 Trench at 3.6 ft. , Location: @ TP 2
›m of Test #2 Trench at 4.5 ft. , Location: Between TP2 & Neilson canal

△ Infil. rate for L. Lost R. b
◇ Infil. rates for Neilson

Plate 4. Infiltration Rate Curve II

SAFETY PAYS

U. S. ARMY



SUMMARY BOREHOLE RECORD
(OFFICE USE ONLY)

DEPTH OF HOLE 126' OF O.B. 103' DIAMETER OF HOLE 6"
ROCK DRILLED 23' % REC DATE STARTED 28 NOV 89
AZIMUTH HOLE ANGLE VERTICAL DATE COMPLETED 4 DEC 89
INITIALS T.M. CONTRACT NO.

SURFACE EL. 6316 HOLE NO. D-2 N861,665 E534,398

DEPTH	DESCRIPTION OF MATERIALS	REMARKS
0	(ML) SILT, W/SAND	
	(GM) GRAVEL, W/SAND, SILT, CLAY	
10	(GC) GRAVEL, W/CLAY AND SAND, WELL GRADED V. DENSE, COMPACT, TIGHT CLASTS TO 4 IN	V. HARD DRILLING SLOW GOING FALLING HEAD TEST (FHT) @ 10FT-.09FT/HR
20	(GW) GRAVEL, W/SAND, CLEAN	FHT @ 20 FT; NO DROP
	(SW) SAND, CLEAN, W/GRAVEL	
	(SC) SAND, W/CLAY, SAME GRAVEL	
	(GC) GRAVEL, W/SAND AND CLAY MATRIX, V. HARD AND TIGHT	V. HARD DRILLING
30	(SW) SAND, FINE-MED GRAVEL CLEAN	FHT @ 30 FT-25.45 FT/HR
	(GW) GRAVEL, W/SAND	EASY DRILLING
	(SC) SAND, W/CLAY	
	(GW) GRAVEL, W/SAND, CLEAN	
40	(GC) GRAVEL, W/CLAY AND SAND, WELL GRDD, V. DENSE AND TIGHT	HARD DRILLING FHT @ 42 FT-35.5 FT/HR
50	(SW) SAND, W/PEAGRAVEL, CLEAN	FHT @ 50FT.-12.1 FT/HOUR
	(GC) GRAVEL, W/CLAY AND SAND	
60	(GC) GRAVEL, AS ABOVE EXCEPT EXTREAMLY HARD V. TIGHT	NO F.H.T. PAST 50 FT.
	(SC) SAND, W/CLAY OCCASS. GRAVEL, V. COMPACT DENSE, AND TIGHT	
70	(GC) GRAVEL, W/SAND AND CLAY, COMPACT AND TIGHT.	
	(SC) SAND, W/CLAY	
80	(CL) CLAY, W/SAND	STATIC WATER LEVEL 86 FT.
	(SC) SAND, W/CLAY	
	(GC) GRAVEL, W/CLAY AND SAND	
90	(GW) GRAVEL, W/SAND, CLEAN	NOTE: GROUND WATER WAS NOT ENCOUNTERED UNTIL 103 FT.
	(GC) GRAVEL, W/CLAY	
100	(GC) GRAVEL, W/CLAY, PEA GRAVEL	

NPW May 77 62 — BIG LOST RIVER — SITE AND PROJECT — D-2 HOLE NO.

SUMMARY BOREHOLE RECORD
(OFFICE USE ONLY)

DEPTH OF HOLE 126' OF O.B. 103' DIAMETER OF HOLE 6"
ROCK DRILLED 23 FT % REC DATE STARTED 28 NOV 89
AZIMUTH HOLE ANGLE VERTICAL DATE COMPLETED 4 DEC 89
INITIALS T.M. CONTRACT NO.

SURFACE EL. HOLE NO. D-2 N 861,665 E 534,398

DEPTH	DESCRIPTION OF MATERIALS	REMARKS
	(GC) GRAVEL, W/CLAY	1ST SIGN WATER
110	RYOLITE - REDISH BROWN FLOW BANDED RYOLITE HIGHLY BROKEN, AND FRACTURED. HIGHLY WEATHERED SURFACES.	TOP OF ROCK V. EASY DRILLING
120	NOTE: THIS ROCK IS IDENTICAL TO THAT EXPOSED IN NEARBY HILLS.	POROUS & PERMEABLE
130	BOTTOM OF HOLE	
140		
150		
160		
170		
180		
190		
200		

NPW May 77 62 — BIG LOST RIVER — SITE AND PROJECT — D-2 HOLE NO.

SUMMARY BOREHOLE RECORD
(OFFICE USE ONLY)

DEPTH OF HOLE 50' OF O.B. DIAMETER OF HOLE 6'
ROCK DRILLED 0 % REC DATE STARTED 25 NOV 89
AZIMUTH HOLE ANGLE VERTICAL DATE COMPLETED 28 NOV 89
INITIALS T.M. CONTRACT NO.

SURFACE EL. 6287.8 HOLE NO. D-3 N 860587 E 537909

DEPTH	DESCRIPTION OF MATERIALS	REMARKS
0	(GM) GRAVEL, W/SILT AND SAND	
10	(GC) GRAVEL, W/SND, CL MATRIX V. COMPACT, V. TIGHT COBBLES TO 8 IN. % CLAY INCREASES W/DEPTH	V. HARD DRILLING GRAVEL CEMENTED BY CLAY MATRIX FALLING HEAD TEST
	(CL) CLAY, W/OCCAS. GRAVEL	(FHT) @ 10FT 6FT/HR
20	(GC) GRAVEL, W/CLAY & SAND V. COMPACT AND TIGHT	V. DENSE, COMPACT CLAY V. HARD, SLOW DRILLING
	(GW) GRAVEL, W/SAND SOME CLAY	
	(GC) GRAVEL, W/CLAY AND SAND V. DENSE AND TIGHT	FHT @ 20FT-NO DROP
30	(GW/GC)-GRAVEL, W/SAND AND SOME CLAY.	FHT @ 30 FT-8.6 FT/HR
40	(GW) GRAVEL, W/SAND AND LESS CLAY THAN ABOVE	FHT @ 40 FT-12.7 FT/HR
	(GC) GRAVEL, W/CLAY & SAND	
	(CL) CLAY, W/GRAVEL	
	(SW) SAND, CLEAN LITTLE CLAY	

GENERAL INFORMATION

NOTES:

1. CLASSIFICATIONS OF MATERIALS ARE VISUAL UNLESS SPECIFICALLY INDICATED ON THE LOGS AS "LAB". ALL VISUAL CLASSIFICATIONS ARE SUBJECT TO ERROR AND DO NOT HAVE THE ACCURACY OF LABORATORY ANALYSIS VISUAL CLASSIFICATIONS ARE, HOWEVER, ADEQUATE FOR DEVELOPING A GENERAL KNOWLEDGE OF THE FORMATION. ALL LAB CLASSIFICATIONS AND SYMBOLS ARE FROM LAB TESTS BASED ON CRITERIA CONTAINED IN THE UNIFIED SOIL CLASSIFICATION SYSTEM, TECHNICAL MEMORANDUM NO. 3-357 PUBLISHED BY THE U.S. ARMY ENGINEERS WATERWAYS EXPERIMENT STATION, EXCEPT FOR THE TERMS "ROCK FRAGMENTS" AND "BOULDER". THE TERM "BOULDER" REFERS TO MATERIAL WHICH WILL NOT PASS THROUGH A 12-INCH SQUARE OPENING. THE TERM "ROCK FRAGMENTS" IS USED TO DESCRIBE AND CLASSIFY MATERIALS OF GRAVEL, COBBLE AND BOULDER SIZES THAT ARE DERIVED DIRECTLY FROM LEDGE ROCK AND ARE NOT CONSIDERED TO BE ALLUVIAL DEPOSITION.
2. THE LIMITING BOUNDARIES BETWEEN THE VARIOUS SIZE RANGES HAVE BEEN SET AT CERTAIN U.S. STANDARD SIEVE SIZES IN ACCORDANCE WITH THE FOLLOWING TABULATION:

DESCRIPTION	SIZE RANGE
BOULDER	GREATER THAN 12 INCHES
COBBLES	ABOVE 3 INCHES TO 12 INCHES
GRAVEL	SIEVE NO. 4 (4.76 MM) TO 3 INCHES
SAND	SIEVE NO. 200 (0.074 MM) TO SIEVE NO. 4
SILT AND CLAY	SMALLER THAN SIEVE NO. 200

3. EXPLORATIONS MAY INDICATE THE PRESENCE OF COBBLES AND BOULDERS SCATTERED THROUGHOUT THE FORMATION. SUCH COBBLES AND BOULDERS MAY ALSO BE CONCENTRATED IN POCKETS OR STRATA.
4. THE TERM "BEDROCK" INCLUDES ALL TYPES OF CONTINUOUS ROCK STRATA REGARDLESS OF QUALITY OR CONDITION UNLESS OTHERWISE INDICATED.
5. EXPLORATION DATA SHALL BE USED ONLY TO THE DEGREE OF RELIABILITY INHERENT IN THE TYPE OF EXPLORATION AND PRUDENCE SHALL BE EXERCISED IN INTERPOLATING BETWEEN EXPLORATIONS.
6. EXPLORATIONS:
   a. TEST PITS (PREFIXED WITH TP) WERE EXCAVATED TO PERMIT EXAMINATION AND SAMPLING OF MATERIALS IN PLACE TO PROVIDE BETTER KNOWLEDGE THAN IS AVAILABLE FROM DRILL HOLES. DATA FROM TEST PITS ARE RELIABLE BUT CONDITIONS THROUGHOUT AN AREA MAY VARY WIDELY COMMENSURATE WITH THE GEOLOGICAL CONDITIONS IN THE AREA.
   b. CHURN DRILL HOLES (PREFIXED WITH D) WERE CLASSIFIED BASED ON VISUAL CLASSIFICATION OF BAILER SAMPLES, AND ARE FOR THE PURPOSE OF DETERMINING GENERAL TYPES OF COMMON MATERIAL.
7. (S.W.L. DATE) REFERS TO THE STATIC WATER LEVEL ELEVATION AND THE DATE OF OBSERVATION. ELEVATIONS INDICATED ON THE LOGS ARE WATER LEVELS ON THE DATE SHOWN AND DO NOT REPRESENT THE LEVEL AT WHICH WATER MAY BE ENCOUNTERED AT OTHER TIMES.
8. FALLING HEAD TESTS (FHT) WERE CONDUCTED AT APPROX. 10 FT. IN TERVALS IN THE CHURN DRILL HOLES. THESE TESTS WERE GENERALLY CONDUCTED FOR 1 HOUR.

[SUMM]ARY BOREHOLE RECORD

[...] OF O.B. ___ DIAMETER OF HOLE ___
[...]% REC. ___ DATE STARTED 20 SEPT 89
[...]HADE ___ DATE COMPLETED ___
CONTRACT NO. ___

HOLE NO. TP-2 N 865700 E 524629

[DESC]RIPTION OF MATERIALS	REMARKS
[GRAV]ELLY SILT WITH SAND [AND] COBBLES. 15-30% FINE TO [COAR]SE, SUBANGULAR TO [SUBRO]UNDED GRAVEL. 15% [GAP] GRADED, V. FINE AND [COAR]SE SAND, SUBANGULAR [TO S]UBROUNDED. 55-70% [SILTY] FINES. 5% COBBLES [W/MA]X. SIZE OF 4 IN.	MATERIAL IS LIGHT BROWN, MOIST, MED. COMPACT, W/OCC. CEMENTED NODULES AND LIGHT CEMENTING ON GRAVEL. GRAVEL AND COBBLES ARE CONGLOMERATE, QUARTZITE, AND SLATE.
[(GW) W]ELL GRADED GRAVEL [W/] SAND AND COBBLES 60-[70%] FINE TO COARSE, SUB-[ROUN]DED GRAVEL. 37-27% [FINE] TO COARSE, SUB-[ANGU]LAR TO SUBROUNDED [SAND.] 3% SILTY FINES. 10-15% [COBBL]ES W/MAX. SIZE OF 9 IN.	MATERIAL IS BROWN, MOIST, MED. COMPACT, GRAVEL PARTICLES ARE IN CONTACT W/VOIDS FILLED W/SAND, LIGHT CEMENTING ON BOTTOM OF GRAVEL, ALLUVIAL. TRENCH SIDES REMAINED VERTICAL WHILE EXCAVATING THIS MATERIAL.
[(GW) W]ELL GRADED GRAVEL [W/] SAND AND COBBLES 50-[..%] FINE TO COARSE SUB-[ROUN]DED GRAVEL 47-37% MED. [TO CO]ARSE, ANGULAR TO SUB-[ROUND]ED SAND. 3% SILTY FINES [..%] COBBLES TO BOULDER [..] BOULDER (OF 1.5 C.F.	MATERIAL IS GRAY BROWN, MOIST, MED. COMPACT, OCCASIONAL LIGHT CEMENTING ON GRAVEL AND COBBLES. TRENCH SIDES CAVED WHILE EXCAVATING THIS MATERIAL.
[BOTT]OM OF HOLE @ 12 FT.	

BIG LOST RIVER — SITE AND PROJECT   TP-2 — HOLE NO.

SUMMARY BOREHOLE RECORD

DEPTH OF HOLE 9½ FT. OF O.B. ___ DIAMETER OF HOLE ___
ROCK DRILLED ___ % REC. ___ DATE STARTED 20 SEPT 89
AZIMUTH HOLE ___ HADE ___ DATE COMPLETED ___
INITIALS ___ CONTRACT NO. ___

SURFACE EL. 6380.0 HOLE NO. TP-3 N 864977 E 529477

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				GRAVELLY SILT W/SAND AND COBBLES 15-30% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 15% GAP GRADED, V. FINE AND COARSE SAND, SUBANGULAR TO SUBROUNDED. 55-70% SILTY FINES. 5% COBBLES W/MAX. SIZE OF 4 IN.	MATERIAL IS LIGHT BROWN, MOIST, MED. COMPACT W/ OCC. CEMENTED NODULES AND LIGHT CEMENTING ON GRAVEL. GRAVEL AND COBBLES ARE CONGLOMERATE, QUARTZITE AND SLATE
				(GW) WELL GRADED GRAVEL W/SAND AND COBBLES. 55-65% FINE TO COARSE, SUBROUNDED GRAVEL. 42-32% MED. TO COARSE, SUBANGULAR TO SUBROUNDED SAND. 3% SILTY FINES. 10% COBBLES W/MAX. SIZE OF 6 IN.	MATERIAL IS BROWN, MOIST, MED. COMPACT, LIGHTLY CEMENTED ON BOTTOM OF GRAVEL AND COBBLES. COBBLES AND GRAVEL ARE CONGLOMERATE, QUARTZITE, AND GRANITE.
				(GW) WELL GRADED GRAVEL W/ SAND AND COBBLES. 60-70% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 37-27% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND. 3% SILTY FINES. 15-20% COBBLES TO BOULDER SIZE. 1 BOULDER 1.5 C.F. SIZE.	MATERIAL IS GRAY-BROWN, MOIST, MED. COMPACT, W/ CEMENT ON BOTTOM OF GRAVEL AND COBBLES. COBBLES AND GRAVEL ARE QUARTZITE AND GRANITE.
				(GW) WELL GRADED GRAVEL W/ SAND AND COBBLES. 55-65% FINE TO COARSE, SUBROUNDED TO SUBANGULAR GRAVEL. 43-33% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND. 3% SILTY FINES. 10% COBBLES W/MAX SIZE OF 7 IN.	MATERIAL IS BROWN, MOIST, MED. COMPACT, W/OCC. LIGHT CEMENT ON BOTTOM OF GRAVEL AND COBBLES. COBBLES ARE QUARTZITE AND GRANITE. GRAVEL IS QUARTZITE, GRANITE AND SLATE
				BOTTOM OF HOLE AT 9½ FT.	TRENCH SIDES ARE VERTICAL TO 6½ FT. DEPTH BELOW WHICH THERE IS SLIGHT CAVING.

NPW May 77 62   BIG LOST RIVER — SITE AND PROJECT   TP-3 — HOLE NO.

SUMMARY BOREHOLE RECORD

DEPTH OF HOLE 10½ FT. OF O.B. ___ DIAMETER OF HOLE ___
ROCK DRILLED ___ % REC. ___ DATE STARTED 20 SEPT 89
AZIMUTH HOLE ___ HADE ___ DATE COMPLETED ___
INITIALS ___ CONTRACT NO. ___

SURFACE EL. 6359.3 HOLE NO. TP-4 N 864977 E 529477

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				(GM) SILTY GRAVEL W/SAND. 45-55% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 15-25% FINE TO COARSE, SUBANGULAR TO SUBROUNDED SAND. 20-40% SILTY FINES.	MATERIAL IS DARK BROWN, MOIST, AND LOOSE.
				(SW) WELL GRADED SAND W/ GRAVEL AND COBBLES. 42-32% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 55-65% FINE TO COARSE, ANGULAR TO SUBROUNDED SAND. 3% SILTY FINES. 1% COBBLES W/MAX. SIZE OF 7 IN. A 1 IN. THICK ZONE OF MED. GRAIN UNIFORM CLEAN SAND @ 3½ FT.	MATERIAL IS GRAY-BROWN, MOIST, MED. COMPACT, WITH CEMENT ON BOTTOM SIDE OF GRAVEL AND COBBLES. GRAVEL AND COBBLES ARE GRANITE AND QUARTZITE.
				(SW) WELL GRADED SAND W/ GRAVEL AND COBBLES. 42-32% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 55-65% MED TO COARSE, ANGULAR TO SUBROUNDED SAND. 3% SILTY FINES. 10% COBBLES W/MAX. SIZE OF 7 IN.	MATERIAL IS GRAY-BROWN, MOIST, MED. COMPACT, W/ OCC. LIGHT CEMENT ON BOTTOM OF GRAVEL AND COBBLES. SOME BEDDING AT APPROX. 1FT INTERVALS W/SOME CEMENTING AT LAYER CONTACT. GRAVEL AND COBBLES ARE GRANITE, QUARTZITE AND SHALE.
				BOTTOM OF HOLE @ 10½ FT.	TRENCH TENDS TO CAVE BETWEEN ½ AND 4 FT. DEPTH.

NPW May 77 62   BIG LOST RIVER — SITE AND PROJECT   TP-4 — HOLE NO.

[SUMM]ARY BOREHOLE RECORD

[...] OF O.B. ___ DIAMETER OF HOLE ___
[...]% REC. ___ DATE STARTED 20 SEPT 89
[...]HADE ___ DATE COMPLETED ___
CONTRACT NO. ___

HOLE NO. TP-6 N 863674 E 532968

[DESC]RIPTION OF MATERIALS	REMARKS
[(GM) SIL]TY GRAVEL W/SAND. 45-[55% F]INE TO COARSE, SUBAN[GULAR] TO SUBROUNDED GRA[VEL. 1]5-25% FINE TO COARSE, [SUBAN]GULAR TO SUBROUNDED [SAND.] 20-40% SILTY FINES.	MATERIAL IS DARK BROWN, MOIST, AND LOOSE.
[(SW) W]ELL GRADED SAND W/ [GRAVE]L AND COBBLES. 42-32% [FINE] TO COARSE, SUBANGULAR [TO SU]BROUNDED GRAVEL. [..]% FINE TO COARSE, [ANGU]LAR TO SUBROUNDED [SAND.] 3% SILTY FINES. [..% C]OBBLES W/MAX. SIZE [OF .] IN.	MATERIAL IS GRAY-BROWN, MOIST, MED. COMPACT, WITH CEMENT ON BOTTOM OF GRAVEL AND COBBLES. GRAVEL AND COBBLES ARE GRANITE, QUARTZITE AND SOME SLATE AND CONGLOMERATE.
[(GW) W]ELL GRADED GRAVEL W/ [SAND] AND COBBLES. 55-65% [FINE] TO COARSE, SUB[ANGU]LAR TO SUBROUNDED [GRAV]EL. 42-32% FINE TO [COAR]SE, ANGULAR TO SUB[ROUN]DED SAND. 3% SILTY [FINES].10% COBBLES W/MAX. [SIZE] OF 7 IN.	MATERIAL IS LIGHT BROWN, MOIST, MED. COMPACT AND LAYERED WITH ZONES OF CEMENTATION AT 1FT. INTERVALS. GRAVEL AND COBBLES ARE QUARTZITE AND GRANITE.
[(SW) W]ELL GRADED SAND W/ [GRAVE]L AND COBBLES. 42-32% [FINE] TO COARSE SUB-	MATERIAL IS BROWN, MOIST, MED. COMPACT, W/OCC. LIGHT CEMENT ON BOTTOM

SUMMARY BOREHOLE RECORD

DEPTH OF HOLE 12 FT. OF O.B. ___ DIAMETER OF HOLE ___
ROCK DRILLED ___ % REC. ___ DATE STARTED 21 SEPT 89
AZIMUTH HOLE ___ HADE ___ DATE COMPLETED ___
INITIALS ___ CONTRACT NO. ___

SURFACE EL. 6276.5 HOLE NO. TP-7 N 862198 E 540730

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				GRAVELLY SILT WITH SAND AND COBBLES. 15-30% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 15% GAP GRADED, V. FINE AND COARSE SAND, SUBANGULAR TO SUBROUNDED. 55-70% SILTY FINES. 5% COBBLES W/MAX. SIZE OF 4 IN.	MATERIAL IS LIGHT BROWN, MOIST, MED. COMPACT, W/OCC. CEMENTED NODULES AND LIGHT CEMENTING ON GRAVEL. GRAVEL AND COBBLES ARE CONGLOMERATE, QUARTZITE, AND SLATE.
				(GW) WELL GRADED GRAVEL W/ SAND AND COBBLES. 55-65% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 42-32% MED. TO COARSE, ANGULAR TO SUBROUNDED SAND. 3% SILTY FINES. 8% COBBLES W/MAX. SIZE OF 7 IN.	MATERIAL IS GRAY BROWN, DRY, MED. COMPACT, WITH CEMENT ON BOTTOM OF GRAVEL AND COBBLES, AND THE GRAVEL PARTICLES ARE IN CONTACT WITH THE VOIDS FILLED WITH SAND. GRAVEL AND COBBLES ARE QUARTZITE, GRANITE AND SOME SLATE.
				(GP ALTERNATING W/SP) ZONES OF COARSE SAND ALTERNATING W/FINE TO MED. GRAVELS. EACH ZONE IS APPROX. 6 IN. THICK AND MATERIAL IS UNIFORM. PARTICLES ARE FLAT AND CONSIST OF SLATE AND SOME QUARTZITE.	

SUMMARY BOREHOLE RECORD

DEPTH OF HOLE 10½ FT. OF O.B. ___ DIAMETER OF HOLE ___
ROCK DRILLED ___ % REC. ___ DATE STARTED 20 SEPT 89
AZIMUTH HOLE ___ HADE ___ DATE COMPLETED ___
INITIALS ___ CONTRACT NO. ___

SURFACE EL. 6398.0 HOLE NO. TP-8 N 866491 E 524566

ELEVATIONS	DEPTH	GRAPHIC LOG	CORE %	DESCRIPTION OF MATERIALS	REMARKS
				GRAVELLY SILT WITH SAND AND COBBLES 15-30% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 15% GAP GRADED, V. FINE AND COARSE SAND, SUBANGULAR TO SUBROUNDED. 55-70% SILTY FINES. 5% COBBLES WITH MAX. SIZE OF 4 IN.	MATERIAL IS LIGHT BROWN, MOIST, MED. COMPACT, W/ OCC. CEMENTED NODULES AND LIGHT CEMENTING ON GRAVEL. GRAVEL AND COBBLES ARE CONGLOMERATE, QUARTZITE AND SLATE.
				(SW) WELL GRADED SAND WITH GRAVEL AND COBBLES 40-50% FINE TO COARSE, SUBANGULAR TO SUBROUNDED GRAVEL. 47-57% FINE TO COARSE, ANGULAR TO SUBROUNDED SAND. 3% SILTY FINES. 5% COBBLES 1 BOULDER 1.5 C.F. SIZE	MATERIAL IS LIGHT BROWN, MOIST, MED. COMPACT, W/ OCC. LIGHT CEMENTING ON GRAVEL AND COBBLES. GRAVEL AND COBBLES ARE QUARTZITE, GRANITE AND CONGLOMERATE.
				(SW) WELL GRADED GRAVEL WITH SAND AND COBBLES. 60-70% FINE TO COARSE SUBANGULAR TO SUBROUNDED GRAVEL. 37-27% FINE TO COARSE, SUBROUND TO SUBANGULAR SAND. 3% SILTY FINES. 10-20% COBBLES	MATERIAL IS BROWN, MOIST, MED. COMPACT. GRAVEL PARTICLES IN CONTACT AND SUPPORTED BY SAND MATRIX. CALICHE ON UNDERSIDE OF CLASTS. COBBLES, GRAVEL AND COBBLES ARE GRANITE, QUARTZITE, DOLOMITE, CONGLOMERATE, AND SLATE.

APPENDIX C

Hydraulic Design of Spillway and Canal Headworks

HYDRAULIC DESIGN OF SPILLWAY AND CANAL HEADWORKS

1. INTRODUCTION.

This is a preliminary hydraulic analysis of a diversion structure to be located on the Big Lost River 13 miles above Mackay Dam. The diversion dam will be designed to pass the 50-year flood of 4,420 cfs over the spillway. A diversion canal will be incorporated into the structure to divert 1,000 cfs into Barton Flats for flood control. The structure will provide adequate head to supply the existing irrigation canal with the required flows during low flow conditions.

2. HYDRAULIC DESIGN CRITERIA.

Design of the Diversion structure at Big Lost River Chilly-Barton Flats was based on information taken from "The Preliminary Report - Big Lost River Basin, Idaho" prepared December 1988 for the Corps of Engineers by Morrison-Knudsen Engineers.

3. REFERENCES.

All designs have been based on accepted engineering standards. The following references were used in the hydraulic design and evaluation of the diversion structure.

a. "Design of Small Dams," Second Edition, 1973, Revised 1977.

b. Chow, V.T., Open Channel Hydraulics, McGraw-Hill Book Company, New York, 1959.

c. "Design of Small Canal Structures," First Edition, 1974, Revised 1978, Reprinted 1983.

d. Roberson/Cassidy/Chaudhry, Hydraulic Engineering, Houghton Mifflin Company, Boston, MA, 1988.

e. EM 1110-2-1603, "Hydraulic Design of Spillways," 16 January 1990.

4. PROJECT DESCRIPTION.

The streambed elevation at the proposed diversion site is 6,393 msl. An existing irrigation canal provides some diversion during flood periods;

hydraulic components:

± A spillway consisting of a 175-foot concrete Ogee crest with an associated stilling basin.

± A canal intake control structure with two 14 foot x 9 foot radial gates with an associated stilling basin and a 176 foot transition to the diversion canal.

± An existing irrigation canal intake requiring 70 cfs during low flow periods.

The layout of these structures is illustrated in plate 1.

a. Spillway.

The two controlling factors in developing the spillway design were the ability to pass the 50-year floodflow without exceeding the maximum allowable water surface elevation upstream of the dam and the need to meet existing irrigation demands.

A discharge coefficient of 3.2 was used to determine the required length of a spillway able to pass the design flow.

Two low flow notches were also incorporated into the design of the crest shape in order to maintain low flow channels in the vicinity of the diversion intakes. These notches are to be located on both ends of the spillway crest. A 20-foot notch will be constructed on the south end of the spillway and a 10-foot notch will be located on the north end of the spillway. Both notches will be 6 inches deep and together will allow flows of approximately 40 cfs to pass before water overtops the normal spillway crest elevation.

The top of the diversion structure was set at elevation 6403. This was chosen to allow 2 feet of freeboard over the maximum design water-surface elevation.

The stilling basin was designed in accordance with EM 1603 [5] and was based on 50-year floodflow. The hydraulic jump type stilling basin will require a length of 13 feet with a 1-foot sloping end sill, and be set at elevation 6391. Tailwater data was taken from figure 1. To reduce stream scouring downstream, a 25-foot-long riprap section will be required.

The Headworks for the diversion canal was designed to divert up to 1,000 cfs during flood conditions. This structure will consist of a 30-foot-rectangular channel controlled with two 14 foot x 9 foot tainter type radial gates. These gates will be separated with a 2-foot-wide pier. The intake invert elevation will be set at the existing streambed.

River flows in excess of 1,500 cfs will be diverted into the canal up to a maximum 1,000 cfs. When river flows reach 2,500 cfs, flows over the spillway can no longer be controlled.

The stilling basin was designed in accordance with the spillway design EM 1603 [5]; however, lack of tailwater effect during initial water-up could be a problem on the canal itself and will be discussed in the operation and maintenance section of this report.

The design length of the stilling basin is 15 feet and set at elevation 6,390 msl with a 2-foot sloping end sill. A 24-inch layer of riprap will extend 25 feet into the transition to the downstream canal.

A channel will transition from a rectangular channel to a trapezoidal channel with a 1 vertical on 4 horizontal side slope. The sides of the transition will be lined with a 24-inch layer of riprap. The total length of the transition was calculated to be 176 feet. This section was designed to create a smooth transition in order to dissipate energy and minimize damage to the canal. Depending on the availability of riprap, the design of the transition may be altered to reduce costs and should be investigated in greater detail in the next phase of the design.

c. Irrigation Intake.

The existing irrigation canal at the site requires 70 cfs during the irrigation season. This requirement generally occurs during low flow periods thus controlling the spillway crest height. Due to limited information available on this canal at this time, several assumptions were made. The invert elevation was assumed to be the same as the streambed and the canal was assumed to be 3 feet wide as defined in the preliminary study. With these assumptions, it was determined that the minimum head required to push maximum flows down the irrigation canal intake is 3.60 feet. This was the basis for choosing a spillway crest elevation of 6,397 msl. A head of at least 4 feet would be created thus satisfying this condition. These assumptions need to be verified in the next phase of the design.

The intake of this canal will be controlled with a 3 foot x 5 foot vertical slide gate with a hand wheel operator. The top of the concrete

This canal may also be used to divert some of the floodwater; however, due to lack of specific information, the impact of this use could not be determined.

5. MISCELLANEOUS REQUIREMENTS.

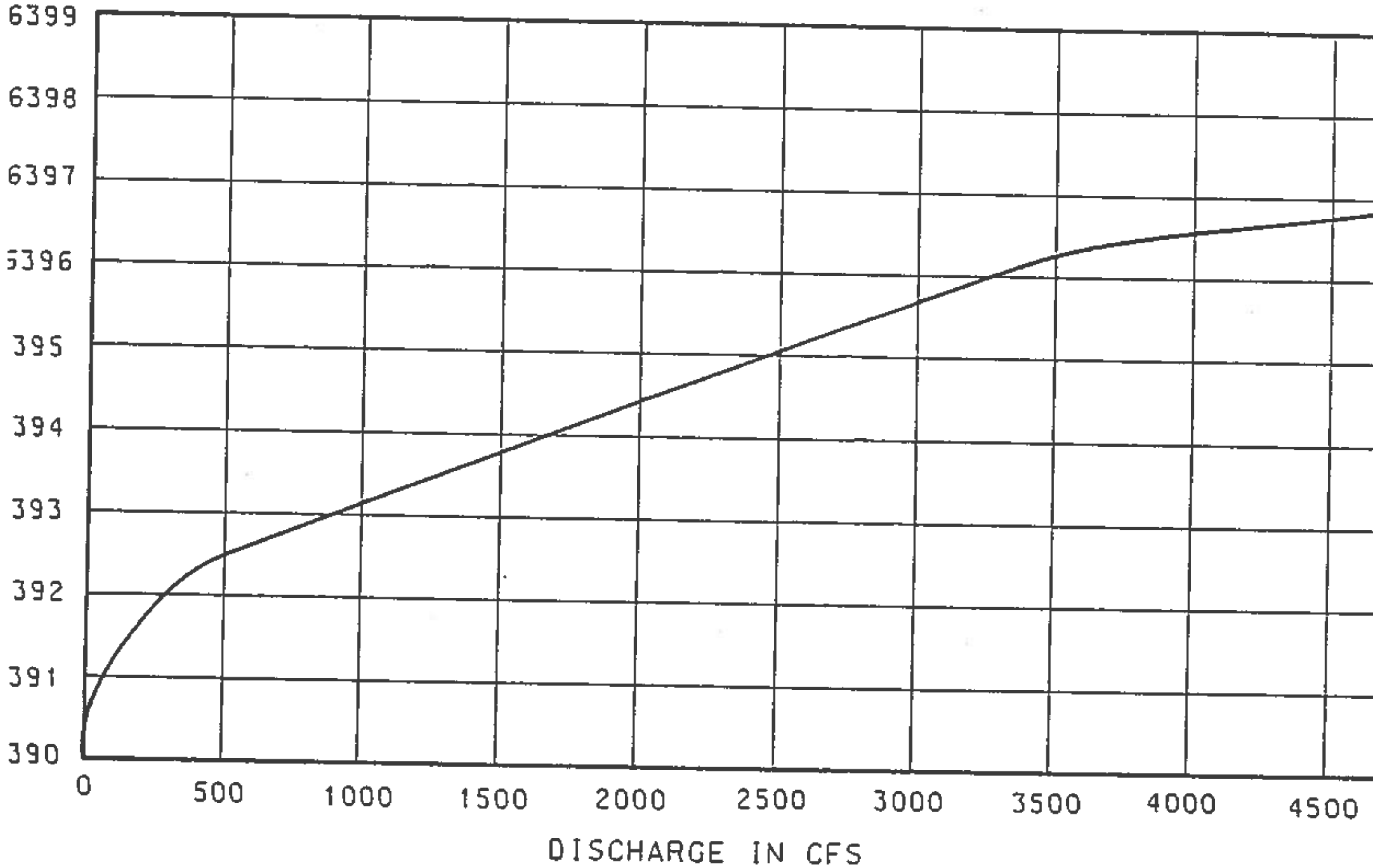
a. Trash and Bedload.

Miscellaneous trash and river debris will be allowed to pass over the diversion dam, however a log boom will be required to keep debris out of the diversion canal. This log boom will tie to a point between the diversion structure and the canal intake and extend across the headworks and tie to turnout structure just upstream of the canal intake. The purpose of this log boom is to divert large floating debris over the main spillway and keep the canal headworks clear.

A settling basin just upstream of the canal intake will be required to allow for bedload material to settle out. The settling basin will be a 10-foot semicircle set at elevation 6391 and have a 10 vertical on 1 horizontal side slope until it catches with the existing streambed. This will require periodic cleaning to keep it operable. If this is determined to be a high maintenance cost item during the next phase of this design, a sluiceway option would need to be investigated.

b. Operation and Maintenance.

Operation of the diversion structure will be based on the flow readings from a gauge station located upstream of the diversion structure. The diversion canal will not be utilized until flows upstream of the structure reach 1,500 cfs. At this point, the canal gates may be opened incrementally to gradually water-up the canal and avoid damage due to sudden surging. Twenty-four hours should be allowed for this water-up procedure. A gate rating curve is included as figure 3 of this appendix.



BIG LOST RIVER E
NEAR ARCO. IDA

RATING CU
AT DIVERSION X-
EXISTING CONDI

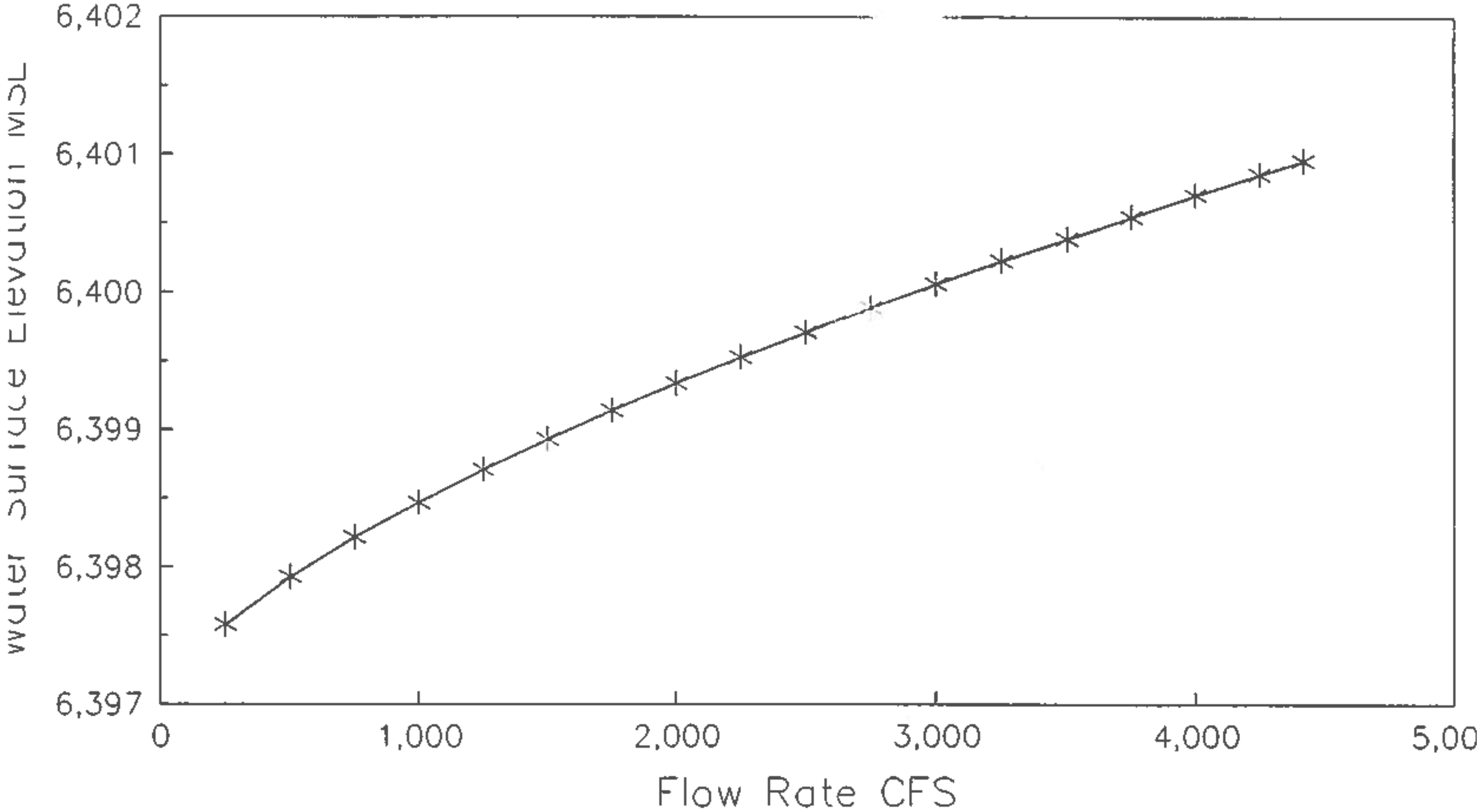
U. S. ARMY ENGINEER
WALLA WALLA - HYDROL

FILE: BLRATING

J. HEITSTUMAN FIGURE

APPEN

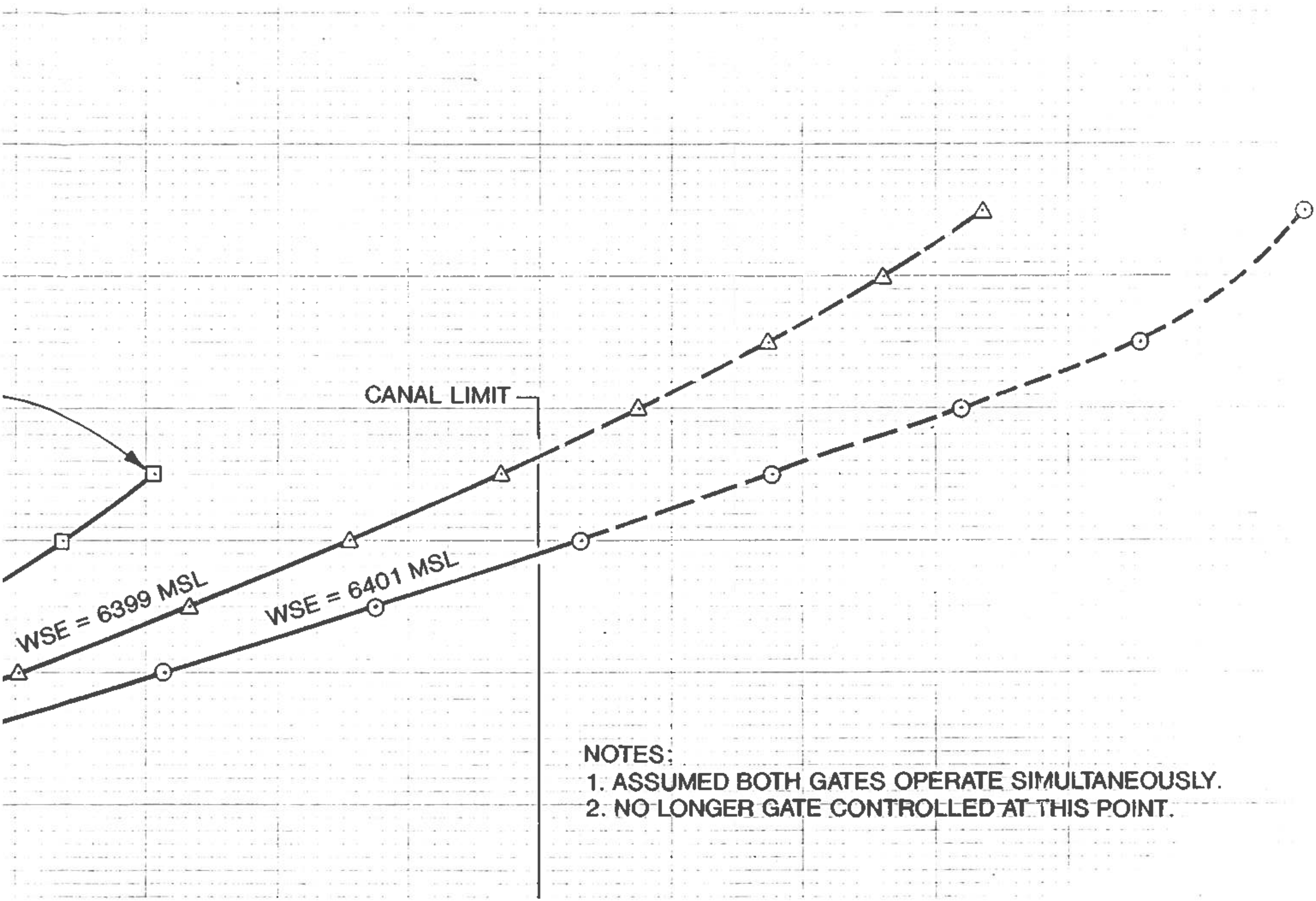
Spillway Rating Curve
for
Chilly Divers



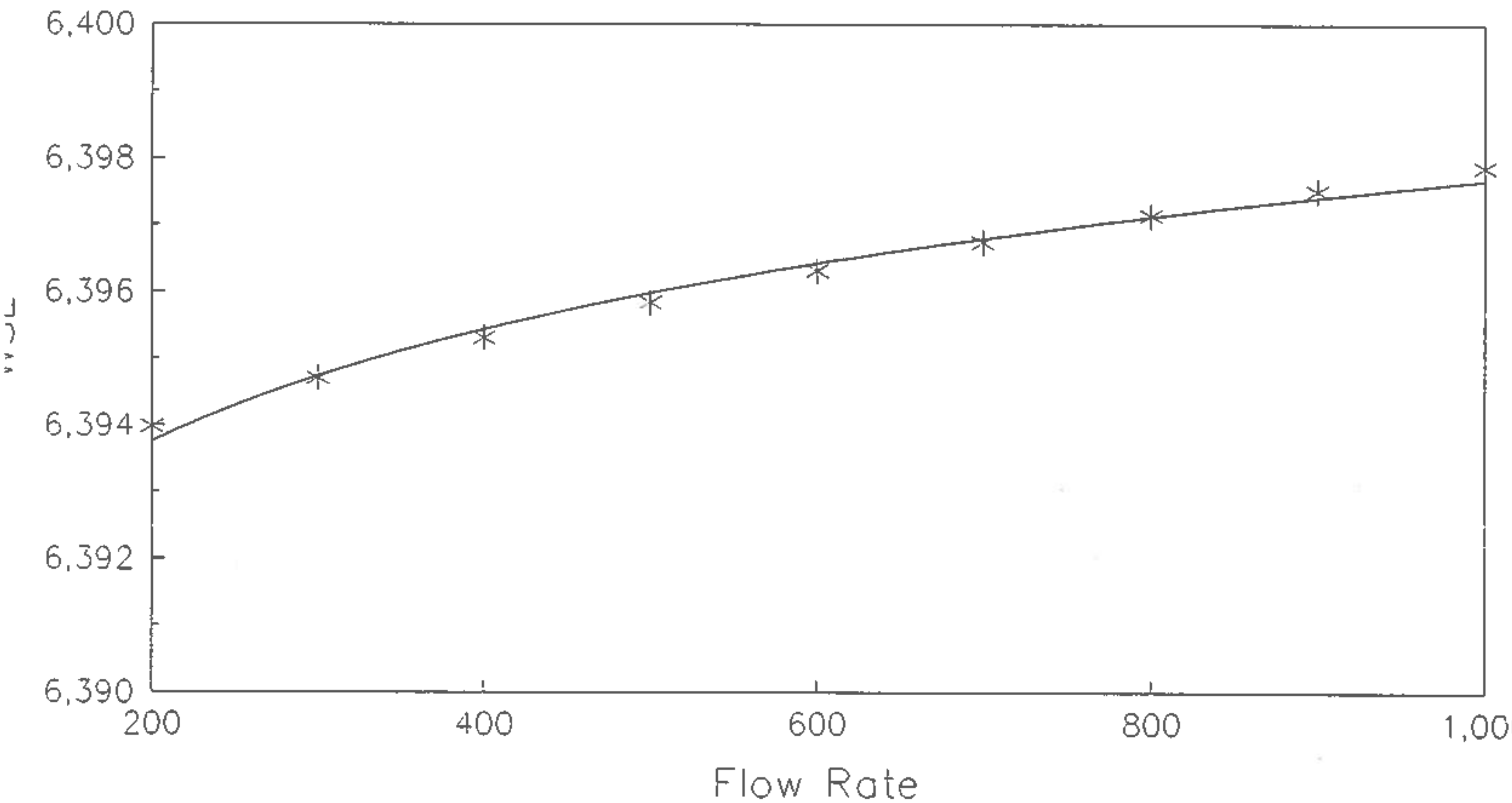
charge Coefficient = 3.20

Fig

APPE


CANAL LIMIT
WSE = 6399 MSL
WSE = 6401 MSL
NOTES:
1. ASSUMED BOTH GATES OPERATE SIMULTANEOUSLY.
2. NO LONGER GATE CONTROLLED AT THIS POINT.

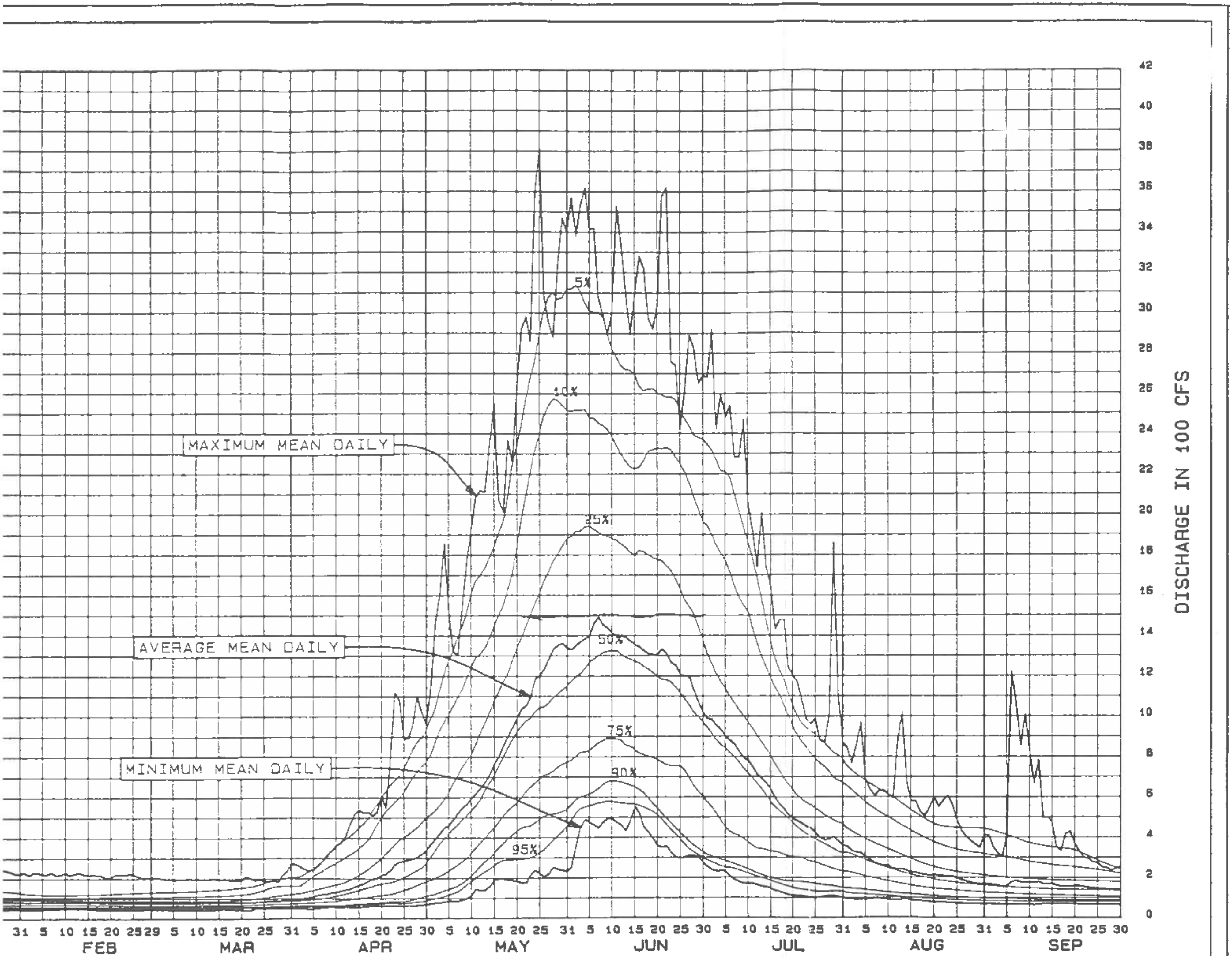
Tailwater Rating Curve
for
Chilly Canal

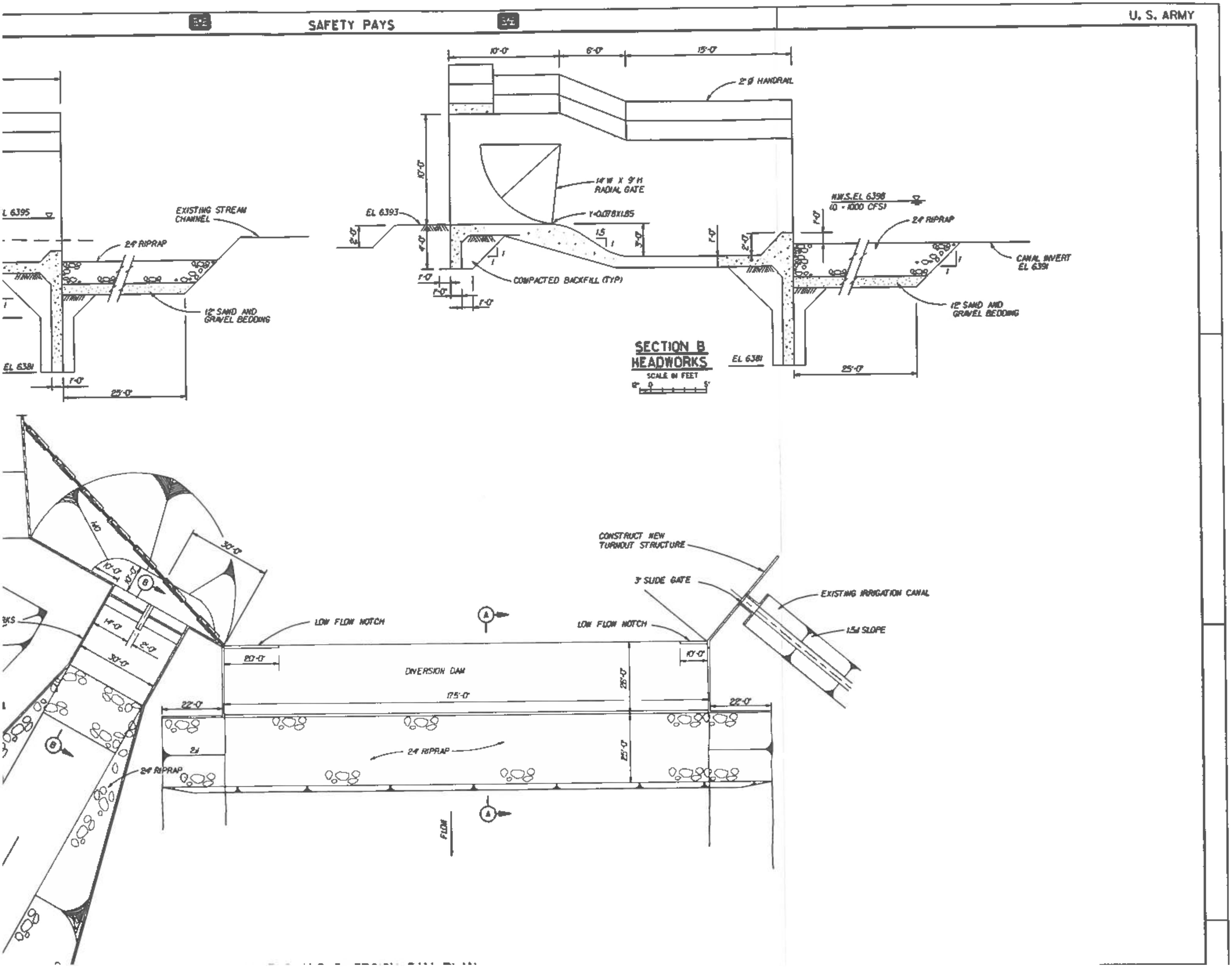


ınings n = 0.028
·rt elevation = 6391
ss section just downstream of stilling basin

Figı

APPEI


DISCHARGE IN 100 CFS
MAXIMUM MEAN DAILY
AVERAGE MEAN DAILY
MINIMUM MEAN DAILY
5%
10%
25%
50%
75%
90%
95%
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP



SAFETY PAYS
U. S. ARMY
SECTION B
HEADWORKS
SCALE IN FEET
10'-0"
6'-0"
15'-0"
2" Ø HANDRAIL
14'W X 9'H
RADIAL GATE
Y=0.078X1.85
EL 6393
N.W.S.EL 6398
(Q = 1000 CFS)
24" RIPRAP
CANAL INVERT
EL 6391
12" SAND AND
GRAVEL BEDDING
COMPACTED BACKFILL (TYP)
EL 6381
25'-0"
EL 6395
EXISTING STREAM
CHANNEL
CONSTRUCT NEW
TURNOUT STRUCTURE
3' SLIDE GATE
EXISTING IRRIGATION CANAL
1.5:1 SLOPE
LOW FLOW NOTCH
DIVERSION DAM
175'-0"
20'-0"
22'-0"
30'-0"
14'-0"
2'-0"
FLOW

APPENDIX D

Flood Damages and Flood Control Benefits

FLOOD DAMAGES AND FLOOD CONTROL BENEFITS

1. PURPOSE AND SCOPE.

The purpose of this section is to present an assessment of potential flood damages in the Big Lost River Basin and estimated flood damage reduction benefits of alternative flood control plans. The intent is to measure damages and benefits in sufficient detail to allow a decision with respect to the feasibility of implementing a project.

The geographic scope of damage and benefits is the Big Lost River Basin from approximately 11 miles upstream of Mackay Reservoir (diversion to Chilly Canal) downstream to where the river disappears below Arco.

2. DATA COLLECTION.

A field inventory of damageable property using a preliminary floodplain outline was made in the fall of 1989. Structure characteristics and locations were recorded along with estimates of first-floor elevation relative to ground at the structure. Ground elevations were estimated from cross-section data within detailed study reaches and from USGS maps for the remainder of the study areas. Recent aerial photography and a post-flood report by the Soil Conservation Service (SCS) (1965 Special Flood Report) were useful resources in estimating flood damages.

Five reaches where cross sections were available were analyzed in detail and the resulting information assisted in damage estimates for intervening areas. The approximate locations of detail study reaches are described below and shown by number on the Big Lost River Basin Map, plate D-1.

a. Between Chilly Canal diversion and Mackay Reservoir.

b. Near Mackay.

c. Near Leslie.

d. Near Moore.

e. Near Arco.

Damages were estimated by category for the 10-, 50-, 100-, and 500-year floods. The flows, acreage in each floodplain, and estimated damage are shown in table 1. Damage categories are explained in the following paragraphs.

a. Structure and Content Damage.

Data gathered for structures in detailed study reaches included size, architectural type, construction materials and pertinent quality features, age, condition of structure, and floor-to-ground elevation. This data was entered into a computer program that performs valuation and damage calculations in 0.1 foot increments based on depth-damage relationships for structures and contents for 27 building types. Structure and content damages from the detailed reaches were used to estimate average damage per structure for each flood event. The damage per structure estimate for each flood event was multiplied by the number of structures within the respective floodplain to estimate total structure and content damages for the 10-, 50-, 100-, and 500-year flood. These damage points were then used to plot a discharge-damage curve.

b. Agriculture Damages.

From conversations with the SCS and County Extension Service, it was determined that the distribution of crops grown in the Big Lost Valley is approximately 10 percent seed potatoes, 30 percent alfalfa/grain, and 60 percent hay. Both agencies agreed that crops would be totally lost after inundation for more than 3 days. Estimates of flood duration are between 2 and 3 days for all floods. Using this information, it was estimated that crop losses would be 75 percent, with a loss of revenue of 75 percent, and 75-percent-less cost incurred after a flood. Crop acreage was estimated from aerial photos, and costs and receipts for crops were taken from 1989-90 Crop Budgets prepared by the University of Idaho. Net crop loss was estimated for each flood event and used for construction of the discharge damage curve for agriculture.

c. Emergency Expenses.

This category includes evacuation; protection of life, property, and health; and temporary housing. It is based on past flood reports and emergencies. The per-house emergency costs were estimated to be $660, plus $75 per day for 3 days of temporary housing. The number of houses in each flood event were multiplied by the costs per house. Emergency costs at each flood event were then plotted to give the discharge-damage curve for emergency expenses.

Damages to roads and bridges were estimated by updating damages reported by the SCS to those features for the 1965 flood to current cost level. This estimate, along with the zero damage point, was used to construct a two-point discharge-damage curve.

4. AVERAGE ANNUAL DAMAGE.

Average annual damage and remaining damage with alternative plans were calculated by the damage-frequency integration method using discharge-frequency curves provided by the Hydrology Branch and discharge-damage curves constructed as discussed above. A tabulation of average annual damage by category, under natural conditions, that is, without a project, follows:

	Average Annual Damage Natural Conditions
Structures and Contents	$345,000
Agriculture	230,000
Roads and Bridges	53,000
Emergency Expense	8,000
Total	$636,000

5. AVERAGE ANNUAL BENEFITS.

The benefits of three diversion plans were evaluated: 250 cfs, 500 cfs, and 1,000 cfs. Remaining damages and benefits with the alternative plans are shown below:

	Average Annual Remaining Damage	Average Annual Benefit
Without Project	$636,000	
250 cfs Diversion	$482,000	$154,000
500 cfs Diversion	$355,000	$281,000
1,000 cfs Diversion	$210,000	$426,000

6. LOCAL PROTECTION PROJECTS.

When it became obvious that diversion alternatives were not economically feasible, the possibility of local protection in eight areas where damage appears concentrated was examined. In five of these areas, the cost tion at the final location would induce damage across the river and benefit one or two property owners, and therefore lacks a Federal interest.

APPENDIX E

Real Estate

REAL ESTATE

1. GENERAL DESCRIPTION.

This project is located in the Big Lost River Basin of Custer County, Idaho, approximately 20 miles northwest of the town of Mackay. Access to the general area is gained via State Highways 75 and 93, although the project area itself is accessible by county and Bureau of Land Management roads. This is an arid region of Idaho, being characterized by a generally flat topography with a few rocky buttes. The soils are porous and vegetation is sparse. Highest and best use of the locale is as marginal rangeland. The purpose of this project is to convey peak floodflows in the Big Lost River through a diversion canal to an infiltration basin in an area known as Barton Flats. The flood waters would percolate into the gravels beneath the unlined canal/basin areas and return to the Big Lost River downstream of flood-prone areas. In order to accomplish the desired flood control, a concrete dam, spillway, and diversion headworks would be constructed. Water would be periodically impounded behind the dam and released through the canal (and appurtenant drop structures) for a distance of approximately 1.3 miles before arriving at the Basin itself.

2. LAND TO BE ACQUIRED.

Five private landowners will be impacted by this project, although no improvements will be involved. Approximately 7± acres in fee will be required to construct, operate, and maintain the damsite and appurtenant structures. An additional 30± acres of flowage easement will also be necessary behind the dam to accommodate the maximum designed impoundment, plus a 4-foot freeboard. The acquisition line for the flowage easement will generally follow the 6,405-foot contour. The 300-foot horizontal distance criteria cited in ER 405-1-12 is not necessary because no conservation pool will be retained behind the dam and the 6,405-foot contour will provide sufficient freeboard during flood events. Below the dam, a canal easement will be acquired for the 45± acres of diversion canal which crosses private ownership. This canal will not be fenced. A small amount of canal (approximately 1 acre) and all of the proposed infiltration basin (approximately 70 acres) are situated on U.S. Government land which is under jurisdiction of the Bureau of Land Management. (Attention is invited to the accompanying real estate planning map, which depicts the project features and the land to be acquired.) It should be noted that two quarry sites have been identified in the vicinity of the project. One, is an existing quarry within the E 1/2, sec. 15, T. 8 N., R. 21 E. at a location known as Bartlett Point. The other is an outcropping of the Wood River responsible for providing all borrow materials for this project. Hence, no additional acquisition requirements for a quarry site are envisioned. Moreover, no additional sites will be required for spoil disposal. All excess excavated materials will be disposed of within the limits of the project by incorporating it into berms, etc.

3. ESTATES TO BE ACQUIRED.

It is recommended that the 7± acre damsite as shown on the accompanying real estate planning map be acquired in fee title, pursuant to the standard fee estate set forth within paragraph 1, figure 5-6 of change 7, ER 405-1-12. The standard flowage easement for occasional flooding (paragraph 6, figure 5-6b of change 7, ER 405-1-12) is recommended for the 30± acres comprising the flood retention area behind the dam. For the portion of the diversion canal that traverses private land, a nonstandard canal easement is recommended. This is an adaptation of the standard channel improvement easement and the proposed estate language follows this Real Estate Section. All remaining lands within the canal itself and those encompassing the entire infiltration basin are under Bureau of Land Management (BLM) jurisdiction. Accordingly, it is recommended that a special use permit be secured from that agency to authorize the utilization of those areas.

4. REAL ESTATE COSTS.

Land value estimates are based upon data provided by the Custer County Assessor and recent sales that have taken place in the vicinity of the project.

Lands and Damages

Item	Unit	Quantity	Unit Price	Amount	
Private Land (fee)	ac	7	$150	$ 1,050	
Private Land (fl esmt)	ac	30	$100	3,000	
Private Land (canal esmt)	ac	45	$100	4,500	
Fed. Land (canal/basin)	ac	71	--	0	
Subtotal-Land Costs				$ 8,550	
		Rounded			$8,600
		Contingencies 20%			1,700
		Total-Land Costs			$10,300
Administrative Costs					
Mapping/Survey		$ 3,500			
Title Evidence		1,200			
Appraisal and Review		10,000			
Negotiation and Closing		5,000			

TOTAL REAL ESTATE COSTS	$30,300