US Army Corps of Engineers
Walla Walla District

Lower Boise River and Tributaries, Idaho
Reconnaissance Study

May 1995

CENPW-PL-PF (1105-2-10b) 24 May 1995

MEMORANDUM FOR Commander, North Pacific Division,
ATTN: CENPD-ET-PF

Subject: Lower Boise River and Tributaries, Idaho Reconnaissance Report

1. Forwarded under separate cover are ten copies of the subject report. The report recommends that the study be put into "inactive" status because of lack of sponsorship at this time. Efforts to identify a sponsor are continuing.

2. In order to complete the report in an expeditious manner, only limited effort was expended responding to your comments included in the 2nd Ind dated 9 May 1995 to the basic letter dated 11 April 1995 Subject: "Lower Boise River and Tributaries, Idaho, Reconnaissance Study-Draft Report". This approach has been coordinated with CENPD-ET-PF. Comments that were addressed included numbers 1, 2, 3, 5, 6, 7d (2), 9 - 12. Comments 4, 7, and 8 will be addressed upon reenactment of the reconnaissance phase.

3. If you have any questions, please contact Mr. Jerry Roediger at (509) 527- 7249.

/signed/

MATHEW M. LAWS, III, P.E.
Chief, Planning Division

LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
RECONNAISSANCE STUDY

EXECUTIVE SUMMARY

The purpose of this reconnaissance study was to review various water resource problems, needs, and opportunities in the lower Boise River Basin, and determine whether the planning process should proceed into the feasibility phase. The study area encompasses the Boise Valley from Lucky Peak Dam downstream to the mouth of the Boise River, and the Mores Creek sub-basin that flows into the Lucky Peak reservoir. The study focused primarily on problem areas along the main river channel and side drainages northeast of the city of Boise.

Initial efforts in the study focused on identifying overall water resource-related problems and needs of the basin. The problems and needs were then screened further to those areas within the purview of the U.S. Army Corps of Engineers' authority. Problem areas addressed in more detail in this report include flood control, environmental restoration, and water supply. The following paragraphs summarize these three problem areas, and discuss potential solutions to the problems.

There is a great concern about potential flooding along the Boise River and the side drainages. Although flood damages have been minor in the past 8 years (a low flow period), there is a general consensus and acknowledgment that there will be major flooding along the river in the future. In 1983, there was a heavy snowpack with unseasonably warm weather conditions. This forced the early evacuation of the upstream reservoirs to meet the flood control rule curve. The flow reached 9,500 cubic feet per second (cfs) in the lower river, measured at Glenwood Bridge. Minor flooding starts to occur when discharges at Glenwood Bridge exceed 4,500 cfs. Major flooding starts at around 7,200 cfs. Above 10,000 cfs, flood damages increase very sharply. On the average, the upstream storage projects are able to regulate floodflows down to only about 7,200 cfs, a 26-year recurrence interval. This is extremely significant, as the Boise River floodplain continues to grow and develop at a fast pace (about 3 percent a year, which is projected to continue over the next 20 years and possibly beyond). Residents continue to live under the misconception that, since the three Federal reservoir projects are upstream, they are protected from catastrophic flooding.

A number of alternatives were considered as possibilities for reducing the threat of floods. One alternative was identified as being highly economically justified, having a benefit-to-cost ratio in excess of 2-to-1. This alternative involves the diversion of floodflows out of the Boise River upstream of the high damage areas, through an existing system of canals and a reservoir, and eventually into the Snake River. Such a plan would reduce flows in the lower Boise River by the same amount that was diverted. It would also increase the flexibility and effectiveness of the upstream storage projects for flood control and irrigation. During periods of evacuation of the reservoir for flood control operations, higher releases could be made from the Lucky Peak Project without exceeding the regulation objective (6,500 cfs measured at Glenwood Bridge). Increased release capability would reduce potential flooding during high runoff (caused by large basin snowpacks and unusual weather conditions). The optimum size project was found to have a diversion rate of 500 cfs, but this may change due to increased development in the floodplain. Such a plan would have minimal adverse environmental impacts.

A series of seven adjacent dry-gulch tributaries in the Boise Front Range drain through narrow canyons onto alluvial fans. From there, they drain into the Boise River within the city of Boise. Most of the Boise Metropolitan Area north of Boise is subject to flooding from these foothill side drainages. The canyons are susceptible to debris-laden flash floods due to intense rainfall during thunderstorms. Flash floods can occur within 15 minutes to 6½ hours of heavy rainfall, and pose an extreme risk for loss of life and property in some areas.

A flood warning system has been identified as an economically-justified solution for the side drainages. Such a system would protect against loss of life and reduce flood damages caused by thunderstorm-type floods. A flood warning system could be included as a solution to flood problems in the side drainages.

Since construction of the three projects upstream of Boise for flood control and irrigation, the configuration and use of the floodplain along the Boise River has changed significantly. Because of the regulation of more frequent floodflows, urban development has encroached into the natural floodplain. This has substantially reduced the natural qualities and riparian habitat of the river. The natural fluvial process has also been modified to such a degree that the Boise River can no longer maintain an environment that allows for regeneration of the black cottonwood forest along the river. These trees are vital to maintaining wintering areas for bald eagles, as well as a wide variety of fish and wildlife. There is a strong interest among the local community to stop further degradation of the black cottonwood forests and restore what has been lost. Although no specific alternatives were evaluated in detail, alternatives were identified conceptually. At least one alternative appears to have the potential for high project outputs.

To meet both present and future water demands, United Water Idaho, Inc. (UWI), formerly known as Boise Water Corporation through 19 March 1995, a provider of water for residents of the city of Boise (under franchise with the city), has begun to acquire excess irrigation storage in the upstream storage projects. They have also begun reallocating the storage from irrigation to municipal and industrial (M&I) water supply. They are systematically purchasing state water rights from irrigation canal companies as land in the Boise River Basin is converted from agricultural use to residential use. They plan to use the storage to meet both their present and future M&I water supply storage needs. With the projected steady growth rate that has been experienced and is expected to continue over the next 20 years, significant future surface water needs exist. The UWI has requested that the U.S. Army Corps of Engineers reallocate an initial 280 acre-feet (AF) of irrigation storage in the Lucky Peak Project to M&I water supply, as a test case, to establish the procedure for future requests. Additional requests for storage reallocations will be made in the future. An appraisal-level evaluation, conducted as part of this study, has determined that there is a Federal interest in the reallocation of the 280 AF of storage, and that more in-depth studies are warranted. Additional surface water needs for the rapidly-growing Boise River Basin are significant (up to 75 million gallons per day over the next 20 years).

Boise County, in the vicinity of Idaho City, is witnessing a water shortage from both surface and groundwater supplies. As a result of the low runoff during the past 8 years, surface runoff has been reduced substantially. Water levels in domestic water wells have fallen dramatically. Although the situation was not evaluated as part of this study effort, it is apparent that Boise County has a definite need for some type of surface storage for M&I purposes.

There is an intense interest in flood control and environmental restoration, and a definite need for the reallocation of storage in the Lucky Peak Project. The State of Idaho, through the Idaho Department of Water Resources (IDWR), supports continual efforts to address the problems and opportunities identified in this report. The IDWR has indicated that they are interested in further discussions and joint exploration (with counties, cities, flood control districts, *etc.*) of the problems and needs of the basin, as part of their Comprehensive State Water Plan for the lower Boise River Basin. This plan is scheduled for initiation in July 1996. Efforts for a follow-on feasibility study are focused on aligning Boise River 2000 to be a catalyst in establishing the state sponsorship currently projected for Fiscal Year 1997. Boise River 2000 is a local organization that acts as a clearinghouse for water resource-related problems within the basin. Participants in Boise River 2000, under a Memorandum of Understanding dated October 5, 1994, include representatives from various Federal and state agencies, affected counties, numerous municipalities along the river corridor, flood control districts, irrigation districts, private companies, national environmental organizations, and other interested entities and individuals that have a stake in the lower Boise River. Boise River 2000's plan is to establish a comprehensive plan for the lower Boise River by the year 2000.

This report recommends that the reconnaissance study be placed in an "inactive" status until sponsorship for the follow-on feasibility study can be developed. Continued coordination with the city of Boise and UWI, Ada County, Boise River Flood Control District Number 10, Boise River 2000, and IDWR will be accomplished under other available authorities until such time as an appropriate sponsorship has been developed.

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RECONNAISSANCE STUDY

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LIST OF ACRONYMS

AF	Acre-foot
APA	Ada Planning Association
BCR	Benefit-to-Cost Ratio
BMA	Boise Metropolitan Area
BLM	U.S. Bureau of Land Management
BPBC	Boise Project Board of Control
BRFCD	Boise River Flood Control District
CAP	Continuing Authorities Program
CEQ	Council on Environmental Quality
cfs	Cubic Feet per Second
Corps	U.S. Army Corps of Engineers
cy	Cubic Yards
EAD	Expected Annual Flood Damage
EPA	Environmental Protection Agency
ESA	Endangered Species Act
°F	Degrees Fahrenheit
fps	Feet per Second
FEMA	Federal Emergency Management Agency
GI	General Investigation Program
GWMA	Groundwater Management Area

H	Horizontal
H.R.	House Record
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IDHW	Idaho Department of Health and Welfare
IDPR	Idaho Department of Parks and Recreation
IDWR	Idaho Department of Water Resources
IWRB	Idaho Water Resources Board
LBRWQP	Lower Boise River Water Quality Plan
LTC	Lieutenant Colonel
MCACES	Microcomputer-Aided Cost Estimating System
M&I	Municipal and Industrial
MOA	Memorandum of Agreement
msl	Mean Sea Level
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service (formerly Soil Conservation Service)
NWS	National Weather Service
O&M	Operation and Maintenance
PAL	Planning Aid Letter
RC&D	Resource Conservation and Development
RCP	Reinforced Concrete Pipe
RM	River Mile
SBMIC	South Boise Mutual Irrigation Company

USBR	U.S. Bureau of Reclamation
USDI	U.S. Department of the Interior
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
UWI	United Water Idaho, Inc. [formerly Boise Water Corporation (through 19 March 1995)
V	Vertical

LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
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SECTION 1 - INTRODUCTION

1.01. STUDY AUTHORITY.

This reconnaissance study was authorized by a resolution passed by the Senate Committee on Public Works (Upper Snake River and Tributaries), on 19 March 1954.

1.02. PURPOSE AND SCOPE.

The purpose of this reconnaissance study was to review various water resource problems, needs, and opportunities in the Lower Boise River Basin; as well as to determine whether the planning process should proceed into the feasibility phase. The study area encompasses the entire Boise Valley, from Lucky Peak Dam downstream to the mouth of the Boise River; and the Mores Creek sub-basin that flows into the Lucky Peak reservoir. The study focused primarily on problem areas along the main river channel and side drainages, northeast of Boise, Idaho.

1.03. PRIOR STUDIES AND REPORTS.

Numerous studies and reports of the Lower Boise River and Tributaries Basin have been completed by various Federal and state agencies, and local cities and counties. The following is a list of U.S. Army Corps of Engineers (Corps) studies and reports used in the preparation of this reconnaissance report.

a. *Definite Project Report on Lucky Peak Dam, Boise River, Idaho*, 3 October 1949. This report provided the general design for the Lucky Peak Project, and recommended construction of the project.

b. *Design Memorandum No. 1, Justification Report, Flood Control Improvements, Boise Valley Project*, 15 October 1958. This report established the economic justification for intermittent Boise River levees from Boise, Idaho, to the mouth of the Boise River.

c. *Upper Snake River Basin, Wyoming-Idaho-Utah-Nevada-Oregon*, 1961. This report was prepared jointly by the Corps and the U.S. Bureau of Reclamation (USBR), and identified development potential for the most reasonable comprehensive use of land and water resources in the area.

d. *Design Memorandum No. 2, Boise Valley Flood Control Project, Boise River*, June 1963. This report found that intermittent levees were economically justified. However, due to the lack of continued sponsorship by Ada County, further studies were terminated.

e. *Review Report, Tributaries of the Boise River, Vicinity of Boise, Idaho*, April 1964. This report presented an overall plan for the protection of Boise and its suburban areas against floods from four principle tributary side drainage's: Cottonwood Creek, Hulls Gulch, Crane Creek, and Stuart Gulch. Of the four side drainage's investigated, it was determined that flood control projects were economically justified on Cottonwood Creek and Stuart Gulch. This report was the basis for the eventual authorization of the Cottonwood Creek and Stuart Gulch Projects by the Flood Control Act of 1966. Both projects were later deauthorized due to a lack of local interest.

f. *Design Memorandum No. 1, Hydrology, Cottonwood Creek Dam and Reservoir, and Stuart Gulch Dam and Reservoir, Boise, Idaho*, July 1969. This report included the hydrology analysis for the two projects, and was used as a basis for the design of the projects.

g. *Design Memorandum No. 2, General Design Memorandum, Stuart Gulch Dam, Boise, Idaho*, October 1973. This report provided the general design for the Stuart Gulch Project, and recommended construction of the project. As indicated above, the project was later deauthorized due to a lack of local interest.

h. *Levee Restudy on Boise River, Ada County, Idaho*, January 1976. This report presented alternatives considered to resolve flood problems and associated wildlife and recreation considerations along the Boise River in Ada County, Idaho.

i. *Boise Valley Regional Water Management Study*, July 1977. The goal of this study was to develop water resource management plans for the Boise Valley Region that promoted general welfare through contributions to economic development, environmental quality, and regional development. Areas evaluated included water quality and wastewater management, flood damage reduction, water supply for the city of Boise, Idaho, and rehabilitating Barber Dam (due to instability). No recommendations were made for construction.

j. *Flood Plain Management Report for Boise River, Idaho*, September 1982. This report was prepared by the Corps for the Idaho Department of Water Resources (IDWR), under the authority of Section 22, Public Law 93-251. The study identified measures of flood damage reduction implementable by local residence and problem areas where gravel removal or other structural actions might be possible. It addressed questions of how and why the channel has changed or is changing, and whether or not these changes might be induced by flow regulation. The study stemmed, in part, from a recommendation made in the earlier levee restudy report (January 1976) identified above. The report included a set of aerial mosaics of the study area showing the 10,000 cubic feet per second (cfs) floodplain and floodway, existing levees, and an alternative levee system designed to control a 10,000-cfs flow.

k. *Water Control Manual For Boise River Reservoirs*, April 1985. This manual was prepared in cooperation with USBR. It was intended to be used for operation of the Lucky Peak Project, in conjunction with UWI's Arrowrock and Anderson Ranch Projects.

1. *Flood Warning/Preparedness Planning Study, Boise Foothills, Ada County, Idaho*, December 1992. The initial study was conducted through the Corps' Floodplain Management Services Program, at the request of the city of Boise and Ada County, Idaho. The study was conducted as a cooperative effort in conjunction with the Corps, the National Weather Service (NWS), and the city of Boise. However, due to a lack of wide local interest, the study was never completed. A wrap-up report was prepared to document the studies that took place, and included a preliminary design, cost estimate, and economic analysis of the flood warning system.

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SECTION 2 - BASIN DESCRIPTION AND EXISTING RESOURCES

2.01. BASIN DESCRIPTION.

The study area encompasses the Boise Valley from Lucky Peak Dam to the mouth of the Boise River, and the Mores Creek sub-basin that flows into the Lucky Peak Reservoir. It includes the Boise, Nampa, and Caldwell metropolitan areas; and also includes portions of Ada, Canyon, Payette, Gem, and Boise Counties (see plate 1).

The Lower Boise River, which is the only major river in the basin, flows a distance of approximately 64 miles from Lucky Peak Dam northwest to the mouth of the Snake River. In the total reach from Lucky Peak Dam to the mouth of the river, the river drops approximately 650 feet. Cities and towns located within the basin include Parma [River Mile (RM) 5], Notus (RM 14), Caldwell (RM 20), Middleton (RM 25), Nampa, Star (RM 34), Eagle (RM 43), Meridian, Garden City (RM 50), Boise (RM 53) and Idaho City (see plates 1 and 2).

The Boise River is a highly regulated stream. Natural flows are greatly modified by three storage projects on the upper river: Anderson Ranch, Arrowrock, and Lucky Peak; one off-stream reservoir, Lake Lowell; and numerous diversion canals. These reservoirs are operated as a system to serve flood control, irrigation, and recreation. Flood control regulation releases often require early releases of higher-than-natural inflows occurring at the time in order to evacuate the reservoirs so that spring floodflows can be reduced. Irrigation flows, diverted into canals early in the year, often complement the flood control operation by allowing higher flows to be released from Lucky Peak Dam. The most significant of these diversions is the New York Canal which, by itself, can reduce downstream floodflows in the Boise River by nearly 3,000 cfs during maximum irrigation demand periods.

A series of seven adjacent dry-gulch tributaries in the Boise Front Range drain through narrow canyons onto alluvial fans and, from there, into the Boise River (within the city of Boise). The seven gulches include Cottonwood Creek, Hulls Gulch, Crane Creek, Stuart Gulch, Polecat Gulch, Pierce Gulch, and Seaman Gulch. The size of the drainages range from 1.2 square miles (Polecat Gulch) to 16.5 square miles (Cottonwood Creek). The locations of the gulches are shown on plate 3.

The climate of the area is marked by hot, dry summers and cold winters. Average minimum daily temperatures for November through March are below freezing, with average minimum daily summer temperatures on the order of 80 degrees Fahrenheit. The frost-free growing season is about 6 months. Elevations in the study area range from about 6,000 feet above sea level in the hills north of Boise, to about 2,200 feet at the mouth of the Boise River.

Normal annual precipitation in the study area varies from 30 inches at the top of the hills north of Boise, to 10 inches at Boise, and about 9 inches in the Caldwell-Nampa area. The winter months have the highest precipitation amounts. Soil types vary considerably, but much of the area consists of loam, silt, or clay loam.

Ada County comprises 1¼ percent of the land area of the State of Idaho, but contains 20 percent of the State's population. It is currently the center of rapid urban growth. From 1980 to 1990, Ada County increased from 173,125 to 205,775, an increase of approximately 19 percent.

Boise, with a population of 125,738 in 1990, is the state capitol of Idaho, and serves as an economic, cultural, and governmental center for the area. The city has increased approximately 23 percent from 1980 to 1990. Several of the nationally-known firms making their home in Boise include the Morrison-Knudson Company, Boise Cascade Corporation, J.R. Simplot Company, Ore-Ida Foods, and Albertson's, Inc. Boise is located near the head of the fertile Boise Valley, with the Boise River flowing through the city. The central city area lies on the north side of the river between the river and the foothills. Boise has expanded alongside the river and into the dry gulches of the foothills. Urban development south of the Boise River has spread and leap-frogged, covering a much larger area. This has been due both to a lack of natural boundaries (*e.g.*, the foothills on the north) and limited land-use controls.

Nampa and Caldwell, with 1990 populations of 28,365 and 18,400, respectively, are the largest cities in Canyon County. The total Canyon County population in 1990 was 90,076, a 7½ percent increase from 1980.

2.02. EXISTING FEDERAL PROJECTS.

Within the Boise River Basin, four separate Federal reservoir projects are operated as one system. This system is referred to as the "Boise River Reservoir System." It is composed of three Boise River reservoirs (Anderson Ranch, Arrowrock, and Lucky Peak) and an offstream reservoir (Lake Lowell and its related facilities: Diversion Dam and the New York Canal). The Anderson Ranch Project was constructed between 1941 and 1950, and storage began on 15 December 1945. The Arrowrock Project was constructed between 1911 and 1915, and first storage began on 22 October 1914. During the period from 1935 to 1937, Arrowrock Dam was repaired and raised 5 feet. The Lucky Peak Project was constructed between October 1949 and December 1957, and storage began on 16 October 1954. The Project began operation in March 1955. The locations of the projects are shown on plate 1.

The three reservoir projects are operated for the purposes of flood control, irrigation, and recreation through a Memorandum of Agreement (MOA) between the Department of the Army and the Department of the Interior. The original MOA was signed in November 1953 and was updated in 1985. The reservoirs have a combined gross storage capacity of approximately 1.109 million acre-feet (AF), and a usable (active) storage of approximately 0.974 million AF. Table 2-1 contains a summary of reservoir storage for each of the projects.

Table 2-1. Reservoir Storage		
Project	**Active Storage (AF)**	**Total Storage (AF)**
Anderson Ranch Reservoir	423,178	503,682
Arrowrock Reservoir	286,600	298,230
Lucky Peak Reservoir	264,371	307,043
Totals	974,149	1,108,955

The Lucky Peak Project consists of an earthfill dam 250 feet high and 1700 feet long at the crest. The spillway, located on the left abutment, has a free-overflow concrete ogee crest that is 600 feet long. The original outlet works, located in the left abutment, consist of a 23-foot-diameter tunnel, with six 5-foot 3-inch by 10-foot slide gates and one 30-inch hollow jet valve. The power potential at the project was developed by non-Federal interests that began producing electrical power in 1988. As part of the non-Federal hydropower development, a low-level diversion tunnel was constructed. The diversion tunnel provides the capability of minimum streamflow releases past the project during periodic maintenance of the outlet works/powerplant tunnel, a capability not previously available.

2.03. EXISTING RESOURCES.

a. General.

As human development has spread through the Boise River Basin, there has been an expected loss of a number of fish and wildlife resources. However, there may be another loss of wildlife habitat in future years as open spaces, in the form of agricultural fields, are turned into subdivisions to accommodate the area's increasing population. Many of the developments are taking place along the Boise River corridor, where riparian areas provide the best remaining habitat available for many species. The following paragraphs address existing resources. For more information regarding current fish and wildlife resources in the lower Boise River Basin, see appendix A [the Planning Aid Letter (PAL) prepared by the U.S. Fish and Wildlife Service (USFWS)].

b. Fish, Wildlife, and Botany Resources.

As human development spreads throughout the Boise River Basin, there has been an expected loss of a number of fish and wildlife resources. There will be additional losses of fish and wildlife habitat in the future as urban areas expand even further into the basin. Agricultural fields turned into subdivisions will mean the loss of edge habitat for a number of species (*i.e.*, ring-neck pheasants, and whitetail deer), depending on the type. Many of the housing developments take place along the Boise River itself, as many people are discovering its attractiveness as a place to live. Riparian corridors are the best place for habitat in the interior west, and they are being disturbed at an alarming rate.

For another description of the fish, wildlife, and botany resources of the Boise Watershed, please refer to the PAL prepared by USFWS in appendix A.

(1) Fish.

Historically, the Boise River supported one of the most valuable fisheries in the region [U.S. Department of the Interior (USDI) and USFWS, 1974]. Large runs of salmon and steelhead entered the river each year to spawn. Over the past 100 years, aquatic habitat has been altered, reducing anadromous runs and affecting resident fish species. In the 1950's, the construction of the Hells Canyon Project by Idaho Power completely eliminated all steelhead and salmon runs in the Boise River Basin. Stocks within the basin were eliminated from the headwaters even before that time by the construction of Arrowrock, Anderson Ranch, and Lucky Peak Dams on the mainstem Boise River.

A variety of fish species now occupy the lower Boise River. The Idaho Department of Fish and Game (IDFG) stocks hatchery rainbow trout (*Oncorhynchus mykiss*) in the river from Barber Pool downstream to Star (Kaltenbecker *et al.*, 1994). Hatchery rainbow trout are locally and seasonally abundant, but native rainbow trout are uncommon. A strain of rainbow trout, redband (*O. mykiss gairdneri*) may occur below Lucky Peak Dam. Bull trout (*Salvelinus confluentus*) are known to occur in the More's Creek sub-basin. Bull trout historically occupied the lower Boise River, but have been extirpated due to a combination of high water temperatures, dam construction, the elimination of anadromous fish stocks, and degraded water quality. Other game fish species present include mountain whitefish (*Prosopium williamsoni*) and brown trout (*Salmo trutta*). Non-game fish species present include suckers (*Catostomus spp.*), chiselmouth chubs (*Arocheilus alutaceus*), and northern squawfish (*Ptychocheilus oregonensis*).

(2) Birds.

More than 150 species of birds use habitat associated with the Boise River. Bird species present during the course of the year range from eagles to hummingbirds. The Boise River valley is an important breeding and wintering area for a variety of waterfowl species, including mallard (*Anas platyrhynchos*), Canada goose (*Branta canadensis*), and wood duck (*Aix sponsa*). Some species are year-round residents, while others are migratory and present only during portions of the year. Many of the species that nest in the valley are neotropical migrants traveling as far south as Central and South American for the winter (Idaho Wildlife, 1992). Species such as the bald eagle (*Haliaeetus leucocephalus*) occur in the lower Boise River drainage as winter residents. Other species use the drainage as a stopover during fall migration from as far north as Alaska and the Northwest Territories, enroute to areas further south; and then again during spring migration on their return flight to northern breeding grounds.

Great blue herons (*Ardea herodias*) commonly occur along the river throughout the year. Herons breed in large communal nesting sites called rookeries. Three rookeries have been identified along the lower Boise River.

(3) Mammals.

At least 37 species of mammals are known to occur within the lower Boise River Basin, ranging in size from the vagrant shrew (*Sorex vagrans*) to Rocky Mountain Elk (*Cervus canadensis*). Some species such as beaver (*Castor canadensis*), mink (*Mustela vison*), and river otter (*Lutra canadensis*) are directly dependent on the river for food; and live in association with the river and side channels. Other species, including striped skunk (*Mephitis mephitis*) and porcupine (*Erithizon dorsatum*), are year-round residents of the riparian forests. Still others, such as mule deer (*Odocoileus hemionus*), are partially or periodically dependent on the river and its associated riparian areas for water, shelter, and forage; and also use surrounding farmlands, and grass and shrub habitats (including the Boise foothills).

(4) Reptiles and Amphibians.

A variety of species of reptiles and amphibians can be found throughout the lower Boise River Basin (Sather-Blair and Blair, 1983). Amphibians are associated with a variety of moist environments (*i.e.,* streams, ponds, and marshes). The lower Boise River drainage likely supports a number of species of frogs and toads, including the bull frog (*Rana cateskeiana*), leopard frog (*Rana pipiens*), and western toad (*Bufo boreas*). Reptiles known or suspected to occur along the lower Boise River include the western garter snake (*Thamnophis elegans*), common garter snake (*Thamnophis sitalis*), sagebrush lizard (*Sceloporus graciosus*), and western fence lizard (*Sceloporus occidentalis*).

(5) Species of Special Concern.

There are two fish species of special concern. The redband trout (*O. mykiss gairdneri*), a strain of the native rainbow trout, is a Category 2 candidate for listing under the Endangered Species Act (ESA). Also found in the drainage is the bull trout, which is a Category 1 candidate.

The bald eagle is a Federally-listed endangered species that spends winter months along the lower Boise River. Its winter habitat use includes communal roosting and the use of daytime perches for loafing and foraging. Numerous researchers (Jensen, 1981; Spahr, 1990; and Kaltenbecker *et al.,* 1994) have documented the importance of the lower Boise River to wintering bald eagles. In particular, Barber Pool has special value as a communal roost.

Bald eagles wintering along the lower Boise River depend on a variety of fish, birds, and mammals for forage (Spahr, 1990; and Kaltenbecker *et al.*, 1994). Their diet consists of rainbow trout, brown trout, and mountain whitefish; rough fish including suckers, chubs, and squawfish; waterfowl; and mule deer carcasses.

Rare and sensitive mammals known or suspected of occurring in the lower Boise River valley include the spotted bat (*Euderma maculatum*) and Townsend's big-eared bat (*Plecotus townsendii*), both candidates for Federal listing. In the More's Creek sub-basin, there have been probable sightings of the gray wolf (*Canis lupus*), which is listed as endangered; and the wolverine (*Gulo gulo luscus*), a Category 2 candidate.

(6) Vegetative Communities.

The typical and historic vegetative community adjacent to the lower Boise River is black cottonwood (*Populus trichocarpa*) forest (Kaltenbecker *et al.*, 1994). Many areas of the black cottonwood forest are classified by the USFWS National Wetlands Inventory (Cowardin, 1979) as palustrine forested wetlands, while other areas are classified as forested uplands. Functions and values provided by palustrine, forested wetlands include groundwater recharge, groundwater discharge, flood storage, reduced flood peaks, increased flow duration, shoreline anchoring, sediment trapping, nutrient retention and removal, food chain support, habitat for fish and wildlife, and active and passive human recreation (Sather and Smith, 1984). Alder (*Alnus spp.*), willow (*Salix spp.*), birch (*Betula spp.*), hawthorn (*Crataegus spp.*), and other shrub species commonly dominate the understory of the black cottonwood forest. Russian olive (*Elaeagnus anustifolia*) are locally abundant. Silver maple (*Acer saccharunum*) occur occasionally in flooded emergent wetlands typically vegetated with sedges (*Carex spp.*), rush (*Juncus spp.*), spikerus (*Eleocharis spp.*), cattail (*Typha spp.*), and bullrush (*Scirpus spp.*) (Tiedeman, 1994).

Much of the Boise River riparian zone has been significantly altered by human activity. It is dominated by non-native, weedy species, or has been converted to landscaping. Previously, the river would have had a much greater amount of overstory community extending back from the river, but these riparian wetlands were filled in during the development of the floodplain. A good example of this is the Boise State University campus, which is located on former wetlands (Bridges, personal communication). The introduction of exotic, weedy plant species has altered the vegetative communities of the riparian area. Non-native plants often outcompete native species because they lack natural control, and the changed character of the plant community often adversely affects native fish and wildlife species. In some areas along the lower Boise River, non-native plants have replaced the native flora. Exotics presently causing concern are Russian olive, reed canary grass (*Phalaris arundianacea*), purple loosestrife (*Lythrum salicaria*), and false indigo (*Amopha fruticosa*) (Brown, 1990).

c. Recreation.

The population of the Boise River Basin continues to grow dramatically, and the number of people who recreate in the river is increasing at a proportional rate. The population of Ada County alone is now well over 200,000. Many people who move to this area cite the availability of nearby recreation as one of their primary reasons for relocating. Many of the people who recreate use the river, in one form or another, for their activities. The mainstem corridor receives all kinds of activity throughout the year, with the peak period occurring during the summer months. Fishing, tubing, rafting, and kayaking are all activities that directly involve the river. The Boise State University campus is located next to the river, and many of the students participate in water-related activities. The Boise River Festival is an annual event that focuses on the river, and attracts people from throughout the region.

Part of the reason for the high demand of outdoor recreational activities in the Boise River area is the availability and proximity of numerous sites. Many of the people who move to the area state that one of the reasons for moving is the outdoor opportunities (Beck and Baird, 1993).

The Boise River system supplies a diversity of species for sports fisherman, with over 15 different types of game fish living within the basin, according to IDFG (*ibid.*). Non-native warmwater species (bass and crappie) occupy the lower end of the river, while native coldwater species (trout, charr, and whitefish) inhabit the middle and upper reaches of the river.

There is a slight preference for fishing on flowing water as opposed to flat water, even though (by a small percentage) most fishing is done on flat water. This could infer that most recreational opportunities are on lakes, and people use the lakes even though they would prefer to use the river.

Recreational use of the Lucky Peak Project is high due to its proximity to the Boise urban area. The project can even be reached along the Boise River Greenbelt bike path. Lucky Peak State Park has the highest use of any state park (*ibid.*). Visitor use is highest in the August to September time period, when temperatures rise and people seek water-based recreation. In low water years, many fish are passed through the reservoir to the Boise River downstream. The Corps has developed plans, in the Master Plan for Lucky Peak, to improve already developed recreational sites, and to create a visitor center in the future.

Lake Lowell is isolated from other water bodies in the basin, but still receives a great deal of use. It is located in relatively close proximity to the cities of Nampa and Caldwell. Therefore, many residents use this area, especially for flat-water recreation.

d. <u>Cultural Resources</u>.

A records search of a portion of the Boise River drainage was performed at the Idaho State Historical Society in support of this study. Survey reports and cultural resource records pertaining to a corridor ½ mile wide on both sides of the Boise River, from Lucky Peak Dam to its confluence with the Snake River, were examined. The results are summarized in the following paragraphs.

Approximately 46 separate cultural resource surveys have been performed in sections partially, or completely, within the abovementioned corridor. The typical survey covered less than 10 acres per section, and was undertaken as a result of a specific proposed action (*i.e.*, highway realignment or subdivision construction). The majority of surveyed areas lie within Ada County, primarily within the greater Boise area. Cultural resource surveys have been executed within the study area since 1948, with the majority occurring prior to 1990. Of the 46 surveys examined, 13 do not contain sufficient information necessary for estimating coverage, while only 3 surveys cover 100 or more acres within sections partially or completely within the corridor.

Approximately 290 cultural resource sites have been recorded within the corridor. These include both historic and prehistoric sites, most of which have been recorded in the Boise area. Approximately 249 resources are designated as architectural properties, and the majority are associated with urban areas (*i.e.*, Boise, Eagle, and Star). These properties include schools; residential and commercial buildings; various bridges spanning the Boise River, Diversion Dam and Powerplant; and the Idaho State Historical Museum. With a few exceptions, these properties date to the early and middle 20th century, and many are currently in use. Approximately 41 of the 290 cultural resources recorded are designated as historic and/or prehistoric resources, rather than architectural properties. Thirteen are prehistoric sites, including seven rockshelters with associated prehistoric artifacts (*i.e.*, projectile points, lithic debitage, ceramic shards, faunal remains, mussel shells, and rock alignments), two open sites, three lithic scatters, and one location noted but not recorded (pestle and "molded rocks"). As a whole, these sites were not documented according to present standards. As a result, there is no age assessment for the sites apart from the infrequent qualitative assessments based upon projectile point typologies and general site character. Another 28 historic sites were recorded as well. These include the Oregon Trail (1843 to the 1870's), a homestead (1869), the Foote House (1880's), a placer mining site, the former Boise City dump (1925 to 1937), the Boise National Forest Administrative Compound (1935 to the present), Urquides or Spanish Town (built in 1863), the U.S. Assay Office (1870 to the present), the old Middleton Cemetery, several bridges spanning the Boise River, several dumps associated with former dwellings, and six rockshelters with associated historic debris. These rockshelters are in the same general area as rockshelters containing evidence of prehistoric use. The presence of historic debris does not preclude the prehistoric use of these shelters, but only historical artifacts were located.

Based upon completed surveys and cultural resource records, the potential for locating unrecorded sites within the corridor is variable; and depends upon location, proximity to the Boise River or other drainages, topography, and urban development. Several reports concentrating on the upper end of the corridor indicate the possibility of locating additional prehistoric sites around and below the Lucky Peak Project. The Lydle Gulch site (an open camp), and several other prehistoric sites located in this area, may indicate a moderate potential for unrecorded prehistoric sites. There is significant potential for recording historic sites and architectural properties in the Boise area, as well as other population centers within or adjacent to the corridor.

The Oregon Trail follows the Boise River throughout most of the corridor. There is significant potential for unrecorded sites associated with this historic trail, especially in the western area where few surveys have been concentrated. Additionally, due to the low level of recordings for a majority of the corridor west of the Boise area, there is potential for a significant number of unrecorded sites in the area.

e. Socioeconomic.

(1) Economic.

The lower Boise River Basin comprises a total land area of approximately 1500 square miles. It includes both Ada and Canyon Counties, and is occupied by about 1/3 of the total population of the State of Idaho. The Boise Chamber of commerce identifies the Boise Metropolitan Area (BMA) by approximately the same geographic boundaries.

The population of Idaho is slightly more than 1 million inhabitants. Boise is the largest city in Ada County, as well as in the State of Idaho. With a population of approximately 158,000, it is more than 300 miles away from another city of comparable size. Ada and Canyon Counties are among the five fastest growing counties in what has traditionally been a rural state. The population of these counties is about 242,000 and 100,000, respectively.

The approximately 180,000 jobs centered in Ada County are largely (85 percent) of a non-manufacturing nature. The remaining jobs are allocated to direct agriculture and manufacturing-type jobs. Two of the major non-agriculture manufacturers located in Boise are Micron Technology and Hewlett-Packard. These corporations employ 45 percent of all manufacturing workers in BMA. Boise Cascade Corporation also has its corporate headquarters in Ada County.

In 1990, approximately 35,000 jobs existed within Canyon County. These jobs are primarily non-manufacturing (61 percent), manufacturing (25 percent), and direct agriculture (14 percent). Since a large portion of the manufacturing industries are involved with agriculture-related products, agriculture is considered an important element to Canyon County's socioeconomic scheme.

The BMA is strong in both wholesale and retail trade. It is estimated that the regional retail trade market (comprised of BMA, 10 other Idaho counties, and 2 Oregon counties) accounts for $3.6 billion in retail sales. In 1992, retail sales of $2.65 billion were generated in Ada and Canyon Counties.

Two other categories of strong economic growth in BMA are the financial services industry and State and Federal Government. The West One Bankcorp corporate headquarters is located in Boise. Key Bank has a regional operation in Boise that serves the far west and Rocky Mountain states. First Security Bank provides consumer loan servicing for a six-state territory. Two other large financial services, the Sears Regional Credit Center and First Interstate Bank, are also located in Boise.

The State and Federal Governments each account for about 10,000 jobs in BMA. The largest Federal agencies are USBR and the U.S. Bureau of Land Management (BLM). Around 6,000 military personnel are associated with the Idaho National Guard (located in Boise) and Mountain Home Air Force Base (located about 55 miles east of Boise).

(2) Projections.

Recent studies indicate increased growth in numerous areas of the lower Boise River Basin. Based on the Boise Area Chamber of Commerce's *Economic Outlook Report 1994*, employment growth in both the manufacturing and trade industries is projected to realize net gains of about 3 percent. Agriculture receipts are expected to generate approximately $3 billion in 1995. Employment related to tourism is projected at 9 percent.

Based on the Boise Area Chamber of Commerce Research Committee's report, *Boise's Changing Profile*, dated January 1994, construction employment gains are expected to average approximately 4.5 percent from 1990 through 2010.

The Boise Area Chamber of Commerce estimates population growth in BMA at 3.3 percent from 1990 to 2000, with smaller average annual gains of 2.7 percent from the years 2000 to 2010. [The Idaho Department of Health and Welfare (IDHW) has projected the population growth rate of the same area at 2.6 percent from 1990 to 2000.]

(3) Social.

A survey by the Boise Future Foundation indicates that increasing numbers of residents are satisfied with the quality of life in BMA. Approximately 86 percent of the people interviewed stated they were either satisfied or highly satisfied with the quality of life. Residents of BMA are concerned about preserving the environment. They take pride in their "rural" atmosphere. Idaho is a sparsely populated state, and is also home to the largest wilderness area in the lower 48 states (River of No Return Wilderness Area in east-central Idaho). There are more people in the city of Minneapolis than there are in the entire State of Idaho. Many species of western wildlife indigenous to the American West reside in Idaho. Boisians, and all inhabitants of Idaho, take pride in their American Bald Eagles. The Boise River corridor currently boasts of 16 bald eagle wintering sites. Of these 16 sites, 11 may be in danger because of potential commercial development.

The Boise River Greenway extends along the river from the Lucky Peak Project downstream through the city of Garden City (near Willow Lane Park). It is used by bikers, hikers, swimmers, picnickers, and naturalists during all seasons of the year. The Boise River Basin has increasing pressures imposed upon it by a developing economy, population growth, agricultural needs, and a desire to preserve the natural state of the environment. This natural environment may be the one element catalyzing the growth, and therein lies the dilemma of trying to balance the desires of various interest groups.

SECTION 3 - BASIN PROBLEMS

3.01. GENERAL.

During the initial stages of this study, efforts primarily concentrated on identifying all water resource-type problems and needs within the basin. Past reports were reviewed and contacts were made with local entities (*i.e.*, the state, counties, cities, flood control districts, and other interested entities and organizations). The following paragraphs contain a summary of the problems identified as part of that effort.

3.02. PROBLEMS IDENTIFIED.

a. Flooding.

(1) Boise River.

Natural flows in the lower Boise River are greatly modified by three storage projects (Anderson Ranch, Arrowrock, and Lucky Peak Projects), one offstream reservoir (Lake Lowell), and numerous diversion canals (see plate 1). The reservoirs are operated as a system to serve flood control, irrigation, and recreation. Regulated releases, for the purpose of flood control, often require early releases of higher than natural inflows. This is done to evacuate the reservoirs so that spring floodflows can be reduced. Irrigation flows diverted into canals early in the year often complement the flood control operation by allowing higher flows to be released from Lucky Peak Dam.

Short reaches of levees have been built and enlarged along the river by individual landowners, Ada and Canyon Counties, and local flood control districts. Some levees are high and sturdy, while others are low and easily erodible. The reservoirs and levee system through downtown Boise and Garden City provide a level of flood control that is well below the 100-year level.

Low flow conditions over the past 8 years have led the growth of trees and brush in the river channel. This has significantly reduced the channel's capacity for the next flood occurrence. Minor flooding along the lower Boise River starts when flows at Glenwood Bridge exceed 4,500 cfs, a flow frequency of about once in 2 years. Major flooding starts at 7,200 cfs (once in 26 years). Flood damages increase sharply above the 10,000-cfs level.

The projects are operated to a target flood control flow of 6,500 cfs (approximately a 3-year flood event), when possible. However, due to unseasonably warm or wet weather conditions in the late winter or early spring, the regulated target flow of 6,500 cfs has been exceeded 13 times since construction of the Lucky Peak Project in 1954. Seven emergency flood fights and five rehabilitation projects have been completed along the lower Boise River since 1971. Despite the levee rehabilitation work, damages have occurred in 8 of the last 12 years. The largest regulated discharge was approximately 9,500 cfs at Glenwood Bridge, and this occurred in 1983.

Confusion has developed in the area of Eagle, Idaho, related to the proper floodplain map used in determining the location of the 100-year floodplain. According to various accounts, there are different flood maps in existence. These have been produced by both the Corps and the Federal Emergency Management Agency (FEMA). As a result, there is confusion as to which maps should be used. In all cases, the rate maps published by FEMA are the appropriate maps to use.

(2) Boise Foothills Area.

A series of seven adjacent dry-gulch tributaries in the Boise Front Range drain through narrow canyons onto alluvial fans. From there, they drain into the Boise River within the city of Boise. A large portion of the city of Boise north of the river is subject to flooding from these foothill drainages. The northern section of the city is crowded with residential, commercial, and government buildings; and lies directly on top of alluvial fans. The canyons are susceptible to debris-laden flash floods due to intense rainfall during thunderstorms. Flash floods can occur within 15 minutes to 6½ hours of heavy rainfall, and pose an extreme risk for loss of life and property in some areas. The locations of these dry gulches are shown on plates 2 and 3.

Drainages in the gulches are confined by steep hillsides and narrow canyon floors. Below the canyon mouths, the streams emerge onto alluvial fans that slope to the Boise River floodplain. High flows are not confined laterally, thus allowing water to spread outward. The lower reaches of the streams flow through a system of manmade channels and pipes. The small artificial waterways in these lower reaches are inadequate for containing major floodflows. Extensive residential and commercial development has occurred in, and adjacent to, the channel in several of the canyons. In some areas, streets that are primary flood escape routes become the drainage path. The northern section of the city is crowded with residential, commercial, and government buildings; and lies directly on top of alluvial fans.

(3) High Groundwater.

Inflows to the Caldwell and Meridian sewage treatment plants increase markedly due to the infiltration of groundwater into the sewage collection systems. This results in large flows that must go through the sewage treatment plant.

Groundwater typically rises near ground level, both during and following the irrigation season. The problem area is served by sanitary sewer systems. Over the years, seepage into the sewer systems, both planned and accidental, has tended to reduce the groundwater effects at the expense of greatly increased sewage flows. The sanitary sewer systems are acting as drains by keeping the summer groundwater table beneath the surface of the ground. As part of a plan to meet required effluent standards, it would be necessary to seal the sanitary sewer systems to prevent the intrusion of groundwater. As the sanitary system is improved and sealed, it is apparent that groundwater and surface water problems will quite possibly appear in a more severe form than ever previously experienced. As an example, the area subject to flooding in the city of Caldwell is a 47-block area north of the railroad tracks. The most critical is a 12-block area between Fifth and Seventh Streets, and the railroad tracks and Interstate 84.

b. Irrigation.

Both the Boise Valley and BMA have undergone rapid population growth. Most of the growth has been at the expense of agriculture, which has seen significant irrigation cropland acreage converted to urban usage. Of primary concern are those changes that have occurred in irrigated land areas (*i.e.*, urbanization, conversion to sprinkler, and change of water source from surface to groundwater). There is a need to quantify the loss of irrigated cropland, as well as to determine the present use of the surface water that was once associated with the lands. There is also a need to determine where and how the irrigation delivery systems have changed since their initial development in the early 1900's.

c. Recreation.

In-river recreation (*i.e.*, canoeing, rafting, boating, *etc.*) is extremely popular on the lower Boise River throughout most of the year. In-water recreationalists are hampered by manmade obstacles such as the irrigation diversion facilities constructed along and within the river channel. These facilities include intake structures situated along the shore of the river. In some instances, low head permanent irrigation diversion dams are required to raise the water surface of the river for diversion purposes. Where only a minimal raise in water surface is required, it is common practice to raise low, temporary gravel dams across the river downstream of the irrigation intake structure to create the raise in water surface needed to allow diversion. The temporary irrigation dams, as a rule, are constructed and maintained by the irrigators. Although the dams are considered temporary, and are not needed during the non-irrigation season, they are usually left in the river. During the spring runoff, the gravel dams raise the upstream water surface, thus increasing the potential for flooding. Some of the gravel dams are washed out and the gravel moves downstream, causing blockages. The following year, the irrigators must again collect gravel and reestablish the gravel dams for the upcoming irrigation season. This process causes a constant disruption to the river and the environment.

In recent years, water delivery organizations and related parties have experienced increasing interest in improving methodologies for diverting water from the rivers and allowing the safe passage of water recreationalists. In response to intensified economic, environmental, and recreational demands; water delivery organizations with diversions from the Boise River, along with other interested parties, have recognized specific benefits in working together to explore alternatives to the present system of low head diversion dams. These alternatives would serve the purpose of irrigation diversion, as well as allow the safe passage of water recreationalists. A standard generic-type diversion dam is needed that could be used to meet the needs of the river.

d. Riparian Habitat.

Since construction of the three projects upstream of Boise for flood control and irrigation, the configuration and use of the floodplain along the Boise River has changed significantly. Because of higher flood protection and the associated reduced flood-prone areas downstream of the projects, urban development has encroached into the natural floodplain. This has substantially reduced the natural qualities and riparian habitat along the river. The natural fluvial process has also been modified to such a degree that the Boise River can no longer sustain an environment that allows for the regeneration of black cottonwood trees. The black cottonwoods are extremely vital in maintaining wintering areas for bald eagles and a wide variety of other fish and wildlife.

Winter streamflows in the lower Boise River periodically fall to critical levels. Natural streamflows are normally reduced during winter periods, when water is being stored in the reservoirs for use during the next irrigation season. Such low flows in winter, and the disruption of natural floodflows and runoff cycles during other parts of the year, adversely impact the fishery in the river as well as portions of the riparian zones.

e. Water Quality.

Over 25 canals and ditches divert water from the lower Boise River for irrigation during the growing season. The water returns to the river from many sources; including direct runoff from adjacent lands, storm water, wastewater, agricultural drainage water, and runoff from tributaries and the groundwater system. Water that returns to the river is of poor quality. This has prompted the Environmental Protection Agency (EPA) to list select reaches of the lower Boise River as "Water Quality Limited" as the result of a lawsuit by the Idaho Conservation League. The poor water quality has limited the beneficial use of the lower portion of the river.

f. Water Supply.

(1) The City of Boise.

In the Boise area, there is no single municipal water supply system. Instead, there are numerous separate systems. The major water system for the area is privately owned. Groundwater is, and in the near future will continue to be, the principal source of supplied water. However, interest has been expressed in obtaining future surface water from Lucky Peak Lake or other surface water supplies. Many of the suburban development tracks have their own well and distribution systems, in combination with septic tanks, for sanitary waste. In the interest of health, better fire protection, and a more efficient area water supply system, consultants' reports in the past have recommended that the city begin to acquire and consolidate the several existing water supply entities.

United Water Idaho, Inc. (UWI), formerly known as Boise Water Corporation (until 19 March 1995), an investor-owned utility under franchise with the city, is a provider of water for residents of the city of Boise. Their source of water comes mainly from wells located strategically throughout the Boise area. One set of wells is of the Ranney-type, and is located adjacent to the Boise River (just upstream of the city). Because of the close proximity of the well system to the Boise River, the wells draw water from the river when they are being used. Through a flow augmentation plan established between the State of Idaho and UWI, irrigation water is released from the Lucky Peak Project and allowed to pass downstream to the area of the Ranney well system in order to replenish the depleted water from the river. The UWI is in the process of purchasing storage for use as part of their flow augmentation plan. Because of restrictions on the use of storage for irrigation, UWI has requested that their share of irrigation storage in the Lucky Peak Project be reallocated from irrigation to a municipal and industrial (M&I) water supply.

(2) Boise County.

Boise County is experiencing a water shortage, both from a groundwater and a surface water standpoint. During the past 8-year series of low water years, conditions have continually worsened. Water levels in domestic wells have dropped, requiring strict water conservation measures. There is a need for conservation measures and/or new surface water sources for M&I purposes.

3.03. SCREENING AND CONSOLIDATION.

The water resource problem areas were screened based on needs and local interest, as well as Corps' authorities. Areas for further study were identified as flood control, environmental restoration, and water supply, as discussed below. These problem areas are addressed in more detail in sections 4, 5, and 6, respectively.

a. Flood Control.

Flood problems along the Boise River were considered to be of utmost concern because of limited flood protection along the river downstream of the projects. It is estimated that the upstream projects provide controlled flood protection for a regulated flood with a recurrence interval of only about once in 26 years, measured along the flood-prone areas downstream of the city of Boise. This represents a regulated flow of only about 7,200 cfs through the flood-prone area. Damages start to increase significantly at about 7,500 cfs, and increase sharply as flows exceed 10,000 cfs. In addition, there is a strong concern of loss of life as a result of runoff from thunderstorm-type floods in the side drainages.

b. Environmental Restoration.

The environmental degradation that has taken place along the Boise River was identified as a major concern. At least a portion of the degradation can be attributed to the construction and operation of the upstream Federal projects, including the Lucky Peak Project. There was considerable interest at the local level to identify problem areas and solutions. A major area of concern was the degradation of black cottonwood trees along the Boise River, as they adversely impact the wintering of bald eagles.

c. Water Supply.

To satisfy a specific request made by UWI for the reallocation of storage from irrigation to M&I water supply, water supply was identified as a high priority purpose and is, therefore, addressed in this report. Although the need to provide an M&I water supply for Boise County was considered of utmost importance, further studies are being deferred until the follow-on feasibility study.

SECTION 4 - FLOOD CONTROL

4.01. BASIN HYDROLOGY AND HISTORIC FLOODFLOWS.

a. Basin Description.

(1) General.

The Boise River Basin has a total drainage area of approximately 4,130 square miles. It is located in southwestern Idaho and is one of the major tributaries of the Snake River, a principal branch of the Columbia River system. The Payette and Salmon River Basins lie to the north, while the Sawtooth Mountains and Big Wood River Basin are located to the east. The main stem of the Snake River is both south and west. The long basin axis trends east/west; and includes large portions of Ada, Canyon, and Elmore Counties, as well as small portions of Boise and Camas Counties. The principal streams within the Boise River Basin flow in a westerly direction, from the headwaters in the Sawtooth Mountains to the mouth of the Boise River (a distance of about 200 RM's). Topography and runoff characteristics naturally divide the Boise River Basin into two separate and distinctive watersheds: an upper and a lower watershed. A ridge, known as the Boise Front, forms the boundary between these two watersheds. In contrast to the upper watershed, the lower watershed is quite heavily populated and extensively developed. Streamflow within the lower watershed is quite limited. The primary tributaries of the Boise River are Indian Creek, Willow Creek, and Dry Creek. These streams, with the exception of Indian Creek, are intermittent, and normally flow only during the spring and early summer months. Plate 1 shows the primary features of the Boise River Basin. A more detailed description of the basin is included in appendix B, Hydrology.

(2) Watershed Topography and Characteristics.

The upper watershed consists of approximately 2,680 square miles of drainage area upstream of Lucky Peak Dam. It is a fan-shaped, mountainous area that contains the headwaters of all the significant tributaries. This area is composed largely of precipitous mountains, and is characterized by a highly-dissected topography with deep V-shaped valleys, steep slopes, and narrow, sharp top ridges. The upper watershed ranges in elevation from 3,000 to 10,600 feet above mean sea level (msl), and the mean elevation is approximately 5,800 feet above msl. The principal tributaries and their drainage areas of the Boise River include: 1) South Fork, 1,310 square miles; 2) Middle Fork and North Fork, 830 square miles; 3) Mores Creek, 430 square miles; and 4) Lucky Peak Lake local inflows, approximately 110 square miles. These four tributaries contain approximately 62 percent of the total area of the Boise River above its mouth. The upper watershed is characterized by sparse population and very limited development.

The lower watershed consists of approximately 1,450 square miles of drainage area below Lucky Peak Dam. This area is composed of river bottoms, terraces, and both low rolling and steep hills with few distinct mountains. Adjoining the Boise River is bottom land, varying from 1 to 3 miles in width, constituting the normal floodplain. Adjacent to this bottom land is a series of two terraces. The first terrace lies approximately 2,500 feet above msl, while the second terrace is between 3,000 and 4,000 feet above msl. The terraces grade upward, toward the east, to a ridge that cuts the basin north and south at approximately the location of Lucky Peak Dam.

(3) Boise Front Drainages.

The Boise Front drainages are located both north and east of the city of Boise. Drainage areas for the seven largest gulches are presented in table 4-1.

Table 4-1.
Drainage Areas of Boise Front Drainages

Gulch Name	Drainage Area (Square Miles)
Cottonwood Creek	16.5
Hulls	4.3
Crane	7.8
Stuart	9.1
Polecat	1.2
Pierce	2.0
Seaman	1.8

All seven gulches are very similar in character with respect to physical features (*i.e.*, ground slopes, soil types, and vegetation) and, therefore, they will be discussed as a group rather than individually. Lands within these drainages rise abruptly from Boise (about 2,800 above msl) to elevations of 5,000 to 6,000 feet above msl, in a distance of about 6 miles. Drainage ways in the gulches consist of small streambeds with only a few square feet of cross-sectional area measured perpendicular to the stream's flow path. In the canyon reaches, flows are confined to a rather narrow floodplain by steep hillsides and narrow canyon floors. Below the canyon mouths, drainage ways expand rapidly into relatively flat outwash cones that slope generally west to the Boise River floodplain. Soils are highly erodible and quite porous.

b. Climate.

The climate of the Boise River Basin is characterized by hot, dry summers and moderately cold winters. Temperatures within the Boise River Basin can fluctuate dramatically from month to month, as well as from year to year. Large amounts of precipitation can, and do, significantly affect the regulation of the Boise River reservoirs. Snowfall and accumulation within the lower watershed is very light when compared to the upper watershed. The accumulation of snow over the upper watershed directly affects the snowmelt runoff, and dictates the degree of regulation necessary and the manner in which the Boise River reservoirs are regulated. Tabulations of temperatures, precipitation, and snowmelt extremes that have occurred at key stations within the basin are presented in appendix B.

The climate of the Boise Gulch drainages is generally moderate. Boise, located immediately to the southwest, has a mean annual temperature of 52 degrees Fahrenheit (°F). Temperatures of 0°F and 100°F represent approximate average annual extremes. Normal annual precipitation varies from about 12 inches at Boise, to about 22 inches at high elevations in the hillside drainages. Occasionally, summer thunderstorms produce intense rainfall over parts of these gulch areas. Several such storms in past years have caused severe floods, and imply that intensities of several inches per hour can occur for brief periods. The maximum observed short-duration intensity at the Boise weather station was 4.1 inches per hour for a 5-minute period. Intensities as high as 7.5 inches per hour have been reported for brief periods at other locations in southwestern Idaho and eastern Oregon.

c. Soils and Geology.

The soils in the Boise River Basin are generally of two types: residuals and sedimentary deposits. The residuals are disintegrated granite, rhyolite, and basalt. From the standpoint of runoff, the granite soil is of major importance since it covers 90 percent of the upper watershed. This portion of the basin contributes almost the entire runoff of the Boise River.

d. Channel Morphology and Sedimentation.

Within the study reach, between Lucky Peak Dam and the Snake River, the Boise River flows in a steep channel formed of material that can be easily eroded and transported by the river (an "alluvial" river). There is a noticeable change in the average stream slope at Eagle Island; with the average slope upstream of Eagle Island being about 13 feet per mile, and the average slope downstream of Eagle Island being about 8 feet per mile. In most reaches downstream of Boise, the channel cross sections continuously change shape in response to the erosive forces of the water as material is eroded or deposited by the river. The river banks are composed mainly of silts, sands, and some gravel; and erode easily at high flow, sloughing into the channel. Depending on the quantity of flow present and the size of the material, materials are disposed of in one of three ways: 1) some of the material is transported completely out of the basin; 2) some material may be left at the slough site; and 3) the remaining material is at least temporarily deposited on bars or islands, or becomes part of a moving sand dune in the downstream reach. As a consequence of this activity, the thalweg (lowest point in the channel, or low streambed) may change with time at a given location. At a specific site, the thalweg may be several feet higher or lower at the end of one season, when compared to the previous season.

Based on the slope of the channel, and the dominant or formative discharge, most segments of the Boise River fall into the "braided" category. Bank full discharge is considered to be the formative discharge for the Boise River (*e.g.*, the discharge where most channel shaping takes place).

Beginning in the mid-1860's, some artificial constraints were imposed on the Boise River. A series of canals, drains, temporary diversion dams, channel alterations (primarily cutoffs of meander loops that caused a steepening of the reach), and material removal from the channel have occurred. Also, large storage reservoirs were constructed on the upper reaches of the river. As a result of this construction, maximum peak flows have been reduced by as much as 50 percent, the period of high flow has been extended from 2 to 3 months to 4 to 6 months, and all large sediment from upland watersheds is trapped in the reservoirs. These changes have significantly altered the characteristics of the river. The system is now part river, part canal, and part drain. The system's discharge varies from mile to mile along the channel and from week to week, depending on annual yield from the watershed and irrigation demands.

e. Streams and Streamflow Characteristics.

(1) Upper Watershed Runoff.

The upper watershed contains four primary sub-basin tributaries to the Boise River: 1) South Fork; 2) Middle Fork; 3) North Fork; and 4) Mores Creek. Most of the natural runoff from the upper watershed results primarily from snowmelt, and high flows occur each year in the spring when temperatures begin to increase and the snow melts. The annual high-water period generally begins with a gradual increase in discharge during March, culminates with a peak discharge (usually between 15 April and 15 June), and terminates with a gradual recession to base flows during July. Low flows normally prevail from August through February. From 1895 through 1994, natural annual runoff volumes from the upper watershed have averaged approximately 1.970 million AF per year. Approximately 78 percent of this total average annual runoff volume comes during the March through July snowmelt period. The amount of seasonal runoff and the peak discharges vary with the amount of water accumulated as snow on the basin. Peak snowmelt discharges are occasionally augmented by runoff from general rainstorms or thunderstorms. Occasionally, rapid snowmelt on frozen ground (especially when augmented by heavy, warm rains) will produce high peak flows during the winter. Most of these winter runoff events are of short duration and limited volume.

(2) Lower Watershed Runoff.

Natural streamflow from the lower watershed constitutes only a small percentage of the total runoff from the entire Boise River Basin. Streams within the lower watershed normally contain very limited amounts of runoff, only in the spring and early summer, and flow intermittently. Occasionally, thunderstorms or rapid snowmelt on frozen ground produce high peaks and short-duration local runoffs. This can cause local flooding and drainage problems, but these storms normally have very little impact on the Boise River flows and little or no impact on the regulation of the Boise River reservoirs.

(3) Floods and Historic Floodflows.

Natural or unregulated annual maximum daily spring snowmelt-event discharges in excess of 20,000 cfs have occurred on ten occasions since 1895 in the Boise River, at the Lucky Peak damsite. Using the observed maximum annual mean daily peak discharges for 1895 through 1976 and estimated peaks for 1865 through 1894, and observed April through July runoff volumes from 1895 through 1974; unregulated frequency data was computed and is shown in table 4-2.

Table 4-2. Unregulated Frequency of Peak Discharge and Runoff

Exceedance Probability[1] (Percent)	Average Recurrence Interval (Years)	Unregulated Annual Spring Snowmelt Peak Discharge (cfs)	Unregulated April to July Runoff Volume (Million AF)
1	100	41,200	3.100
2	50	36,200	2.900
5	20	30,000	2.550
10	10	25,200	2.270
20	5	20,400	1.950
50	2	13,800	1.400

[1]Frequency data for unregulated streamflow and runoff volume of the Boise River at Lucky Peak Dam.

Significant winter rainstorm-snowmelt flood events occurred in the upper watershed in November 1909, December 1955, and December 1964. The December 1964 flood event had a computed instantaneous peak discharge of approximately 44,000 cfs, and is estimated to have been in excess of a 100-year winter flood event. More detailed flow data is included in appendix B.

(4) Droughts.

Years of low runoff volumes from the upper watershed can critically affect irrigation within the lower watershed. Since 1895, 10 years have had annual runoff volumes of less than 1.250 million AF, as compared to an average of 1.970 million AF. The 1977 drought year was the lowest runoff year of record, and the annual maximum mean daily peak discharge only reached 3,190 cfs. Table 4-3 summarizes annual runoff volumes and peak discharges for the 10 lowest runoff volume years of record. Five of the lowest ten annual runoff volumes have occurred during the 1987-through-1994 period, and show the long-term severity of the present continued low flow conditions.

Table 4-3. Volume Runoff and Peak Discharges (Ten Lowest Runoff Volumes)		
Year	**October to September Annual Runoff Volume (Million AF)**	**Annual Maximum Mean Daily Peak Discharge[1] (cfs)**
1977	0.653	3,190
1992	0.798	4,150
1994	0.860	5,490
1924	0.885	5,190
1987	0.937	5,610
1931	0.939	5,430
1991	1.006	6,320
1988	1.062	6,230
1934	1.072	6,110
1926	1.105	7,090
[1]Unregulated flow at the Lucky Peak damsite.		

(5) Boise Gulches.

Surface flows in most of the gulches are quite intermittent, and occur for only a few weeks a year in the late winter and spring, or following severe rainstorms. Runoff from the gulch areas is not measured. However, some streamflow records exist for Cottonwood Creek.

Floods in the gulch areas originate from two primary causes: 1) high intensity thunderstorm rainfall, usually during the summer months; and 2) a combination of general storm rainfall and snowmelt with frozen ground conditions in the winter and early spring. Floods from the thunderstorms do not occur as frequently as those caused by general rain and snowmelt conditions, but are far more severe. Thunderstorms typically occur on the Boise Front from March through September each year, but thunderstorm floods can occur at any time of the year. Winter storm floods generally occur from January through March.

The slower peaking winter general rain and snowmelt flood events may occur on all of the Boise Front drainages during the same timeframe. The quicker peaking thunderstorm flood events will likely occur on two or three of the drainages at one time. Peaks for both of these types of floods occur in a rather short time (*e.g.*, from 15 minutes to 6.5 hours). Both types of floods carry high sediment loads, especially the thunderstorm floods.

f. Boise System Operation.

(1) Background.

A Water Control Plan that defines reservoir regulation procedures for joint use of the storage spaces in Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs is presented in *Water Control Manual for Boise River Reservoirs*, chapter VII. This plan basically retains the same uses and priorities as those defined in the 1953 MOA, with modifications agreed upon by all concerned parties. Storage in Lake Lowell is affected by the Water Control Plan through regulation of the upstream storage projects, but Lake Lowell is an offstream irrigation project regulated by the Boise Project Board of Control through an operation and maintenance contract between them and USBR. Thus, the Water Control Plan contains no direct regulation criteria for Lake Lowell.

(2) System Operation.

As a system, Anderson Ranch, Arrowrock, and Lucky Peak reservoirs normally add water to storage from the end of the irrigation season (in October of any given year) until the end of the annual flood control season (ranging from 15 April to 1 July of any given year), depending on basin conditions (with respect to snowpack and predicted precipitation). Minimal instream flows are released from Lucky Peak in the winter. As early as 1949, IDFG has requested minimum instream flows for the Boise River, but these efforts have not produced much in the way of results. These efforts to gain instream flow have created acrimony in the basin, and this is still an issue today (Horton, 1993).

The amount of water stored in the system and the timeframes in which it is stored are dependent on water rights, the amount of water available as runoff, the timing of the runoff, and the required flood control regulation. Flood control regulation during the refill period endeavors to maintain adequate flood control spaces within the reservoirs and refill them without exceeding 6,500 cfs, as measured at the Glenwood Bridge gaging station. After the annual spring flood season is over, until the end of the irrigation season, the reservoirs are drafted to maintain irrigation flows. Arrowrock Reservoir is drafted first to maintain the power head at Anderson Ranch Reservoir, as well as to maintain a desirable recreation pool level at the Lucky Peak reservoir. If the storage at Arrowrock has been used before the end of August, both the Anderson Ranch and Lucky Peak reservoirs are drafted without exceeding powerplant capacity at Anderson Ranch. After the end of August, irrigation demands are met primarily from storage in the Lucky Peak reservoir.

(3) Project Purposes.

Flood control and irrigation are the primary uses for Anderson Ranch, Arrowrock, and the Lucky Peak storage spaces. Other primary uses include 50,000 AF of space for streamflow maintenance and the 102,300 AF of space for streamflow maintenance at the

Lucky Peak reservoir. Secondary uses include power generation at Anderson Ranch and Lucky Peak, and recreation at Lucky Peak. Incidental uses include recreation at Anderson Ranch, Arrowrock, and the lower Boise River downstream of Lucky Peak Dam; downstream water quality maintenance; and sedimentation pools within the reservoirs.

Because the Boise System is managed as a multipurpose system, it is not possible to optimize regulation for each of the separate uses. Thus, the Water Control Plan represents compromises between the various uses, and flood control use directly conflicts with all other system uses to some degree. Optimum flood control protection would require that the reservoirs be kept empty and available to control floodwaters. Even with this type of regulation, however, previous studies have shown that the existing system, with its limited downstream channel capacity, would not adequately control large spring snowmelt volumes or events of approximately a 50-year magnitude or larger. Optimum irrigation use would require that the system be maintained as full as possible to provide carryover storage water for the drought years. However, even this operation would not necessarily ensure adequate water supplies for a series of drought years. The key Boise River system usage conflict is that of flood control versus system refill. The operational flood control rule curves given in the system's Water Control Manual define a system of operation to balance flood control risks and refill assurances. They were specifically designed to minimize the impact of volume forecast errors and abnormal runoff timing sequences.

(4) Annual Peak Flow and Volume Summary.

Tables in appendix B collectively illustrate how peak flows and runoff volumes can be modified by manmade projects on the Boise River. For example, during the 1983 runoff year, an inflow of 24,294 cfs to the reservoir system was computed. A flow of only 9,560 cfs was measured at Glenwood Bridge; only 39 percent of the inflow to the reservoir system. During 1983, only 68 percent of the annual volumes at the Lucky Peak reservoir were also measured at Glenwood Bridge, but 84 percent of the volume was measured at Parma (a gain of 16 percent). This illustrates the effect of irrigation diversions and returns on annual flood volumes.

4.02. HISTORIC AND POTENTIAL FLOOD DAMAGES.

a. Historic Flood Damages.

There have been no major flood damages along the lower Boise River since completion of the Lucky Peak Project. Since Lucky Peak Dam began operations in 1955, the maximum target flow of 6,500 cfs (measured at Glenwood Bridge) has been equaled or exceeded 13 times. The most recent occurrence was in 1993, when flows reached about 6,500 cfs. The largest regulated flow in the lower Boise River was witnessed in 1983, when flow at Glenwood Bridge was measured at 9,500 cfs. As the result of a major flood fighting effort by the Corps and the local community, actual flood damages were kept to a minimum. Because of limited damages, a post flood damage survey was not warranted or completed by the Corps. Based on information included in *When the River Rises, Flood Control on the Boise River 1943-1985*, by Susan M. Stacy, the only damage survey estimate was done by the Ada County Civil Defense Coordinator.

The damages were estimated to be $146,900 at 1983 price levels (or $193,000 at 1994 price levels), and included personal property damages, Government employee overtime, erosion repair, and other property protection work. The estimates did not include any repair expenditures made by farmers, homeowners, or public agencies in the months following the flood.

b. Economic Impacts.

Economic impacts are expressed as average annual dollars. The expected annual flood damage (EAD) is the average flood damage expected over a long period of time. Expected annual values are stochastically determined by observations over many years. The EAD values are typically seen in flood control studies where the expected annual damage is the average damage that can be expected to result from many years of flow experience where conditions remain unchanged. It is computed by weighing each damage value according to its probability of exceedance. Graphically, it represents the area under the damage frequency curve. Computer programs are used to estimate EAD's. For a more detailed description of the calculation of flood damages, see appendix C.

(1) Methodology.

The study area, the Boise River Basin, consists of approximately 1500 square miles; and includes both Ada and Canyon Counties. Since flow differential in the subject area is minimal, and the type of development is similar, the study area was considered as one reach for analysis purposes. Potential flood damages were estimated for both the 100- and 500-year flood events.

Estimates of flood damages were collected and analyzed for the following categories of damages: residential, commercial, industrial, agricultural, public, utilities, transportation, emergency expenses, other agriculture, clean-up expenses, and business losses.

To obtain an accurate assessment of property valuation and damage, each damage category was studied independently. The value and damage of each category was determined by the best method available (assessor's data, depreciated replacement value, or values assigned by category experts). A brief description of the survey method utilized to assess floodplain structures is contained in the following paragraphs. However, for a complete discussion on the methodology used to assess damages for each damage category, refer to appendix C.

(2) Structures.

Flood damages for existing conditions were estimated in a two-phase process. The 1974 inventory of structures in the 500-year floodplain (conducted for *Boise Valley Regional Water Management Study*, U.S. Army Corps of Engineers, 1977) was updated to a 1994 price level to adjust for inflation and development. Secondly, a field inventory was conducted in August 1994 to identify all structures within the 500-year floodplain in Ada County that were built subsequent to the 1974 field survey. The level of growth within Canyon County since the 1974 field inventory did not warrant the detail of another field survey in 1994. Therefore, only a population growth factor was applied to the 1974 inventory of structures and other damage categories for Canyon County.

The inventory of structures built after 1974 within the 500-year floodplain was based upon information obtained from Ada County. The Ada County database included residential, commercial, industrial, and public structures built after 1980. Information was not available for structures constructed from 1975 to 1979. No adjustment was made to account for construction during this period, because construction activity was considered relatively minor.

For the period from 1980 to the present, a field survey of the 500-year floodplain was conducted in August 1994, based upon data obtained from Ada County. Due to the size of the floodplain, as well as time and budget constraints, a 10-percent sample of residential structures was completed. However, a 100-percent field inventory of commercial, industrial, and public structures was conducted. Detailed information was obtained in the field on the structures (including structure type, square footage, condition, age, and elevation of the first floor to the ground). Ground elevations, used to establish water depths, were derived from U.S. Geological Survey "quad" maps, and cross sections from FEMA flood insurance maps. Replacement values for each structure were estimated. The total value of the sampled residential structures was then multiplied by a factor of 10 to arrive at the estimated total value of all new structures constructed between 1980 and the present. This data was combined with water depths and depth/damage functions for various structures to estimate damages to structures and contents.

(3) Remaining Damage Categories.

The remaining damage categories in Ada County [including agricultural crop losses, utilities, transportation (roads, bridges, railroads), emergency expenses, other agriculture, clean-up expenses, and business losses] were updated based on interviews with representatives from the counties and utilities, price-level updating of previous figures to the 1994 price level, and using statistical indices and adjustments for development. Damages for Canyon County were considered relatively minor, and were updated by factors for inflation and population except where otherwise noted (see appendix C).

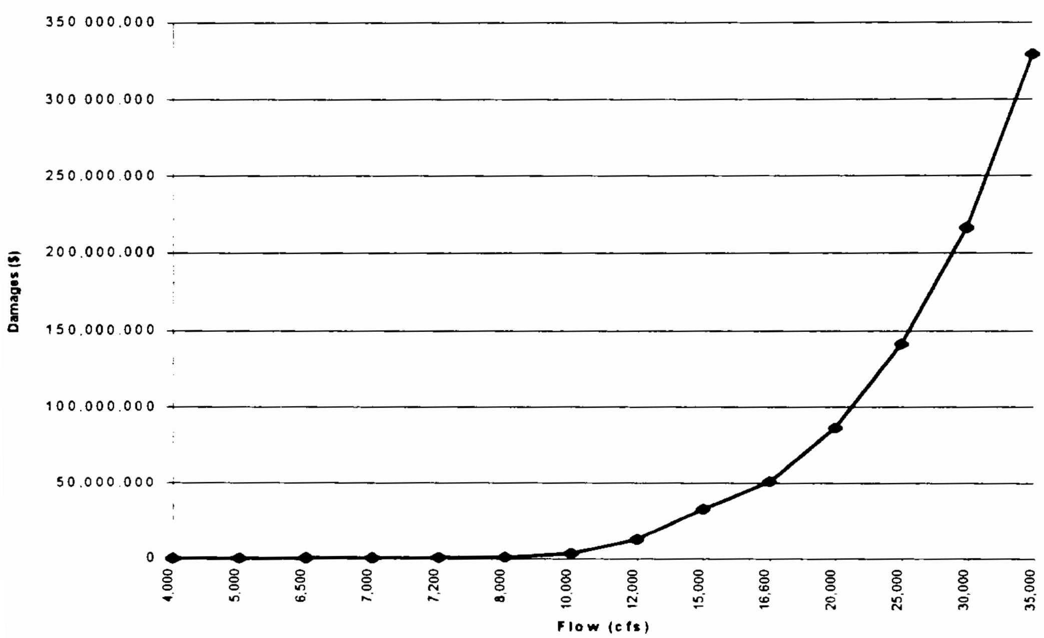
c. Average Annual Damages.

From the above information, a discharge/damage table was developed. Table 4-4 shows the relationship between the potential flood damages that would occur under existing conditions for a given flow rate, as measured at Glenwood Bridge.

Table 4-4. Flow Versus Flood Damages Existing Conditions Within the 500-Year Floodplain (1994 Price Level)	
Flow (cfs)	**Damages ($)**
4,000	0
5,000	46,000
6,500	147,000
7,000	349,000
7,200	434,000
8,000	759,000
10,000	3,300,000
12,000	12,700,000
15,000	33,000,000
16,600	51,176,000
20,000	86,000,000
25,000	141,000,000
30,000	216,000,000
35,000	329,000,000

The following is a graphical presentation of table 4-4.

Chart 4-1. Flow Versus Flood Damages--Existing Conditions Within the 500-Year Floodplain



Based on the information presented in table 4-4, average annual damages were computed for the basin using a program developed by the Corps, Walla Walla District. The average annual damages under existing conditions were estimated to be $1,436,000. A more detailed discussion of methods and procedures used is included in appendix C. Table 4-5 indicates the breakdown of average annual damages by category or damage type.

Table 4-5. Existing Conditions 1994 (1994 Price Level)

Damage Category	Number	Percent of Total Damages	Total Damages ($1,000)	Average Annual Damages ($1,000)
Residential Structures	8000	15.4%	51,000	221.1
Residential Content	8000	5.9%	19,300	84.7
Commercial Structures	600	20.5%	67,300	294.4
Agriculture (crop) (acres)	59,000	0.7%	2,200	10.0
Other Agriculture	*	4.7%	15,500	67.5
Utilities (miles of line)	N/A	13.5%	44,400	194.0
Transportation (miles)	177	35.3%	116,200	507.0
Emergency Expenses (days)	2,321	0.5%	1,600	7.2
Clean-up Expenses (cubic yards of sediment)	219,183	0.5%	1,700	7.2
Business Losses (number of businesses)	600	3.0%	9,800	43.0
TOTAL		100%	$329,000	$1,436

*Included in the 59,000 crop acres.

4.03. PROBLEMS AND NEEDS.

a. Boise River.

The lower Boise River is regulated by separate Federal reservoir projects that are operated as one system, referred to as the "Boise River Reservoir System." The three upper reservoirs have a combined gross storage capacity of approximately 1.1 million AF, and a usable (active) storage capacity of approximately .97 million AF. The active storage in the three projects is only about ½ of the average annual runoff of the basin. The breakdown of storage between projects is presented on table 2-1, and the locations of the projects are shown on plate 1.

The upper three reservoir systems are used to control Boise River water for irrigation, flood control, power generation, recreation, and fish and wildlife under an MOA between the Department of the Army and the Department of the Interior, effective November 20, 1953. The projects are operated jointly by the Corps and USBR according to a set of operational flood control rule curves included in *Water Control Manual for Boise River Reservoirs, Boise River, Idaho*, dated April 1985. The rule curves reflect a balance between operation for flood control and refill for irrigation to be used during the upcoming season. The projects are operated for flood control from 1 January to 15 July. The remainder of the year, the projects are operated for irrigation and other purposes. Table 4-6 is a summary of the unregulated and regulated flow frequencies released from the Lucky Peak Project. Because of the flat shape of the frequency curve (see appendix B, chart 2), 7,200 cfs represents a regulated flow frequency ranging from approximately 10 to 26 years.

Table 4-6. Annual Peak Spring Discharge Flood Frequencies (cfs) at Lucky Peak Dam

Average Recurrence Interval (years)	Unregulated Flow	Regulated Flow
10	25,200	7,200
20	30,000	7,200
50	36,200	11,000
100	41,200	16,600
500	54,000	35,000

Although the storage projects reduce downstream floodflows significantly, they have major limitations. The limits of the 100-year and 500-year floodplains along the Boise River, including the city of Boise downstream through the city of Caldwell, are shown on plate 4. As can be seen, portions of Garden City and areas downstream fall within the 100-year floodplain. Large areas fall within the 500-year floodplain.

The flood control rule curves are based on annual runoff volume forecasts of snow pack in the upper basin and average conditions in the basin (*i.e.*, temperature and rainfall). The rule curve is also based on a target flow of 6,500 cfs, measured downstream of Boise at Glenwood Bridge located just upstream of Eagle Island [see plates 2 and 4 (sheet 2 of 4)]. The target flow is defined at Glenwood Bridge because flood damages at the lower flow levels occur downstream from this point. The regulated target flow of 6,500 cfs has only about a 3-year recurrence interval.

The flood control and irrigation seasons generally overlap, and the amount of water being diverted from the river for irrigation directly affects release amounts from Lucky Peak when trying to limit floodflows at Eagle Island to 6,500 cfs or less. Between Lucky Peak Dam and Eagle Island, there are nine irrigation canals diverting approximately 3,730 cfs from the Boise River during the irrigation season (1 April to 15 October). Inflows into the Boise River in this same reach are approximately 30 cfs. Lucky Peak releases of approximately 10,200 cfs will normally result in Boise River flows of about 6,500 cfs (10,200 + 30 - 3,730).

As a rule, flows can be maintained at or below the 6,500-cfs flow level during years of normal or below normal conditions in the basin. There are, however, many uncertainties inherent in the runoff volume forecast, as related to volumes, timing, and weather conditions. During above-normal conditions, the 6,500-cfs flow level has been exceeded 13 times since the construction of Lucky Peak Dam to allow for evacuation of the reservoir to meet requirements of the flood control rule curve. In 1983, flows reached 9,500 cfs. More detailed information regarding mean daily flows at Glenwood Bridge from 1955 to 1994 are presented in appendix B.

From a landowner's standpoint, there appear to be two major problems with the current flood control operation. The first problem is that, at the target flow of 6,500 cfs, there is flooding in the Eagle Island area. The second problem is the rate of increase of flow. The landowners also complain that they are being flooded at lower flows today than they were several years ago. While insufficient information is available to draw any firm conclusions, it is probable that the channel capacity varies with time from location to location due to unstable streambed conditions. Changes in flow regime, caused by flood control operations, provide for periodic long durations of moderate flows that may have made the channel more unstable. This instability may allow the creation of local bars in the river bed, thereby raising water surface elevations. Past construction of levees across high-flow channels in the lower river has decreased channel capacity. This activity forces the flow into a narrower, more confined channel, thus increasing the water surface elevation adjacent to and upstream of the levees. Some cases of reduced stream channel capacity are easily attributable to gravel irrigation diversion dams in the channel. These irrigation diversion dams are often washed out by spring flows. Gravel fills in behind them, and raises the streambed and water surface immediately upstream.

Both the Boise River reservoir system and the levee system through downtown Boise and Garden City provide a level of flood control well below the 100-year level. Low water conditions for the past several years have allowed the growth of trees and brush in the channel, which has significantly reduced the channel's capacity for the next flood occurrence. This situation has been further impacted by urban development along the river that is continually encroaching on the floodplain. Because of the flatness of the lands next to the river, when floodflows do escape the river channel, water can flood large areas. This factor, and the highly erodible gravel streambed, have resulted in a constantly shifting river channel.

The capacity of the Boise River channel through the lower watershed varies between approximately 3,500 cfs and 10,000 cfs. At 4,500 cfs, a few areas are subjected to out-of-channel flow and are inundated. For flows up to 6,500 cfs at Glenwood Bridge (see plate 2), flooding is normally limited to pastureland, low-lying farmland, gravel pits near the river, a few buildings located near the edge of the river, and a few houses located in the Eagle Island area. Flows in the 5,000-cfs to 6,500-cfs range result in significant channel and bank erosion. Flood damages caused by flows within the 5,000-cfs to 8,000-cfs range represent an accumulation of bank and channel erosion problems over a 50-mile reach. Flooding and damages increase very sharply above 10,000 cfs.

Seven emergency flood fights and five rehabilitation projects have been completed along the lower Boise River since 1971, under Public Law 84-99. Despite the levee rehabilitation work, damages have occurred in 8 of the last 12 years. The largest regulated discharge of 9,500 cfs occurred in 1983. It was triggered by snowmelt runoff resulting from unseasonably warm weather conditions in the basin. This situation occurred because of limited storage capacity in the upper reservoirs, as well as the limited downstream channel capacity. Regulated releases of 6,500 cfs were initiated 3 months prior to the natural flood peak in an effort to minimize damages. Flows were then increased in 500-cfs increments until the flow level reached its peak (9,500 cfs). In 1993, a similar situation occurred that caused flows to reach 6,500 cfs. Some houses were flooded in 1993 around Eagle Island, but overall damages were considered relatively minor. It was pointed out at a public meeting that some of the houses around Eagle Island that did not get flooded during the 1983 flow did get flooded during the smaller flow in 1993. This tends to indicate that the channel capacity in that area has been reduced even more since 1983.

Much of the reduced flow carrying capacity of the channel is caused by an accumulation of sediment from within the river channel. The area below Eagle Island is particularly susceptible to sedimentation because of the relatively flat gradient of the river channel compared to the river upstream. The reduction of the gradient reduces flow velocities and the consequent deposition of sediments.

A major portion of the sediment in the lower reaches is caused by streambank erosion resulting from flow impingement on the streambank, bank sloughing due to rapid rising and falling of the water levels, and bank sloughing caused by the seepage of irrigation return flows through the streambanks back into the river. Sediment from irrigation runoff is also a major contributing factor. There is a strong need for a regular maintenance program to keep the channel free of accumulated sediment and remove fallen trees, brush, and debris.

b. Boise Foothills.

A series of seven adjacent dry-gulch tributaries in the Boise Front Range drain through narrow canyons onto alluvial fans and, from there, into the Boise River within the city of Boise (see plate 3). The larger drainages are tabulated in table 4-7, showing their respective drainage area and flow frequencies.

Table 4-7. Boise Foothills Side Drainage Flow Frequencies			
Drainage Basin	Drainage Area (Square Miles)	Discharges[1] (cfs)	
		10-Year	100-Year
Cottonwood Creek	16.5	700	7,200
Stuart Gulch	9.1	400	3,600
Crane Creek	7.8	320	3,100
Hulls Gulch	4.3	200	1,630
Pierce Gulch	2.0	140	1,100
Seaman Gulch	1.8	140	1,100
Polecat Gulch	1.2	110	780
[1]Composite winter and thunderstorm.			

The canyons are susceptible to debris-laden flash floods caused by intense rainfall during thunderstorms. Flash floods can occur within 15 minutes to 6.5 hours after the onset of heavy rainfall. The potential combination of flood depths, flow velocities ranging from 5 to 9 feet per second (fps), and the speed of the onset of flooding, is sufficient to pose an extreme risk of loss of life in some areas.

Drainages in the gulches consist of small streambeds that have only a few square feet of cross-sectional area. In the stream reaches, the flow is confined to a rather narrow floodplain by steep hillsides and narrow canyon floors. Below the canyon mouths, the streams emerge into relatively flat outwash cones that slope to the Boise River floodplain. High flows are not confined laterally and, in many cases, the portion of the floodplain immediately below the canyon mouth is higher than the ground on either side, thus causing water to spread out. The lower reaches of the streams through town flow through a system of manmade channels and pipes. The small artificial waterways in these lower reaches are inadequate for carrying major floodflows. Through this reach, Stuart Gulch Channel has a capacity of only 50 to 60 cfs, while the capacity of Cottonwood Creek Channel is about 250 cfs. A 33-inch buried pipe carries flows across the city from Hulls to Crane Drainage.

Most of the BMA north of Boise is subject to flooding from the foothill drainages. Extensive residential and commercial development has occurred in or adjacent to the channels in several of these canyons. In some areas, streets that are primary flood escape routes run down the thalweg. Along some reaches, homes are located in the thalweg. The thalweg is the location of the lowest elevation in a channel section. The northern section of the city is comprised of residential, commercial, and government buildings, and lies on top of the alluvial fans. Over 4,000 structures and 10,000 residents are located in the 100-year floodplain in the canyons and alluvial fans. The limits of the 100-year and 500-year floodplains, as identified by FEMA, are shown on plate 4.

4.04. EXPECTED FUTURE CONDITIONS.

The channel capacity of the Boise River is expected to decrease even more in the future. Population is also expected to increase substantially in the lower Boise River Basin. Based on current trends and the attractiveness of the river for future development, much of the growth will concentrate along the lower Boise River, thereby causing further encroachment on the floodplain. Table 4-8 shows the present and projected populations for cities and counties along the lower Boise River. The estimates of projected populations are based on an annual growth rate of 3.125 percent and 2.17 percent for Ada and Canyon Counties, respectively. The growth rates are based on the average over the past 5 years. It is anticipated that development will progress along the river upstream of the city of Boise, as well as downstream from the town of Eagle.

Table 4-8. Present and Projected Populations

County/City	Year 1994	Year 2014 (20 Years)	Year 2044 (50 Years)
Ada County	**242,400**	**449,000**	**1,129,000**
Boise	157,700	292,000	735,000
Garden City	8,300	15,000	39,000
Eagle	7,700	14,000	36,000
Meridian	18,900	35,000	88,000
Canyon County	**100,300**	**154,000**	**293,000**
Middleton	2,740	4,200	8,000
Nampa	31,600	48,600	92,400
Caldwell	20,300	31,000	59,000

Because of the floodplain zoning ordinances currently in effect, future urban development within the 100-year floodplain will continue to be controlled and limited. All new structures constructed within the 100-year floodplain must have first floor elevations at least 1 foot above the 100-year flood level. In turn, this should minimize future damages to structures constructed after the implementation of these floodplain ordinances. However, urban development within the 100-year floodplain will continue to take place because of the attractiveness of being near the river. In addition, construction outside the 100-year floodplain will be substantial because there are few restrictions. As a result, it is anticipated that average annual flood damages will increase significantly.

The change of runoff patterns will continue as a result of high urban development in the Boise area. The development, in many cases, is displacing lands that are currently under irrigation. The runoff from these areas will be much faster and greater due to overall reduced infiltration rates. This will reduce travel time and create higher peak flows in the rivers than when the land was under irrigation. Also, because of reduced irrigation areas and the associated reduced water demand for irrigation, water traditionally used for irrigation will, to some degree, become excess. In some cases, irrigation storage in the upstream reservoirs is being reallocated from irrigation to M&I water supply. In the event that M&I storage in the reservoirs is considered dedicated storage (for M&I use only), the storage in the reservoirs available for flood control under the flood control rule curve will be reduced by that amount. This would reduce the effectiveness of the upstream reservoirs for controlling floods.

Development will probably continue in the basins of the Boise foothills side drainages, and this will further reduce the travel time of the runoff. From a safety standpoint, this will create an even more critical situation because of the potential threats to loss of life.

4.05. PLANNING OBJECTIVES AND CONSTRAINTS.

Several planning objectives, consistent with national objectives, were utilized throughout the formulation process. These planning objectives were developed on the basis of the study authority and the problems, needs, and opportunities identified by Federal, state, and local agencies. They include the following:

- Reduce economic losses from flooding along the lower Boise River.

- Since most of the current flood damages for low frequency floods occur in the Eagle Island area, formulate and select alternatives to reduce flooding in that specific area.

- Limit the adverse impacts to the environment.

- Mitigate for all environmental degradation that takes place as a result of the construction and operation of all identified alternatives.

- Where possible, make environmental restoration an integral part of the project to help justify the alternative.

4.06. ALTERNATIVES CONSIDERED.

a. Boise River.

In the 1977 *Boise Valley Regional Water Management Study (Plan Formulation Appendix, Volume 2 - Flood Damage Reduction, August 1977*, a number of alternatives were identified and evaluated to reduce flood damages along reaches of the Boise River below the city of Boise. Each alternative was based on changing the regulation of the upstream reservoirs by increasing the target flow from the present 6,500 cfs to some higher level, and eliminating all damages up to that flow level. Through a scoping process, it was determined that a flow level of 10,000 cfs produced the maximum net benefits. Alternatives that were evaluated included the construction of riverside levees, a combination of riverside levees and setback levees, channel deepening, and management of the floodplain through land purchase or easements (included limited setback levees) to control flooding up to 10,000 cfs. The only alternative that showed any prospect of economic feasibility was the management of the floodplain through land purchase or easements. A large portion of the potential benefits that would be derived from this alternative are directly attributable to fish and wildlife enhancement. Since that time, however, the method of evaluating fish and wildlife benefits has changed, and this would reduce the benefits substantially. Consequently, it is doubtful that such an alternative would be economically justified today unless environmental restoration outputs were considered.

Two alternatives were considered to obtain more flood control storage. These were: 1) raising Lucky Peak Dam 12 feet; and 2) using part of the existing dead storage by modifying the outlets. Neither alternative was found to be economically justified because of high first costs. In addition, the second alternative would have reduced the conservation pool, causing adverse impacts to the resident fishery. Since that time, a low level outlet has been added to the Lucky Peak Project that would allow a portion of dead storage to be used for flood control. However, this would still cause adverse impacts to the resident fishery.

Another alternative evaluated in the 1977 report included the diversion of water from the Boise River at Diversion Dam through the New York Canal, Lake Lowell, Deer Flat Lowline Canal, Fargo Wasteway, and eventually into the Snake River (see plate 5). Such a plan would reduce flows in the lower Boise River by the amount that was diverted. It would also increase the flexibility and effectiveness of the upstream storage projects for flood control and irrigation. During periods of evacuation of the reservoir for flood control operations, higher releases could be made from the Lucky Peak Project without exceeding the regulation objective of 6,500 cfs measured at Glenwood Bridge. Increased release capability would reduce the potential flooding during high runoff caused from large basin snowpacks and unusual weather conditions. Diversion rates of 500 cfs, 1,100 cfs, and 2,500 cfs were evaluated in the 1977 report. An alternative with a diversion rate of 500 cfs was determined to have the maximum net benefits. With diversion rates up to 500 cfs, only the Fargo Wasteway required modification. Diversion rates higher than 500 cfs required substantial modifications to the New York and Deer Flat Lowline Canals, as well as the Fargo Wasteway. The benefit-to-cost ratio (BCR) for the 500-cfs plan was estimated at that time to be 3 to 1. It was also estimated to have minimal adverse environmental impacts, because most of the required conveyance facilities were already in place and had adequate capacity. There was also little construction work required along or in the river that would limit adverse environmental impacts.

As part of the current reconnaissance study, a number of additional alternatives were identified and evaluated on a cursory level only. A list of those alternatives are presented in the following paragraphs, along with brief comments regarding their effectiveness.

- **The development of wetlands adjacent to the channel for temporary storage of flood waters.** This alternative could be effective in reducing downstream floodflows, but there are limited land areas upstream of the areas with high flood damage potential. This alternative could have very positive environmental outputs.

- **A combination of channel widening, land purchase/relocation, and environmental restoration.** This type of alternative could be effective in reducing flood damages, but it would not likely be economically justified based on flood damage reduction alone. Outputs for environmental restoration could also be used in the justification of such a plan.

- **Convert a portion of dead storage to flood control in the Lucky Peak Project.** The cost of this alternative would be minimal, but the reservoir fishery would be adversely impacted.

- **New upstream storage.** This type of alternative is costly, but could be extremely effective in reducing flood damages. However, it is doubtful that it could be considered at this time because of the high potential for adverse environmental impacts.

- **Channel clearing and maintenance program.** This alternative would include an initial clearing of sediment, trees, brush, and debris from the channel up to a predetermined flow capacity, and a formal annual maintenance program to maintain channel capacity. Although such an alternative could be effective in reducing flood damages, adverse environmental impacts would be of concern. In addition, it would be difficult to obtain broad support and economically justify this type of project.

- **Floodplain regulation and management.** This alternative would involve working with responsible state agencies and local officials to identify problem areas and implement an action plan (*e.g.*, floodplain regulations) that would be undertaken locally. Such a plan would not be effective in eliminating the existing flood problems, however.

b. <u>Boise Foothills</u>.

A feasibility report, *Review Report on Tributaries of Boise River, Vicinity of Boise, Idaho*, dated April 1964, looked at various alternative solutions to the flood problems for the side drainages. Channel improvement down through the city to the Boise River was considered but, since the drainage path to the river was on an alluvial fan, channel improvements were found to be impractical. Upstream storage projects to catch the floodflows were evaluated for Cottonwood Creek, Hulls Gulch, Crane Gulch, and Stuart Gulch. In that report, it was determined that upstream storage on Cottonwood Creek and Stuart Gulch were economically justified. On the basis of that report, upstream storage projects for Cottonwood Creek and Stuart Gulch were authorized for construction. However, due to high development in the reservoir areas after project authorization, the construction costs increased significantly. The increased costs made the storage projects economically unjustifiable. Consequently, the two projects were eventually deauthorized.

The flood problem on Stuart Gulch was reevaluated in 1990, under Section 205 of the 1960 Flood Control Act, *Small Flood Control Project*. As part of that study, it was confirmed that upstream storage and downstream channel improvement was not economically justified, and the study was terminated.

A study, conducted under the authority of Section 206 of the 1960 Flood Control Act, was initiated to evaluate the feasibility of a flood warning system for the side drainages that would provide early warning of thunderstorm flood conditions for the protection of loss-of-life and property. However, due to the lack of local interest, the study was terminated. A wrap-up report, *Flood Warning/Preparedness Planning Study, Boise Foothills, Ada County, Idaho*, dated

December 1992, was published. As part of the study effort, however, the National Weather Service designed a flood warning system for the side drainages. The flood warning system included nine rain gages and two river gages. These gages were located strategically throughout the basin to provide advance warning of potential floods cause by thunderstorms. The locations of the rain and river gages are shown on plate 3. An economic evaluation of the flood warning system showed that a project of this type had a BCR of over 2, based on reduced flood damages alone.

4.07. ALTERNATIVES CONSIDERED IN MORE DETAIL.

Based on having the highest potential for economic justification and having the least adverse environmental impacts, the alternative involving the diversion of floodflows through existing irrigation systems into the Snake River was chosen for inclusion in this report. Although the flood warning system was also considered to be highly justifiable economically, and was environmentally sound when related to the side drainages, that plan was not included. The following paragraphs contain descriptions of both the no action plan and the plan for the diversion of floodflows into the Snake River.

a. Alternative 1--No Action.

(1) Description.

Under this alternative, the following conditions were assumed:

- No major additional flood control measures would be undertaken. All improvements would be limited to resolving flood problems in localized areas.

- Flooding and flood damages will continue along the lower Boise River. The basin will continue to rely on the three upstream storage reservoirs for the majority of its flood control protection.

- The target flow of 6,500 cfs will continue to be maintained downstream of the city of Boise. Flood damages from more frequent floods will increase over time. In addition, flood damages above the 100-year flood level will increase considerably.

- A formal channel clearing and maintenance program will not be initiated anytime in the near future.

- Urban development will continue along the lower Boise River downstream of Eagle. This will further constrict the floodway and reduce fish and wildlife habitat.

- Some type of flood warning system will eventually be installed to protect against flash flooding and loss-of-life from the side drainages.

- Sediment entering the river from irrigation drains will be reduced somewhat, but will have limited impact on the flow carrying capacity of the river.

(2) Impacts of the Alternative.

(a) Fish and Wildlife.

With continued population growth, the pressure for urban expansion along the river will continue. Strong steps must be taken to ensure the preservation of the wildlife habitat and continued wintering of the bald eagle population. Zoning can positively affect the status of the wintering bald eagle population. However, should current trends of extensive development continue without some type of zoning or planning, the future presence of the bald eagle is much less certain.

Without any changes in the hydroperiod regime, the continued vigor and existence of the black cottonwood community along the river corridor will be in jeopardy. Along with the black cottonwood community, the many species (both terrestrial and aquatic) that are dependent on it will also have uncertain futures. With continued development in the greater Boise area, there will be reduced wildlife habitat for bald eagles, as well as many other species. Of special concern is the riparian corridor, which provides the greatest diversity and density of both fish and wildlife resources.

(b) Recreation.

The amount of water-based recreation will continue to grow in the basin. More pressure will be felt upon the fish stocks in the basin, and this may lead to the implementation of even more restrictive fishery regulations (*e.g.*, catch and release). It may provide an impetus to increase the amount of fish stocking that takes place in the Boise River system. Currently, there are no restrictions in the amount of floaters that use the river. County and city governments may have to consider restricting the unlimited access that people now have to float the river. The increasing number of people floating the river may lead to conflicts among user groups.

Should stocking of the Boise River continue to increase, a negative effect on the wild spawning populations of the basin will continue to occur. Hatchery fish are documented to have negative impacts to wild salmonids. The stocking of domesticated strains of rainbow trout will result in genetic intragression to the detriment of native stocks. These native stocks will, in turn, become less capable of survival under harsh natural conditions, particularly when in competition with other native and non-native fish species (Behnke, 1992). It is also likely that increased stocking will negatively affect bull trout. Should bull trout become listed under the ESA, IDFG may have to reconsider their current stocking program and seek to protect this species, because of the negative interactions between hatchery fish and bull trout.

(c) Cultural Resources.

Additional cultural resource sites will be disturbed as development of the Boise River Basin continues. It is likely that some of these sites will be lost as they are disturbed through the construction of new subdivision and highways, and other aspects of new or expanded infrastructure.

(d) Socioeconomic.

The primary socioeconomic impact of this alternative would be the continuation of basin-wide exposure to the risk of a major flood, as well as exposure to minor flooding in agricultural areas at low flow levels. Assuming the continuation of the current development rate of over 5 percent per year (2.6-percent population growth and 2.4-percent inflation), average annual damages are estimated to exceed $1 billion by the year 2020 for the 500-year flood (35,000 cfs). This alternative may mean prolonged confrontation between the water needs of agriculture and industry, without neutralizing interactions designed to solve the needs of both groups. The continuation of the trend under this alternative will also mean a consequent decrease in the "quality of life" that Boise area residents value so highly. There will be reduced recreational opportunities as development continues to take place in the basin. The aesthetics of the Boise River corridor will degrade if the cottonwood community decreases in vigor. Sectors of the economy that depend upon recreation and tourism will not experience the same magnitude of benefits from growth that other sectors may enjoy.

b. Alternative 2--Diversion Into the Snake River.

(1) Background.

This plan involves diverting floodflows from the Boise River, through an existing irrigation system, into the Snake River. Such a plan would reduce flows in the Boise River by whatever amount is diverted.

Under the current irrigation system, water used for irrigation purposes is diverted from the Boise River at Diversion Dam, located approximately 2.5 miles downstream from Lucky Peak Dam near Boise (see plate 2). Water is diverted into New York Canal and, in turn, into Lake Lowell for storage until the irrigation season. The water is distributed to the various irrigation laterals by means of Deer Flat Lowline Canal. Located on the canal near Homedale, Idaho, is the Fargo Wasteway. This wasteway allows the diversion of excess water from the canal into the Snake River, and provides water to five laterals.

An alternative with a diversion rate of 500 cfs was determined to have the maximum net benefits, as discussed above in paragraph 4.06., *Alternatives Considered*. With diversion rates up to 500 cfs, only the Fargo Wasteway would require modification. Diversions larger than 500 cfs would require construction and/or rehabilitation of canals and wasteways.

The Fargo Wasteway, as it now exists, has a nominal hydraulic capacity from the canal of about 200 cfs. However, because of the deteriorated state of the Wasteway, the dependable capacity is probably somewhat less. Also, because of the condition of portions of the Wasteway, it is extremely doubtful that the Boise Project Board of Control (BPBC) could allow even emergency use of this facility for non-irrigation uses.

(2) Description.

The proposed plan is limited to the modification of the Fargo Wasteway. The plan would include the construction of a bypass pipe parallel to two existing sections, replacing the first two sections of existing pipe to operate as it currently does, enlarging the capacity of the lower open channel section, and enlarging the capacity of the final pipe section into the Snake River. Details of the plan are shown on plate 6. The main features of the plan are listed below.

- Purchase approximately 6 acres of land.
- Provide a new outlet structure on Deer Flat Lowline Canal.
- Place a new pipe, 2,920 feet long, parallel to the upper two sections of 48-inch pipe.
- Construct a new stilling basin and escape channel at the end of the bypass pipe.
- Rehabilitate the upper two sections of existing 48-inch pipe.
- Increase the capacity of 4,540 linear feet of channel to 500 cfs.
- Replace two drop structures located in the channel section.
- Replace the intake structure leading into the final section of pipe into the Snake River.
- Increase the capacity of the third and final pipe section into the Snake River to 500 cfs.
- Construct a new stilling basin at the end of the pipe section at the Snake River.
- Enlarge culverts under the state highway and other country roads.
- Plant grasses and shrubs to mitigate wildlife losses and provide erosion control in areas disturbed by construction.

Flows from the Deer Flat Lowline Canal into the Fargo Wasteway will be controlled by manually-operated slide gates located in both the new and existing intake structures. All pipes are designed to flow under open channel conditions, with supercritical flows at all times. The intake structure to the parallel pipe is designed to provide adequate head on the pipe opening to obtain the required velocity of supercritical flow. This is similar to the design of the original Fargo Wasteway. In replacing the upper two sections of 18-inch pipe, hydraulic conditions similar to those currently existing will be maintained. The two drop structures that will be replaced in the lower channel section will be designed to pass the entire 500 cfs. One of the structures will be calibrated to allow for the measurement of flows to the Snake River. The final section of pipe into the Snake River is also designed for open channel flow under supercritical flow conditions.

Two new intake structures will be constructed. One will be located on the parallel pipe on Deer Flat Lowline Canal, and the other will be located on the third and final pipe section into the Snake River. The new intake structure on the parallel pipe is made of concrete, and is designed similar to the existing intake structure on Fargo Wasteway. The structure is equipped with three 3-foot by 3-foot manually-operated slide gates that control flows into the pipe. Wing walls are provided on the structure to direct flows into the gates. On the downstream side of the control gates, a plunge basin is provided in order to meet the hydraulic conditions of the pipe. An air vent will be provided at the pipe entrance. The intake structure into the third and final section of pipe is a concrete structure with no control gates, but it does have training walls and a plunge basin that satisfies the hydraulic conditions of the adjoining pipe. An air vent will be provided at the entrance of the pipe. There are two stilling basins required for the plan, one located at the end of the parallel pipe and the other located at the end of the final section of pipe on the Snake River. The design capacities of the basins are 300 cfs and 500 cfs, respectively. Both basins are Type III basins, as defined in UWI's Engineering Monograph Number 25, *Hydraulic Design of Stilling Basins and Energy Dissipaters*. Bank protection will be placed on the channel banks immediately downstream of the basins.

Both the new section of channel below the parallel pipe and the enlarged channel section will be trapezoidal in shape, with 1V-on-2H side slopes. The bottom widths of the channel will vary up to 16 feet, depending on the slope and depth of the channel. A minimum of 1 foot of freeboard will be maintained. Velocities in the channel are such that bank protection other than grasses will not be required.

The two drop structures are designed as simple Type B structures, as defined in *Engineering Handbook on Drop Spillways*, Section 11, published by the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service. Each structure has approximately a 12-foot drop from headwater to tailwater.

All pipe installed on the project will be buried, reinforced concrete pipe (RCP). The new pipe, parallel to the upper two sections of the existing 48-inch pipes, includes 1,212 linear feet of 18-inch pipe, 875 linear feet of 66-inch pipe, and 830 linear feet of 54-inch pipe.

The pipe was sized to maintain open channel flow conditions in the pipe and maintain supercritical flow. The final pipe into the Snake River is a 520-foot-long, 72-inch RCP designed on the same basis. All pipe will be laid on gravel bedding.

Existing culverts under the two county roads and the state highway will be replaced with single 9.5-foot by 6.4-foot corrugated steel pipe-arch culverts.

To mitigate for wildlife habitat losses and provide for erosion control, native grasses and shrubs will be planted on lands denuded by construction activity. A planting program would be developed in cooperation with IDFG, USFWS, and USBR.

(3) Lands and Damages.

The existing Fargo Wasteway is under the jurisdiction of USBR and is operated by BPBC. While the land for the existing Fargo Wasteway is not free-owned by USBR, they do appear to have easement rights granted by the Canal Act of 1890. For estimating purposes, it was assumed that all additional land required for the project would be purchased in fee. Adequate land was provided to allow the construction of a road along the channel sections. Approximately 6 acres of additional land will be required.

(4) Construction.

It is estimated that the project could be designed and constructed in less than 2 years. Construction facilities for the irrigation system will not be required, because construction can be accomplished during the non-irrigation season. During the replacement of existing culverts under the state highway and county roads, traffic will be detoured around the construction area. Construction would be scheduled to minimize traffic disruptions. The time estimate for the construction alone is 1 year. The plan will require the removal of 2,430 linear feet of existing 48-inch pipe; the removal of two drop structures, an intake structure, and one stilling basin; and channel excavation of about 12,900 cubic yards (cy).

(5) Operation and Maintenance.

Flood control diversion to the Snake River, using Fargo Wasteway, will require an agreement between the Corps and USBR. Before this agreement could be reached, a formal agreement between USBR and the Boise Project water users would have to be negotiated for purposes of flood control operation and maintenance. In discussions with USBR and the Project Manager of BPBC, as part of the 1977 report, both groups had indicated a willingness to operate and maintain the irrigation system leading to Lake Lowell and the Fargo Wasteway. They also indicated a willingness to maintain and operate the Fargo Wasteway so that up to 500 cfs can be diverted out of the Boise River into New York Canal anytime after January 15, as required for flood control operations to limit flows in the Boise River at the Glenwood Bridge gaging station to 6,500 cfs. This diversion rate would normally continue until the irrigation diversions start (about mid-April). During the irrigation season, normal diversions from the river into New York Canal are about 3,000 cfs.

The impact of diversions on Lake Lowell levels will depend upon the operational procedure used. There are three possible operation procedures, and they are as follows:

- Same flows in and out of Lake Lowell, with no change in pool level.

- Start diverting 500 cfs out of Lake Lowell prior to diversions into New York Canal, resulting in a drawdown. This would be followed by diversions into Lake Lowell of around 1,000 cfs, which would raise the lake to its original level.

- Diversions of about 1,000 cfs into Lake Lowell with outflows of 500 cfs, and this would result in an increased lake level. It is anticipated that flood control diversions will be required in only about one year in twenty.

(6) Impacts of the Alternative.

(a) Fish and Wildlife.

Because this alternative entails construction on land where a project already exists (the current irrigation canal), it will not cause the same magnitude of disturbance that would be likely if there were no existing project. Expanding and improving the canal to accommodate more water flows will disrupt wildlife communities very little, and will not disturb aquatic species at all. Wildlife use will be disturbed during the construction period, but will most likely return to its original state as soon as construction is completed. However, both using the canal and allowing it to divert more water from the mainstem of the Boise River, will likely have impacts on natural resources.

It is possible that, by reducing floodflows in the mainstem of the Boise River, the recruitment of juvenile cottonwood trees in the riparian zone would be reduced. Cottonwood trees are dependent upon high flows to allow for unimpeded reproduction. The reduction of cottonwood regeneration could consequently lead to a reduction in roosting, perching, and loafing habitat for bald eagles along the river. Reducing the amount of water that flows in the channel will reduce the amount of fine material scoured from the streambed, and may lead to an increased incidence of cobble embeddedness. This would make it more difficult for wild salmonids to reproduce in the river channel.

The impacts to Lake Lowell will vary, depending on the mode of project operation. For instance, raising the lake level may improve habitat for waterfowl and bass, but decrease it for wading birds. Raising the pool at the wrong time of the year (*e.g.*, during nesting season) may cause poor recruitment during that year for waterfowl. There may be no impact to fish and wildlife if the lake level remains the same by releasing the same amount of water as the amount released into the lake. Other things should also be taken into consideration. If the lake level was increased for 2 or more years consecutively, it is likely that the productivity of the lake would increase from the increased nutrient input. However, if there is any irrigation return flow into the diversion upstream of the lake, higher water levels would allow chemicals from irrigation return flows to gain access to places to which they were previously excluded. Also, one lake levels were returned to normal, these toxins would oxidize and become a potential threat.

The water entering the lake should be sediment free and of high quality as it comes from Lucky Peak. The amount of degradation that takes place during its travel time in the irrigation ditch would have to be determined by further studies. Increasing releases from the lake to compensate for increased intake flows into Lake Lowell could act as a "flushing flow" in the lake, and could provide some positive ecological benefits. However, it will increase turbidity. This, in turn, will decrease productivity and possibly impact the waterfowl and aquatic populations. Further impacts could be realized from the timing of increased flows into the lake, and the duration of the changes. All of these impacts would be thoroughly examined and developed before considering the implementation of this alternative.

(b) Recreation.

In the event that diversions took place during high flow periods, it is likely that there would only minimal impacts on the immediate recreation activities, since many people would be precluded from engaging in normal recreation activities at this time anyway. The amount of water diverted into the Snake River would only have minimal effects immediately. However, over the long term, if other impacts take place as stated in the previous paragraph, this would ultimately affect recreation. Fewer cottonwood trees along the river would have a negative impact upon the fisheries, as they would not provide the same amount of shade and allochthonous input into the river. If cobble embeddedness increased, this would lead to a reduction in the number of wild fish in the river. This, in turn, would likely lead to one of the two outcomes mentioned in the previous paragraph, where the number of wild fish would decrease in the river. The IDFG could attempt to compensate for this reduction by increasing the amount of hatchery fish introduced into the river. Some recreationalists would view this as a degradation of the resource. If cottonwood regeneration along the mainstem Boise River were reduced, this would also have a negative effect on river aesthetics. From a visual sense, the river would be less appealing to the recreationalist.

(c) Cultural Resources.

This alternative would not noticeable change impacts to cultural resources in the basin, particularly when compared to the No Action alternative. It is likely that any cultural resource sites would have already been disturbed during the original construction of the irrigation canal. Reducing the flow in the mainstem of the Boise River should not have any impacts on this resource for the area.

(d) Socioeconomics.

Construction modifications for this alternative are limited to the Fargo Wasteway, and will cause only limited adverse impacts to the environment. Since it is located in a relatively remote area, populated areas will not be impacted. The positive socioeconomic impact would be the reduction of flood damages within the floodplain. For diversions greater than 500 cfs, major construction and/or the modification of canals and waterways would be required, thereby yielding larger diversions that are not cost effective and possibly detrimental to the environment.

(7) Cost Estimate.

The estimate of first costs are for the construction of all facilities needed to implement the project. All costs are related to modifications to the existing Fargo Wasteway. The quantities of principal construction items were estimated on the basis of preliminary design. Cost estimates for the alternative are based on information presented in the 1977 report referenced above. The lands and damages portion of the cost estimate was updated based on USBR's *Construction Cost Trends, Land Indexes for Idaho*. Quantities for the construction cost estimate were calculated based on information presented in this report and on plate 6. A contingency allowance of 25 percent was included. Engineering and design, as well as supervision and administration, amount to approximately 36 percent of the estimated lump-sum items, based on the cost of similar projects throughout the country. Table 4-9 is a summary of the construction cost estimate of alternate 2. Table 4-9 is based on the Microcomputer-Aided Cost Estimating System (MCACES) summary cost estimates presented as exhibit 1, and rounded to the nearest $100. Table 4-10 is a summary cost estimate and computation of the total annual costs for the same alternative. Interest during construction is based on a construction period of 1 year, at an interest rate of 7-3/4 percent. Annual costs are based on an interest and amortization rate of 7-3/4 percent, over a 50-year project life. Annual operation and maintenance reflects only the increment above and beyond the existing operation.

Table 4-9. Construction Cost Estimate of Alternative 2 (October 1994 Price Level)

01	Lands and Damages	$20,200
06	Fish and Wildlife Facilities	103,700
08	Roads, Railroads, and Bridges	196,500
09	Channels and Canals	1,892,200
	Subtotal	**2,212,600**
30	Engineering and Design	501,300
31	Supervision and Administration	250,600
	Total Project Cost	**2,964,500**

Table 4-10. Summary Cost Estimate of Alternative 2	
Lands and Damages	$20,200
Construction Cost	2,192,400
Subtotal	**$2,212,600**
Engineering and Design	501,300
Supervision and Administration	250,600
Total Project Cost	**$2,964,500**
Interest During Construction	114,900
Total Investment Cost	**$3,079,400**
Annual Cost	
Interest and Amortization	244,500
OMRR&R	12,000
Total Annual Cost	**$256,500**

(8) Benefits.

The U.S. Congress, in the Flood Control Act of 1936, established a nationwide policy that flood control (*i.e.*, flood damage reduction) on navigable waters or their tributaries, is in the interest of the general public welfare and is, therefore, a proper activity of the Federal Government in cooperation with states and local entities. The Federal Government may improve streams or participate in improvements "for flood control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected."

Flood damage reduction benefits for alternative 2 were calculated as the difference between the damages under existing conditions and damages with alternative 2 in place. Average annual benefits for alternative 2 were estimated to be $559,000, as shown in table 4-11.

Table 4-11. Average Annual Benefits for Alternative 2	
Average Annual Damages, Existing Conditions	$1,436,000
Average Annual Damages, With Alternative 2	($877,000)
Average Annual Benefits, Alternative 2	**$559,000**

Table 4-12 depicts the breakdown of average annual benefits by category or damage type. More detailed information regarding the derivation of average annual benefits can be found in appendix C.

Table 4-12. Average Annual Benefits, Alternative 2 (1994 Price Level)		
Benefit Category	**Percent of Total Benefits**	**Average Annual Benefits ($)**
Residential Structures	15.4%	$86,000
Residential Content	5.9%	$33,000
Commercial, Public, and Industrial	20.5%	$115,000
Agricultural Crop Losses	0.7%	$4,000
Other Agricultural Losses	4.7%	$26,000
Utilities	13.5%	$75,000
Transportation	35.3%	$197,000
Emergency Expenses	0.5%	$3,000
Clean-Up Expenses	0.5%	$3,000
Business Losses	3.0%	$17,000
TOTAL	**100%**	**$559,000**

(9) Economic Analysis.

Table 4-13 is a summary of the economic analysis for alternative 2.

Table 4-13. Economic Analysis Summary--Alternative 2	
Average Annual Cost	$256,500
Average Annual Benefits	$559,000
Benefit-to-Cost Ratio	2.2

(10) Discussion.

The diversion of 500 cfs into the Snake River was found to be economically justified. It substantially reduces remaining flood damages on the Boise River and, with proper erosion control measures, could result in improved wildlife habitat. Such a plan, however, would probably have limited support from many of the individual landowners in the floodplain since it would not reduce the frequency of flows of less than 6,500 cfs. These flows are the primary cause of minor flooding and inconveniences to agricultural landowners along the river. Consideration was given to diversion into the irrigation system, on an almost annual basis, to meet a 4,000-cfs objective on the Boise River as opposed to the present 6,500-cfs target flow. It was determined, however, that it would cause unacceptable operational problems and cost. In addition, monetary benefits are very limited for these lower flows.

LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
RECONNAISSANCE STUDY

SECTION 5 - ENVIRONMENTAL RESTORATION

5.01. EXISTING CONDITIONS AND PROBLEMS.

a. River Channel.

The lower Boise River channel has been diked and leveed through much of the reach. This, combined with development encroaching on the floodplain (despite local regulations against such activity), has changed the channel morphology significantly (USFWS, 1995). It has also simplified the river channel from a biological perspective. The channel has lost sinuosity, and has been replaced by straitened sections in some areas. As vegetation, channel length, and the amount of floodplain have been reduced, bank storage that would normally act to augment late season flows has also been reduced. This loss of channel diversity has reduced the quality of the habitat, while channel straitening has reduced the quantity and quality of habitat that once was available to aquatic and terrestrial species (IDFG, 1988).

Cover for salmonids in the Boise River is limited due to the present condition of the river channel. Salmonids look for instream cover (*i.e.,* boulders or large woody debris), and cover is lacking in this system. It is unusual to find trout in a stream that is not associated with cover of this type. Without such cover, a large portion of the habitat will remain unsuitable and unused by trout. The lack of cover also exacerbates problems associated with low inter-streamflows in the Boise River. Also, interstitial cover for juvenile salmonids was not found in great abundance due to cobble embeddedness. The three storage projects upstream trap spawning-size gravel in the reservoirs, thereby not allowing it to be used downstream by the salmonids (Asbridge and Bjornn, 1988).

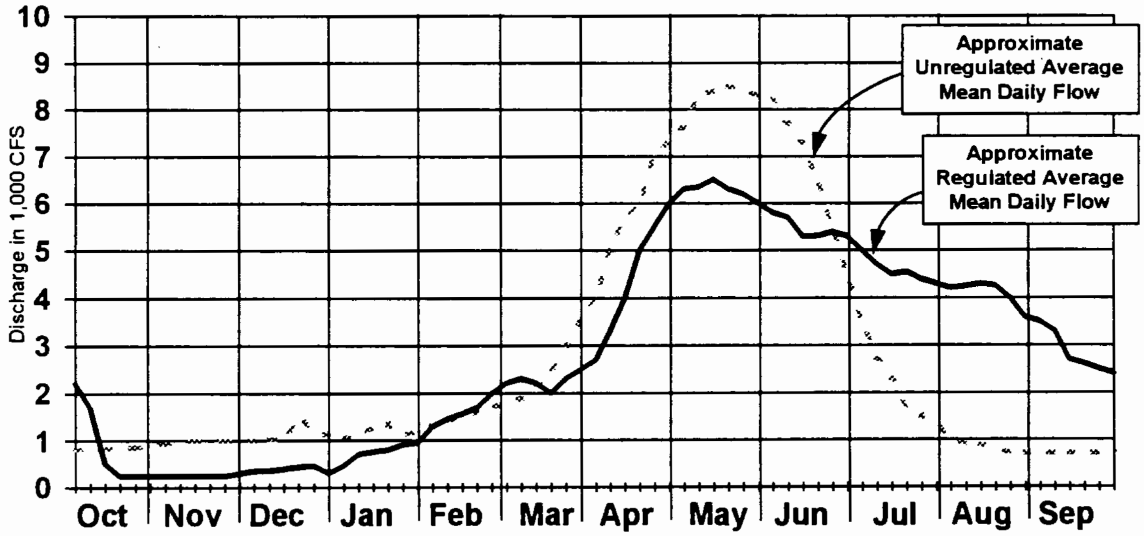
b. Streamflow.

Streamflow in the Boise River has been manipulated greatly. This has happened throughout much of the American west because of the introduction of irrigated agriculture. Initially, water was diverted from the river during the irrigation season, but was limited to available water in the river. Streamflow was further altered as a result of the construction and operation of the three upstream storage projects. These projects were built primarily to serve the agricultural community and, to a lesser degree, provide flood control. During the winter, the streamflow is stored in the reservoirs, and minimal instream flow from Lucky Peak Dam is released for passage downstream. Lower streamflows in the winter are deleterious to coldwater biota in the stream. In extreme cases, these lower streamflows have caused fish kills. One solution for improving the salmonid population is to increase winter streamflows. Anchor ice is also more likely to form when there are extremely low flows (and associated low velocities) in the winter. Increased streamflows would alleviate this problem.

A significant reduction of the spring freshet flow by the three projects on the Boise River has nearly eliminated the scouring flows that historically took place on an annual basis. This greatly detracts from the natural movement of bedload and sediment, and dewaters side channels that would otherwise fill with water each spring (USFWS, 1995). Such a lack of flushing flows contributes to cobble embeddedness, which decreases invertebrate productivity as well as available spawning habitat for salmonids.

Regular water releases have affected the riparian plant community in a way that is typical of areas downstream of water storage projects. Previously, cottonwood and other riparian plants existed in a much wider band than exists today. High water flows were allowed to disperse throughout the floodplain, in contrast to the current situation. The riparian community is now concentrated along a very narrow strip adjacent to the river, and this has led to a consequent degradation of the habitat (USFWS, 1995). This is caused both by a decrease in the magnitude of flows and encroachment on the floodplain. Chart 5-1 demonstrates the change in flow conditions from pre-project to post-project conditions.

Chart 5-1. Boise River Idaho at Lucky Peak Dam Summary Hydrographs



Notes
1. Period of record = 1955 through 1994.
2. Drainage area = 2,680 square miles.

Most of the reproduction of cottonwood trees that now occurs along the Boise River is asexual rather than sexual. This phenomenon is largely attributable to the regulation of the hydroperiod (USFWS, 1995).

c. Water Quality.

Water quality has been recognized as an issue of concern for a number of years in the Boise River Basin (Corps, 1975). An intensive water quality sampling program was conducted by several agencies as early as 1972. Water quality is becoming a greater concern in the lower Boise River. Many different users depend on the water in one form or another. The interest of users has increased, as these users are concerned about the possible chemical content of the water. The Lower Boise River Water Quality Plan (LBRWQP) group was established in 1992 to begin long-term water quality planning on the Boise River. Initially focusing on nutrients and sediments, the LBRWQP initiated a sampling plan to begin the assessment of water quality conditions and prioritize actions.

The LBRWQP has goals to assist in the determination of the problems in the river, as well as the best way to spend money on efforts to improve water quality. Due to a legal decision, two reaches of the lower Boise River are now listed as water quality limited, according to state standards. This decision was in response to state standards for sediment, temperature, and nutrients [Idaho Department of Environmental Quality (IDEQ), 1994].

The water released from Lucky Peak Dam is of high quality. It is degraded as it flows downstream through the Boise/Garden City areas, because of urban runoff and irrigation return flows laden with nutrients. As the volume of water is decreased, the concentration of pollutants and sediments increases. There is evidence that all flows below the town of Star, at certain times of the year, consist entirely of irrigation return flows. Many activities that affect water quality are beyond the scope of the Corps' ability to change (*i.e.*, grazing, agricultural return flows, wastewater treatment facilities, *etc.*). However, certain methods of watershed improvement can improve water quality (*e.g.*, restoring wetlands in an area). Such treatments are designed primarily to alleviate flooding, but also can act as "filters" to improve water quality by trapping sediments and organic nutrients.

It does not appear that the wastewater treatment facilities are having any effect on water quality in the lower Boise River [U.S. Geological Survey (USGS), 1988]. Strong associations among insect communities above and below these facilities indicates that treatment facilities have little impact on the water quality of the Boise River. In fact, there may even be a benign nutrient enriching effect from the effluent.

d. Fisheries.

(1) Boise River.

The lower Boise River is known for its temperature and low flow problems. The IDFG has completed only limited survey work on the lower Boise River because its present poor condition (S. Grunder, personal communication). There is a heavy stocking of trout to provide a fishery that would not otherwise be possible, based on the current number of angler hours. Between 55,000 and 65,000 trout are stocked in the river each year. Whitefish are known to be in great abundance in the river, but are underutilized by sportfishermen (IDFG, 1992).

Trout and whitefish are probably the best fish to use as indicators of the condition of the aquatic environment. These fish will normally move downstream in the fall, as the water cools. However, many of the water diversions represent impediment or barriers to the fish as they attempt to migrate upstream at a later date. ı he potential exists for fish to be stranded and die as they attempt to migrate upstream in the summer while seeking cooler water. There are a large number of spring-fed drains and sloughs that enter the river between Glenwood and the lower end of Eagle Island. These drains and sloughs provide quality nursery areas for juvenile trout (Holubetz, 1988).

There is currently a slot limit on certain sections of the Boise River. This limit is intended to produce trophy-sized fish in the stream. Only single-point barbless hooks are allowed, and no fish of 12 to 20 inches may be kept. This regulation encompasses the reach of river from Eagle Road upstream to the head of Eagle Island. There has been discussion about removing these regulations, as they do not seem to have had the desired effect on enhancing the fish populations. However, even as it exists today, the Boise River is considered an outstanding fishery in the reach through the city of Boise, in light of the urban area in which it is located. True flies, or diptera, make up the majority of benthic invertebrate species in the lower Boise River (IDFG, 1988). The non-game fish species distribution is generally affected by the same factors that affect resident trout.

The Boise River fish populations provide forage for the wintering bald eagle population. Hatchery rainbow trout make up a noticeable component of the bald eagle diet during these months.

(2) Regional.

Currently, the Boise River is blocked from anadromous fish passage by Hell's Canyon Dam (on the mainstem of the Snake River). This precludes any attempt at re-establishing historical salmon or steelhead populations in the basin. However, the Snake River Salmon Recovery Team has identified obtaining passage upstream of Hell's Canyon Dam as a strategy that should be investigated to increase the number of chinook salmon throughout the Snake River Basin. Should this be implemented, salmon and steelhead populations could once again be present in the river, which would help the river return to a more fully-functioning ecosystem. such reintroduction, for example, would help the bald eagle population by providing additional feeding opportunities. However, other limiting factors would need to be addressed once the passage issue was solved. As stated above, low winter flows would need to be augmented to ensure that naturally spawning fish had enough water to cover their redds during the winter months and provide them with oxygen.

e. Wildlife.

Riparian lands in the Boise River have historically been in a continuous state of change. The unregulated Boise River frequently flooded large areas adjacent to the river channel. A flood event approximately every 2 years promoted the development of the floodplain, scoured upland areas, and exposed river cobbles, gravel, and sand. Areas where soils were either exposed or deposited by the river were colonized by cottonwood and willow, which serve as wildlife habitat and stabilize the floodway banks and flood fringe. The water-saturated dikes also provide appropriate substrate for the germination of cottonwood and willow seed. Historically, the riparian community naturally regenerated itself by this periodic natural disturbance. Seasonal flooding is an important factor in the life cycle of cottonwood trees.

Since construction and operation of the three upstream projects for flood control and irrigation, the process has been moderated to such a degree that the Boise River no longer creates an environment that allows for the regeneration of the riparian black cottonwood forest. The fluvial processes that maintained diverse, self-perpetuating populations of cottonwoods have been disrupted by damming the river. The dams have reduced the intensity of floodflows, and have shifted the time of their occurrence (as documented on chart 5-1). Floodflows now confined to the channel, and a lesser concentration of suspended sediment carried in the channel, have eliminated the process that creates alluvial seedbeds. Water levels no longer recede gradually, and do not provide the moisture to support seed germination of the black cottonwood trees. A narrow band of riparian vegetation has reestablished itself along the steep banks of the river.

Loss of riparian habitat in the Boise River has negatively impacted the wildlife community and, in particular, the bald eagle. The lower Boise River has been identified as a prime wintering area for the bald eagle. Wintering bald eagles have three basic requirements: 1) an abundant food supply; 2) suitable foraging habitat with adequate perch trees; and 3) protected areas where they can roost communally at night. Bald eagles are more susceptible to disturbances in roost areas than in perching and foraging areas.

Black cottonwood trees are commonly used by bald eagles for perching and roosting. A prime example of critical bald eagle habitat along the Boise River is in the Barber Pool area, located between Diversion Dam and Barber Dam. Diversion Dam is located approximately 2 miles downstream from the Lucky Peak Project (see plate 2). There is considerable local interest in reestablishing the regeneration of black cottonwood trees for continuation of bald eagles and other wildlife.

5.02. POTENTIAL ALTERNATIVE SOLUTIONS.

The following paragraphs describe four alternative solutions that were identified, during the reconnaissance phase of this study, as having potential environmental benefits to one degree or another. The solutions were only conceptualized, and environmental outputs or impacts were not evaluated. More detailed studies would be required in a follow-on feasibility study. Much of the focus of the following restoration alternatives is centered around the regeneration of the black cottonwood trees, primarily because of high local interest. The regeneration of the black cottonwood trees will improve bald eagle wintering habitat, fisheries habitat, aesthetics, and small mammal habitat.

a. Flood Easements.

The concept of purchasing flood easements along the Boise River to preclude development is not a new idea (Corps, 1977). Areas having high potential for flooding could be purchased, and improvements could be cleared from the area. Such a non-structural method of flood control would also have numerous environmental benefits. In addition to flood damage reduction, this would increase the amount of habitat available and secure it for the future. By dedicating these lands to an undeveloped state, habitat would be provided for both wildlife and fish. One example is improvement for bald eagles, as they have varying degrees of tolerance for disturbance. Setback areas severing as buffer zones will secure loafing and feeding stands along the corridor. Such easements also have the possibility of improving water quality in the river, as these riparian zones would act as filters to clean the water as it passes through them. Ponds and stilling basins could also act in this capacity.

b. Release of Water from the Lucky Peak Project.

A larger sustained flow from the Lucky Peak Project, on an irregular basis, could be released to provide a "flushing flow" in the channel. This alternative would have to be used in conjunction with the purchasing of flood easements to limit downstream flooding as a result of the higher flows.

Vegetation growth continues to encroach upon the Boise River channel. The spring freshet that once took place annually is no longer present. As vegetation continually moves towards the center of the river from both banks, it increases the chance of flooding because of its reduced channel capacity. Consequently, flood control districts in the basin enter the channel with heavy mechanized equipment to remove woody vegetation. This action disturbs the stream bottom and riparian corridor in a more damaging fashion than if a high water event caused the same amount of tree removal. Such a flushing flow has the effect of removing debris and live growth in the channel without causing any "unnatural" environmental damage. Such a controlled flow release mimics the natural type of high flow event that would take place in an unregulated system. By increasing the flow in this manner, cobble embeddedness in the stream would be reduced. Conditions for spawning salmonids would also be improved, as they would find more gravel that is suitable for digging in their redds. Such flushing flows would also improve cottonwood regeneration, and may help control the spread of noxious plants. Purple loosestrife, a non-native species, has expanded its range tremendously in many reaches of the river. It is speculated that a high flow event, such as that described above, would help to dislodge this otherwise difficult-to-remove plant from the river channel.

c. Recontouring of the Floodway.

As a way of inducing flows to spread out, recontouring portions of the floodway could be implemented. This alternative would be particularly applicable in the Barber Pool area. This alternative would entail reshaping the land by lowering the surface elevation of the land area adjacent to the river and replanting the area with black cottonwood trees. Lowering the ground elevation would bring the new cottonwood trees within reach of the groundwater table, thereby assuring a continued viable stand of trees. In addition, old abandoned flow channels within the floodway could be reinstated, by means of excavation, to assure the conveyance of water in the channels during relatively low flow conditions. Cottonwood trees would then regenerate naturally in these zones, and provide new populations.

Currently, cottonwood regeneration is confined to the immediate streambank where water is available. Older trees are found at a distance from the Boise River, with fewer juveniles. The recontouring alternative would be limited to the Barber Pool area, because there is sufficient room to allow this type of topography manipulation to take place. One drawback with this alternative, however, is the lack of natural sediment movement in the river. The three upstream storage projects act as sediment traps, keeping fines and cobbles from being transported downstream where they would normally spread out across the floodplain. Such a development would have to be coordinated to ensure significant releases from Lucky Peak Dam so that the newly contoured areas were flooded at the proper time of the year. Another consideration is that the high water, in order to mimic nature, would have to vary in duration and intensity every year.

d. Raising Barber Pool.

This alternative involves the periodic raising of the water level of Barber Pool, in conjunction with the replanting of new cottonwood trees. This would involve raising the height of Barber Dam. Based on existing information, it is apparent that the existing Barber Dam would have to be replaced in order to allow for the raising of the pool.

Such a plan would provide periodic flooding of areas to assure a continued viable habitat. However, potential foible with this solution is that it may not provide the amount of sediment needed to prevent other plants from competing with the young cottonwood shoots. The three upstream dams have prevented sediment from being passed downstream to act as a blanket in preventing other plants from competing with the cottonwood trees. Sediment that does exist would drop out in the slow moving water, but would be insufficient to allow for the sustained growth of the new cottonwood trees.

SECTION 6 - WATER SUPPLY

6.01. INTRODUCTION.

Two water supply-type problems have been identified as part of the study effort. These problems are: 1) the need for water in the area of Idaho City along Mores Creek for M&I purposes, as discussed in section 2; and 3) the need for the reallocation of storage in the Lucky Peak Project for M&I purposes. Although a definite need does exist for M&I water in the Idaho City area, studies in this area were not pursued as part of this reconnaissance study. This problem should be addressed in the follow-on feasibility study. Efforts for this study have been limited to the reallocation of 280 AF of storage in the Lucky Peak Project for M&I purposes.

This section is a summary of the report included in appendix D. The report is an appraisal-level study identifying Federal interest in pursuing a reallocation of irrigation storage space in the Lucky Peak reservoir for M&I purposes. This is in response to a request from UWI in Boise, Idaho, for the reallocation of 280 AF of irrigation storage in Lucky Peak Lake for M&I purposes.

a. Authorization.

Section 301(a) of the Water Supply Act of 1958, as amended (43 United States Code 390b), establishes a policy of cooperation in the development of water supplies for domestic, municipal, industrial, and other purposes. Section 301(b) is the authority for the Corps to include M&I water storage in reservoir projects.

b. Lucky Peak Dam and Lake.

The Lucky Peak Project is owned and operated by the Corps, but USBR retains the storage license for the Lucky Peak reservoir. This license is issued by Idaho IDWR for a total gross storage of 307,043 AF. The active storage of 264,371 AF is used for flood control and irrigation water storage. Irrigation storage is contracted by USBR. Irrigation storage allocations are shown in appendix D.

c. United Water Idaho, Inc..

The UWI is an investor-owned utility that services 53,600 residential, commercial, and industrial customers. The 92-square-mile area served by UWI has a population of approximately 150,000.

Much of UWI's water supply comes from groundwater wells located throughout its service area. A significant portion of this supply, particularly during the irrigation season, is pumped from three Ranney collectors located directly adjacent to the Boise River. These collectors allow the diversion of high-quality groundwater from the alluvium adjacent to the Boise River. The quality of water minimizes treatment costs and, ultimately, the cost to water consumers. However, because of their proximity to the river, a portion of UWI's diversions from the Ranney collectors can affect surface flows in the Boise River.

Over the last few years, UWI has acquired natural flow rights from canal companies and shareholders in areas that are being taken out of agricultural production due to expanding suburbs and commercial developments in the Boise area. These diversions are junior to earlier surface water rights and, because they can affect more senior rights, UWI operates its collectors under an augmentation plan approved by IDWR. The plan involves the use of senior Boise River natural flow and storage rights in Anderson Ranch to "make up" approximately 1000 AF per year of depletion in river flows that IDWR believes is directly attributable to pumping from the Ranney collectors.

The South Boise Mutual Irrigation Company (SBMIC) rights, together with rights obtained from the Boise City Canal Company and Thurman Mill, are used primarily for direct diversion into UWI's system for M&I use. As such, the Lucky Peak storage water sought as a result of UWI's acquisition of SBMIC shares would be diverted from the Boise River through a river intake structure at UWI's Warm Springs Water Treatment Facility.

6.02. WATER SUPPLY NEEDS.

The portion of Ada County representing UWI's service area, and areas to which it may expand in the future, had a population of 164,780 in 1990. This area has a projected population of 253,483 in the year 2015, as shown in table 6-1.

Table 6-1. Estimated Water Demands
Existing and Future Service Area

Year	1990	1994	2015
Population	164,780	179,000	253,480
Water Needs	20 to 50 mgd[1] (31 to 77 cfs)	44 to 52 mgd[1] (68 to 80 cfs)	30 to 75 mgd[1] (46 to 116 cfs)

[1]Million Gallons Per Day

Based on the above limited data, UWI's expansion capability of existing facilities to 80 cfs is less than the projected peak demand of 116 cfs in the year 2015.

6.03. CONSTRAINTS.

a. Groundwater Resources.

On May 3, 1995, IDWR rescinded that portion of its moratorium affecting new water right applications for that portion of the Snake River Basin within the Boise River Drainage Area (Basin 63).

Several areas within Basin 63 are designated as Groundwater Management Areas (GWMA). These include the Boise Front Low Temperature Geothermal Area and the Southeast Boise Groundwater Management Area. Conditions of water supply in the Southeast Boise GWMA do limit UWI's water supply options in that area. Despite the lifting of the moratorium for Basin 63, these GWMA's remain subject to the limitations on water rights development and administration imposed pursuant to Idaho Code §42-233b.

b. Boise River Reservoir System Flood Control.

Within the Boise River Basin, four separate Federal reservoir projects are operated as one system, referred to as the "Boise River Reservoir System." This system includes Anderson Ranch; Arrowrock; Lucky Peak; and an offstream storage reservoir, Lake Lowell. All reservoirs are operated as a system for flood control and irrigation by a Memorandum of Understanding that was executed on November 20, 1953. Table 2-1 shows a breakdown of active and total storage for each of the three projects.

6.04. REALLOCATION OPTIONS.

Three possible options for reallocating storage for M&I use are: 1) the reallocation of joint-use flood control/irrigation storage to joint-use flood control/M&I storage; 2) the reallocation of joint-use flood control/irrigation storage to dedicated M&I storage; and 3) the reallocation of conservation storage to dedicated M&I storage.

Joint-use of flood control space is shared space. This option would require no change in the existing operation of the Lucky Peak Project. All water releases for flood control will be determined, controlled, and directed by the Corps, in conjunction with USBR. Releases for M&I purposes would be secondary to flood control.

The reallocation of flood control space is possible where the reallocation of flood control storage volumes are small and have little or no affect on flood protection. The 280 AF requested is about 0.1 percent of the active storage at Lucky Peak. This represents about 0.03 percent of the total active storage in all three projects that is available for flood control.

The reallocation of conservation space is a possibility if the originally-authorized project purposes are no longer required to meet present needs or may be available for new or higher purposes. Conservation space in the Lucky Peak reservoir is designated for fish and wildlife and sediment build-up. The conservation storage is 28,767 AF, at a pool elevation of 2,905 msl. At this point, a 1-foot differential in water surface elevation is equal to about 800 AF. The 280 AF represents about 0.3 feet (3.6 inches).

6.05. IMPACTS.

a. General.

The proposed change in use from irrigation to M&I purposes would not require any physical modification of Corps facilities, or significantly change the operation of the Lucky Peak Project to store or deliver water.

The incremental change in project releases from the 280 AF of dedicated storage is small (0.1 percent of the total storage). Changes in reservoir elevations would also be small. This appraisal indicates that impacts are minimal and easily surmountable. Dedicated storage for M&I purposes would slightly impact flood control or conservation pool purposes, as well as hydropower production at Lucky Peak. Environmental impacts at the reservoir, and downstream in and along the Boise River, would also be minimal. However, further investigations are necessary to clearly identify and quantify these impacts.

b. Change in Average Monthly Project Releases.

The current operation, under the IDWR augmentation plan, has not changed the historic releases from the Lucky Peak Project. Releases from the Lucky Peak Project continue as though the water was used for irrigation purposes according to state water rights. Table 6-2 shows average monthly releases from Lucky Peak from 1955 to 1994.

Table 6-2. Average Monthly Total Project Releases from Lucky Peak Dam (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
916	205	318	575	1405	2128	4157	6199	5495	4618	3989	2915

Dedicated storage for M&I purposes allows the user to request water from storage at any time. Assuming releases for M&I water supply are a simple plus and minus to the average monthly flow, table 6-3 illustrates possible changes in project releases.

Table 6-3. Estimated Change in Average Monthly Total Project Releases (cfs)											
280 AF Released at a Constant Flow from Storage Over a Period of 2 Months											
Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
								+2.3	+2.3	-2.3	-2.3
916	205	318	575	1405	2128	4157	6199	5497	4620	3986	2913
or											
280 AF Released at a Constant Flow from Storage Over a Period of 6 Months											
Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
+1							+1	+1	+1	-2	-2
917	205	318	575	1405	2128	4157	6200	5496	4618	3987	2913

c. Flood Control.

Total usable storage for flood control at Anderson Ranch, Arrowrock, and Lucky Peak is about 974,000 AF. The combined use of all three reservoirs does not provide sufficient flood control along the lower Boise River, because this amount of space is not large enough to control the runoff from large floods (50- to 100-year events). Any reduction in active storage at Lucky Peak would impact flood control to some degree.

d. Environmental.

Under the established augmentation plan approved by IDWR, the current operating method allowing flows to remain in the Boise River is mitigating any potential effects attributed to the Ranney collectors.

6.06. COST OF RESERVOIR STORAGE.

The cost allocated to the non-Federal sponsor for dedicated storage is normally established as the highest of the benefits or revenues foregone, the replacement cost, or the updated cost of storage in the Federal project. Based on appraisal-level analyses presented in appendix D, UWI's estimated appropriate share of the cost of storage at Lucky Peak would be the combination of the updated cost of storage ($56.00 per AF) and appropriate operation, maintenance, replacement, repair, and rehabilitation (OMRR&R) costs ($1.63 per AF), for a total estimated cost of $57.63 per AF (October 1994 price levels).

6.07. THE LEAST-COST ALTERNATIVE.

As a test of financial feasibility, the annual cost of reallocated storage should be compared to the annual cost of the most likely, least costly alternative that would provide an equivalent quality and quantity of water that the non-Federal interest would undertake instead of utilizing the Federal project. Additional groundwater wells, or the construction of an additional storage reservoir in the Boise River drainage, are considered the most likely alternatives.

As mentioned in paragraph 6.03.a., above, conditions of the water supply in the Southeast Boise GWMA do limit UWI water supply options in this area. Additional wells are not an option for UWI at this time.

Constructing a new dam and reservoir is not considered to be a viable alternative because of the inherent high costs for small volumes. Previous cost analyses for small reservoir projects having storage capacities of 6,000 AF and 8,800 AF show costs to be about $500 to $600 per AF (1991 price levels).

6.08. SPONSORSHIP.

a. Sponsor.

The sponsor is responsible for coordinating and securing or transferring all necessary water rights for M&I purposes. The UWI, the present sponsor, operates as a regulated public utility pursuant to a certificate of public convenience and necessity issued by the Idaho Public Utilities Commission, as well as a franchise from the city of Boise. Under Idaho statute, UWI has some of the characteristics of a public entity, including condemnation powers. Because UWI is an investor-owned company, they may not qualify as a non-Federal sponsor. In that event, the city of Boise, Idaho, is a potential sponsor for reallocation.

b. Coordination.

Preliminary coordination with USBR began in 1992 at the time of UWI's initial request for reallocation. The level of coordination to date is commensurate with the level of detail for the appraisal stage. More intense coordination will be necessary to deal with policy and contractual agreements between the Corps and USBR.

6.09. FEDERAL INTEREST.

a. Project Authorization.

Contained in House Record (H.R.) 6597, 79th Congress, 2d Session, is a report from the Board of Engineers for Rivers and Harbors, dated April 30, 1946. Portions of this authorizing document state:

> "The plan of the district engineer contemplates joint use of the storage in Lucky Peak, Arrowrock and Anderson Ranch Reservoirs and his recommendation makes initiation of construction of Lucky Peak Reservoir contingent upon securing certain prior agreements from local interests. In the opinion of the Board, the plan should be flexible in regard to combined operation of the reservoirs in order that the use of storage may at all times conform to changing conditions and best serve the varying needs of the locality."

Although Lucky Peak was initially authorized for flood control and potential future changes for flood control, irrigation, and power; the local need for an M&I water supply is a beneficial change in the use of water. This change is consistent with the intent of the Board of Engineers for Lucky Peak to serve, at all times, the varying needs of the locality. Based on this document, satisfying those needs is in the Federal interest. Investigations, supported by a non-Federal sponsor, to quantify the impacts of reallocating storage for M&I purposes are also in the Federal interest.

b. Implementation.

Alternatives to reallocating Lucky Peak storage are either too costly or are not implementable. To meet the M&I needs of the locality, reallocation is the only viable solution. The change in use would not require any physical modification to Corps facilities. Implementation, however, could be fraught with administrative and coordination problems.

The method of reallocation chosen will depend upon UWI's need for dedicated storage or joint-use of storage, as well as future coordination with all regulating agencies. The various agencies are in the process of identifying their specific needs.

Dedicated storage from flood control space, or from the conservation pool space, are other options.

LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
RECONNAISSANCE STUDY

SECTION 7 - STUDY PARTICIPANTS AND COORDINATION

This study was conducted under the management of the Corps, Walla Walla District. The overall management responsible for this effort was:

Lieutenant Colonel (LTC) James S. Weller, District Engineer
Mr. Matt Laws III, Chief, Planning Division
Mr. Gareth Clausen, Ms. Gina Trafton, and Mr. Carl Christianson, Acting Chiefs, Plan Formulation Branch, during the period of the study

The reconnaissance investigation was conducted by the Corps Study Team. Other individuals contributed information for the study through members of the study team. The study team consisted of the following individuals:

Jerry Roediger (Study Manager)	Plan Formulation Branch
Fred Buerstatte	Real Estate Division
Gary Ellis	Plan Formulation Branch
Chris Hyland	Environmental Resources Branch
Chris Sneider	Engineering Division
Gene Spangrude	Hydrology Branch

A short presentation was made to the Idaho Water Resources Board (IWRB) in Pocatello, Idaho, on July 8, 1994. The presentation explained the scope and schedule of the study.

Overall coordination for the study was accomplished through Boise River 2000, a local organization acting as a clearinghouse for water resource-related problems within the basin. Participants in Boise River 2000, under a Memorandum of Understanding dated October 5, 1994, include representatives from various Federal and state agencies, affected counties, numerous municipalities along the river corridor, flood control districts, irrigation districts, private companies, national environmental organizations, and other interested entities and individuals that have a stake in the lower Boise River. Boise River 2000's plan is to establish a comprehensive plan for the lower Boise River by the year 2000. Coordination was maintained through meeting attendance, as well as through presentations made to the group regarding the study. An initial meeting was held with Boise River 2000 on July 11, 1994. At that time, a presentation was made regarding the study and input was solicited regarding the problems and needs within the basin. A letter was received from the Boise River Flood Control District (BRFCD) Number 10, dated September 14, 1994, reiterating both their support of the study, as well as that of Boise River 2000 (see exhibit 2).

Coordination was also maintained with the LBRWQP group. The LBRWQP was established in 1992 to begin long-term water quality planning on the Boise River. Initially focusing on nutrients and sediments, LBRWQP initiated a sampling plan to begin the assessment of water quality conditions and prioritize actions. Coordination was maintained through attending and making presentations at scheduled meetings. Currently, the group is limiting their efforts to monitoring and collecting water samples, but eventually plan to expand the scope of their efforts.

The study team toured the study area during the week of July 18 through July 22, 1994, to become familiar with the basin and its identified problem areas. On July 19, 1994, the team was accompanied by Mr. Jim Wylie, from the city of Boise. Mr. Wylie pointed out flood problems along the river through the city of Boise. On July 20, 1994, Mr. Jack Harrison and Mr. Kevin Nielson, representing the LBRWQP group accompanied the study team to discuss water quality problems along the river. On July 21, 1994, Mr. Bill Clayton, Chairman of BRFCD Number 10, along with other BRFCD employees, Gene Gibson from IDWR, as well as Jack Gantz from the Idaho Department of Environmental Quality (IDEQ), accompanied the study team on a tour of the flood-prone areas in the vicinity of Eagle Island (downstream of Star Bridge). Critical problem areas were pointed out, and solutions were discussed. On the afternoon of July 21, 1994, the study team was accompanied by Ms. Alison Beck-Haas, from USFWS, and Ms. Marti Bridges, from Idaho Rivers United. At this time, they toured Barber Pool and other areas downstream to discuss environmental degradation and the impact it has on the wintering of bald eagles.

A presentation was made to the Southwest Idaho Resource Conservation and Development Area (RC&D) Council Meeting on September 20, 1994, in Kuna, Idaho. The presentation was intended to inform them of the ongoing study, furnish a status report, and aid in the coordination process.

Coordination was maintained with the Ada Planning Association (APA) through individual meetings and Boise River 2000 meetings, primarily to deal with issues related to bald eagles. The APA published a report in 1994, titled *Boise River Wintering Bald Eagle Study, Boise River Corridor, Lucky Peak Dam to Ada/Canyon County Line*. On August 3, 1994, a meeting was held with Mr. Clair Bowman, of APA, to discuss the problem and solutions regarding the degradation of the black cottonwood trees as it impacts the wintering of bald eagles.

Coordination was maintained with USBR through meetings associated with the LBRWQP group. Mr. Ron Golus was UWI's representative to LBRWQP group meetings. The USBR conducted an appraisal-level study to identify problems and alternate solutions for reducing irrigation return flows, latent with nutrients and sediment, into the lower Boise River. As part of the study, a number of alternative solutions were identified, screened to a manageable number, and evaluated on a preliminary basis. Ten alternatives were selected for further consideration. Four of these ten alternatives were then identified as having the potential for further consideration. A final report, *Lower Boise River Irrigation Waste Water Reuse Assessment, A Report for the Lower Boise River Water Quality Plan*, dated September 1994, was published. The potential for ways in which UWI's authority and the Corps' environmental restoration authority could complement each another and find a better overall solution to the problem, for the good of the community, was discussed. The USBR was attempting to identify a sponsor so that they could move to the next level of study.

LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
RECONNAISSANCE STUDY

SECTION 8 - LOCAL COOPERATION AND SUPPORT

The initial prospective sponsor for the study was identified as IDWR; with support from Ada and Canyon Counties, interested cities, flood control districts, and other entities. In a meeting on September 20, 1994, with an IDWR representative, it was learned that IDWR was not in a position to act as a sponsor for the study at this time. In cooperation with IDWR, efforts then focused on working through Boise River 2000, as well as through individual meetings with other prospective sponsors (county commissioners for Ada and Canyon Counties, Mayors of the cities of Boise and Garden City, and BRFCD Number 10). Meetings were also held with APA and the Idaho Department of Parks and Recreation (IDPR).

The following is a summary of formally-scheduled presentations and meetings that took place for the purpose of identifying a local sponsor:

- **October 5, 1994.** Presentation to Boise River 2000.

- **October 20, 1994.** Meeting with Ms. Yvonne Ferrell, Director, and Mr. Franklin Boteler, Deputy Director, of IDPR. At the meeting, they indicated interest in being a secondary sponsor in support of a primary sponsor for an environmental restoration project in the Barber Pool area. Exhibit 3 is a letter from them indicating their support.

- **October 21, 1994.** Meeting with Mayor Brent Coles and Mr. Bill Ancell, Director of Public Works, from the city of Boise. At that meeting, they indicated concern about the lack of capacity of the side drainages through the city of Boise to the Boise River, as well as their willingness to participate in cost-shared studies.

- **October 21, 1994.** Meeting with Mr. George Vance, Chairman, and Mr. Abe Vasquez, Commissioner, from the Canyon County Commissioners.

- **November 16, 1994.** Meeting with Mr. Gary Glenn and Mr. Rodger Simmons, Ada County Commissioners.

- **November 16, 1994.** Meeting with Mr. Ted Ellis, Mayor of Garden City.

- **January 11, 1995.** Meeting with Mr. Bill Clayton, Chairman of BRFCD Number 10, who was also active in the formation of Boise River 2000. The focus of this particular meeting was to discuss the role of Boise River 2000 as related to the basin's water resources problems, needs, and potential solutions. A letter was received from BRFCD Number 10, dated September 14, 1994, reiterating their support of the study, as well as that of Boise River 2000 (see exhibit 2).

- **January 12, 1995.** Meeting with Mr. Benjamin Hepler and Mr. Michael Creamer of the then Boise Water Corporation, regarding the reallocation of storage to M&I water supply. The Boise Water Corporation changed its name to United Water Idaho, Inc., effective 20 March 1995.

- **February 9, 1995.** Meeting with representatives from IDWR, regarding the State of Idaho's comprehensive state water plan, as well as ways the state and the Corps can cooperate on future studies.

- **February 16, 1995.** Presentation to Boise River 2000 addressing the Corps' planning program, and the services and capabilities of the Corps in relation to solving water resource problems.

A series of two Public Meetings was held in the cities of Boise and Nampa on November 15 and 16, 1994, respectively. The purpose of both meetings was to present and discuss water resource problems and needs, alternate solutions, information on the costs and economic feasibility of alternatives, and to receive comment from the public. The focus of the meetings was to identify a study sponsor for the reconnaissance and follow-on feasibility study. Comments from the public included the concern of flooding in the Eagle Island area, limited flow-carrying capacity of the river channel, lack of a channel maintenance program, and lack of concern by the general public of flood potential. There was concern over solutions for flood control and how they would adversely impact the environment. The converse was also voiced, regarding the adverse impacts of environmental restoration on flood control. It was pointed out that a holistic approach must be taken when identifying solutions to problems in the basin. There was both support and objection voiced concerning the environmental restoration alternatives identified.

Although an overall sponsor has not been identified for a follow-on feasibility study, there is considerable interest in the areas of flood damage reduction, environmental restoration, and water supply. Boise River 2000 is a clearinghouse for water resource-related problems and solutions in the basin. By a letter, dated 15 May 1995, the Advisory Council of the Boise River 2000 group has stated their support for continued investigations in the lower Boise River Basin, and pledged to act as a catalyst in developing support for the sponsorship of future planning efforts. A copy of this letter is included as exhibit 4.

SECTION 9 - DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

9.01. DISCUSSION.

a. Flood Control.

Based on coordination meetings and discussions conducted as part of the study, the concern regarding potential flooding along the Boise River and its side drainages is very apparent. Although flood damages have been minor in the past 8 years (during a drought period), there is a general consensus and acknowledgment that major flooding will occur along the river in the future. In 1983, there was a heavy snowpack with unseasonably warm weather conditions that forced an early evacuation of the upstream reservoirs to meet the flood control rule curve. The average daily flow reached 9,500 cfs in the lower river. Minor flooding starts to occur when discharges exceed 4,500 cfs. Major flooding starts at about 7,200 cfs. Above 10,000 cfs, flood damages increase dramatically. On the average, the upstream storage projects are able to control floodflows only to around 7,200 cfs, a 26-year recurrence interval. This is extremely significant, as the Boise River floodplain continues to grow and develop (with extensive residential areas) at a fast pace (about 3 percent annually, projected to continue over the next 20 years, and possibly beyond). Residents continue to live under the misconception that, since the three Federal reservoir projects are upstream, their lives and property are protected from catastrophic flooding.

A number of alternatives were considered to reduce the threat of flooding. A single alternative was identified as being highly economically justified, having a BCR in excess of 2-to-1. The alternative involves the diversion of floodflows out of the Boise River upstream of the high damage areas, through an existing system of canals and a reservoir, and eventually into the Snake River. Such a plan would reduce flows in the lower Boise River by the amount that was diverted. It would also increase the flexibility and effectiveness of the upstream storage projects for flood control and irrigation. During periods of evacuation of the reservoir for flood control operations, higher releases could be made from Lucky Peak Project without exceeding the regulation objective of 6,500 cfs, as measured at Glenwood Bridge. Increased release capability would reduce potential flooding during high runoff periods (caused by large basin snowpacks and unusual weather conditions). The optimum size project was found to have a diversion rate of 500 cfs. Such a plan would have minimal adverse environmental impacts. A general layout of the plan is shown on plate 5, with details shown on plate 6.

A series of seven adjacent dry-gulch tributaries in the Boise Front Range drain through narrow canyons onto alluvial fans. From there, they drain into the Boise River within the city of Boise. Most of BMA north of Boise is subject to flooding from these foothill side drainages. The canyons are susceptible to debris-laden flash floods due to intense rainfall during thunderstorms. Flash floods can occur within 15 minutes to 6½ hours of heavy rainfall, and pose an extreme risk for loss of life and property in some areas.

A flood warning system has been identified as being economically-justified for the side drainages to provide notification and evacuation, as well as potentially reduce costs and/or reduce loss of life from thunderstorm-type floods. A flood warning system could be included as a solution to flood problems in the side drainages. A flood warning system would be of particular benefit used in conjunction with the NWS doppler radar, as many homes in the foothills are built over the channels of the side drainages.

b. Environmental Restoration.

Since the construction of the three projects upstream of Boise for flood control and irrigation, the configuration and use of the floodplain along the Boise River has changed significantly. Because of the regulation of high frequency flows, higher flood protection, and associated reduced flood-prone areas downstream of the projects, urban development has encroached into the natural floodplain and has substantially reduced the natural qualities and riparian habitat along the river. The natural fluvial process has also been moderated to such a degree that the Boise River can no longer maintain an environment that allows for the regeneration of the black cottonwood forest along the river, which is vital in maintaining wintering areas for the bald eagles as well as a wide variety of fish and wildlife. There is a strong interest within the local community to stop further degradation of the black cottonwood forests, and restore what has been lost. Although no specific alternatives were evaluated in detail, alternatives were identified conceptually. At least one alternative appears to have the potential for high project outputs.

c. Water Supply.

To meet both present and future water demands, UWI (a provider of water for residents of the city of Boise, under franchise with the city), has begun to acquire excess irrigation storage in the three upstream storage projects. They are reallocating the storage from irrigation to M&I water supply. They are systematically purchasing state water rights from irrigation canal companies, as land in the Boise River Basin is converted to residential use from agricultural use. They plan to use the storage to meet their present and future M&I water supply storage needs. With a 3-percent annual growth rate, which has been experienced and is projected to continue over the next 20 years, significant future surface water needs exist. The UWI has requested that the Corps reallocate an initial 280 AF of irrigation storage in Lucky Peak Project for M&I water supply, as a test case to establish the procedure for future requests. Additional requests for storage reallocations will be made in the future. An appraisal-level evaluation, conducted as part of this study, determined that there is Federal interest in the reallocation of the 280 AF of storage. In addition, this evaluation indicated that further, more in-depth studies are warranted. Additional surface water needs for the rapidly growing Boise River Basin are significant (up to 75 mgd over the next 20 years).

Boise County, in the vicinity of Idaho City, is witnessing a water shortage from both surface and groundwater supplies. As a result of the drought over the past 8 years, surface runoff has been reduced substantially. Water levels in domestic water wells have fallen dramatically. Although the situation was not evaluated as part of this study effort, it is apparent that there is a definite need for some type of surface storage (for M&I purposes) to serve Boise County.

9.02. CONCLUSIONS.

There is an intense interest in flood control and environmental restoration, and a need for reallocation of storage in Lucky Peak Project. The State of Idaho, through IDWR, supports continual efforts to address the problems and opportunities identified in this report. The IDWR has indicated that they are interested in further discussion regarding the joint exploration (with counties, cities, and flood control districts, *etc.*) of the problems and needs of the basin as part of their Comprehensive State Water Plan for the lower Boise River Basin, scheduled for initiation in July 1996. The IDWR and the Corps are developing the necessary plan of action to provide funding in the states Fiscal Year 1997 budget to sponsor further work, in cooperation with the public, various interest groups, and Boise River 2000 (acting as the catalyst for state sponsorship). Boise River 2000 is a local organization acting as a clearinghouse for water resource-related problems within the basin. Participants in Boise River 2000 include representatives from various Federal and state agencies, affected counties, numerous municipalities along the river corridor, flood control districts, irrigation districts, private companies, national environmental organizations, and other interested entities and individuals that have a stake in the lower Boise River.

9.03. RECOMMENDATIONS.

It is recommended that this reconnaissance study be placed in an "inactive" status until sponsorship for the follow-on feasibility study can be formulated. Continued coordination with IDWR, BRFCD Number 10, Boise River 2000, UWI, the city of Boise, and Ada County will be accomplished under other available authorities until such time as appropriate sponsorship has developed.

/signed/
James S. Weller
Lieutenant Colonel, Corps of Engineers
District Engineer

LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
RECONNAISSANCE STUDY

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EXHIBITS

	QUANTITY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT COST
AA LOWER BOISE RIVER & TRIB STUDY						
AA 01 LANDS AND DAMAGES	6.00	ACR	16,160	4,040	20,200	3366.66
TOTAL LANDS AND DAMAGES	6.00	ACR	16,160	4,040	20,200	3366.66
AA 06 FISH AND WILDLIFE FACILITIES						
AA 06 03 Wildlife Mitigation & Erosion ct			82,948	20,737	103,685	
TOTAL FISH AND WILDLIFE FACILITIES			82,948	20,737	103,685	
AA 08 ROADS, RAILROADS, AND BRIDGES						
AA 08 01 Roads			157,161	39,290	196,451	
TOTAL ROADS, RAILROADS, AND BRIDGES			157,161	39,290	196,451	
AA 09 CHANNELS AND CANALS						
AA 09 01 Rehabilitate Existing System			1,513,748	378,437	1,892,185	
TOTAL CHANNELS AND CANALS			1,513,748	378,437	1,892,185	
AA 30 PLANNING, ENGINEERING AND DESIGN			401,000	100,250	501,250	
AA 31 CONSTRUCTION MANAGEMENT			200,500	50,125	250,625	
TOTAL LOWER BOISE RIVER & TRIB STUDY			2,371,517	592,879	2,964,396	
TOTAL Lower Boise River Study Reconn			2,371,517	592,879	2,964,396	

Reviewed and Approved: *Kim Callan*

Date: *4-28-95*

KIM CALLAN, P.E.
Acting Chief, Cost Engineering Branch

Exhibit 1
Sheet 1 of 3

	QUANTITY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT COST
AA LOWER BOISE RIVER & TRIB STUDY						
AA 01 LANDS AND DAMAGES	6.00	ACR	16,160	4,040	20,200	3366.66
TOTAL LANDS AND DAMAGES	6.00	ACR	16,160	4,040	20,200	3366.66
AA 06 FISH AND WILDLIFE FACILITIES						
AA 06 03 Wildlife Mitigation & Erosion ct						
AA 06 03 73 Habitat Restoration			82,948	20,737	103,685	
TOTAL Wildlife Mitigation & Erosion ct			82,948	20,737	103,685	
TOTAL FISH AND WILDLIFE FACILITIES			82,948	20,737	103,685	
AA 08 ROADS, RAILROADS, AND BRIDGES						
AA 08 01 Roads						
AA 08 01 01 Mob, Demob & Preparatory Work			8,378	2,095	10,473	
AA 08 01 02 Drainage - New Culverts	3.00	EA	53,753	13,438	67,191	22396.91
AA 08 01 13 Traffic Control	25.00	EA	78,742	19,686	98,428	3937.11
AA 08 01 39 Road Surfacing & Restoration	900.00	SY	16,288	4,072	20,360	22.62
TOTAL Roads			157,161	39,290	196,451	
TOTAL ROADS, RAILROADS, AND BRIDGES			157,161	39,290	196,451	
AA 09 CHANNELS AND CANALS						
AA 09 01 Rehabilitate Existing System						
AA 09 01 01 New Intake Structure	1.00	EA	56,413	14,103	70,517	70516.57
AA 09 01 02 Replace Existing 48" RCP	1950.00	LF	266,470	66,617	333,087	170.81
AA 09 01 03 New 48" RCP Pipe	1212.00	LF	156,861	39,215	196,076	161.78
AA 09 01 04 New 18" RCP Pipe	1212.00	LF	67,786	16,947	84,733	69.91
AA 09 01 06 New 66" RCP Pipe	875.00	LF	239,732	59,933	299,665	342.47
AA 09 01 07 New 54" RCP Pipe	830.00	LF	250,791	62,698	313,488	377.70
AA 09 01 08 New Stilling Basin	1.00	EA	46,996	11,749	58,744	58744.38
AA 09 01 09 New Channel Section 300cfs	150.00	LF	4,953	1,238	6,191	41.28
AA 09 01 10 Replace Existing Drop Structure	2.00	EA	50,269	12,567	62,837	31418.42
AA 09 01 11 Enlarge Existing Channel 500cfs	4540.00	LF	149,912	37,478	187,390	41.28
AA 09 01 13 Replace Existing Intake Structre	1.00	EA	55,756	13,939	69,695	69694.81
AA 09 01 14 Replace Existing 48" RCP w/ 72"	520.00	LF	117,540	29,385	146,925	282.55
AA 09 01 15 Replace Existing Stilling Basin	1.00	EA	50,269	12,567	62,837	62836.84

		QUANTITY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT COST
	TOTAL Rehabilitate Existing System			1,513,748	378,437	1,892,185	
	TOTAL CHANNELS AND CANALS			1,513,748	378,437	1,892,185	
AA 30	PLANNING, ENGINEERING AND DESIGN			401,000	100,250	501,250	
AA 31	CONSTRUCTION MANAGEMENT			200,500	50,125	250,625	
	TOTAL LOWER BOISE RIVER & TRIB STUDY			2,371,517	592,879	2,964,396	
	TOTAL Lower Boise River Study Reconn			2,371,517	592,879	2,964,396	

Exhibit 1
Sheet 3 of 3

BOISE RIVER FLOOD CONTROL DISTRICT #10

P.O. Box 46
Star, Idaho 83669

September 14, 1994

Jerry Roediger
U.S. Army Corps of Engineers
Building 613A
Walla Walla, WA 99362-9265

Dear Jerry:

I am writing pursuant to our meeting earlier this summer about the Boise River. I would like to reiterate the position of Flood Control District #10 as well as a general feeling from the Boise River 2000 group concerning the overall approach to a study and subsequent project on the Boise River. The Boise River has always been looked at in piecemeal fashion and we feel it is necessary to put the pieces together in a long term approach.

Three areas of high priority for the Corps of Engineers Projects, as I understand them, are:

1. Flood Control
2. Navigable Waters
3. Environmental Restoration

The proposed project would fulfill two of the requirements: flood control and environmental restoration. One of the big concerns about flood control is channel capacity and it may be appropriate for the Corps to consider creating channel capacity prior to additional growth. Channelization that is currently taking place in or along the river due to building is channelizing the river which is creating more of a concern on the part of the Flood Control District for the downstream flows. The river, in its multifaceted facility, is now being required to handle more water which would normally go into the ground. That water is now being funneled to the river which forces normal watershed areas and an increasing amount of urban water to serve as a flood channel. Since inception of the dams, the river has changed dramatically, especially in the Barber Dam area. In addition, land use adjacent to the river has changed dramatically and farming and urban encroachment along the river have created a massive difference in the demands on flood control.

Flood control and aesthetics (old cars and concrete) along the river are minimally compatible. The concrete is especially poor and both the cars and the concrete do not allow vegetation to restart. Aesthetically and environmentally flood control is extremely poor and we would like to consider doing a project which would include removal of the cars and concrete replaced with jetties and barbs for protection of the river. In addition, areas in which water could dissipate should be considered. Removal of gravel from the river in appropriate places and the institution of the barbs and jetties is critically important. Once this is fixed, additional barbs and jetties would be beneficial in a project that would be of great significance to the river and its inhabitants in the form of a diversion dam system.

As you are aware, irrigation districts are under no restriction regarding construction and maintenance of their diversion dams along the river. As can be seen in a view of the river, diversion dams consist of both engineered facilities as well as unstructured facilities. During high water, gravel from unstructured facilities is flushed down the river. Major problems exist at the Middleton and Star Bridges where flushed gravel is deposited downstream. The irrigation district comes in the following year, pushes more gravel into that area because the hole has been refilled with gravel and the river is disturbed again. The Corps could make a significant contribution to a permanent generic diversion dam. Your members were shown one design along the Star Bridge in which concrete is put into the river all the way across. Structures that would hold 2x12's are designed so that during the irrigation season, the structure can be put up, the wood put in, and the diversion created during the irrigation season. At the end of the season the wood is taken down and the pipes laid back down with their braces. As a result, the river bottom has not been disturbed and gravel remains in place. A generic dam would have to be engineered for each specific location. We would like to include facilities for canoeists, etc. and I sincerely believe that the irrigators would consider something like this if they were shown the benefits. In addition, if justification for paying for this through the Corps cannot be made then perhaps long term financing could be created since this would be very beneficial to flood control on the river.

The river environment has changed dramatically due to the lack of flooding. I know you have received a recommendation from the Eagle Task Force which is an excellent organization that is focusing on the wintering bald eagles. We would like to see consideration not only for the eagles but also restoration of the cottonwood forest along the Boise River. Because there has been no flooding action, the cottonwoods are dying and unless this is done in the near future the mature trees will be lost and there will be no young trees coming along. There are methods that can be used for quick growing of trees and we feel that this is something that was destroyed by the dam construction and greatly fits into environmental restoration. This could be done and be of great benefit to all those involved.

Finally, the Corps has an opportunity along the Boise River to create a unique project that could be the vanguard of many projects throughout the United States. If the Corps would consider coming in and doing the whole river from Lucky Peak Dam to the confluence of the Snake River, it would provide a new focus in projects for all rivers in the United States. Provision could be made for this area before it gets built up and possibly save the river from being cemented in the future. The Corps would be the one to provide the leadership. This is an opportunity for leadership to come forward and it is hoped that this will be considered.

Sincerely,

Clair M. Bowman/for

William C. Clayton, Chairman
Flood Control District No. 10

pc: Boise River 2000

CB\CLAYTON.LTR

IDAHO DEPARTMENT OF PARKS & RECREATION

P.O. BOX 83720
BOISE, IDAHO 83720-0065
(208) 334-4199
FAX (208) 334-3741
TDD 1-800-377-3529
Street Address
5657 Warm Springs Avenue

February 14, 1995

Lt. Colonel James S. Weller
District Engineer
Department of the Army
Walla Walla, Washington 99362-9265

SUBJECT: Lower Boise Tributaries Reconnaissance Study

Dear Colonel Weller:

The department would like to express its support for the Lower Boise Tributaries Reconnaissance Study. In particular, we are interested in developing management prescriptions for the Barber Pool area of the Boise River and implementing appropriate natural resource management activities. This area serves as important habitat for overwintering bald eagles, deer, and other wildlife. It has been called one of Idaho's ten most unique natural areas.

We would be interested in participating as a partner in a larger study intended to examine and improve the ecology of the Boise River corridor.

Sincerely,

Yvonne S. Ferrell

P:FRBO43

Exhibit 3

Boise River 2000

"An organization comprised of citizens, user groups, and government to coordinate activities related to the Boise River"

May 15, 1995

LTC James S. Weller, District Engineer
U.S. Army Corps of Engineers, Walla Walla District
201 N. Third Ave.
Walla Walla, WA 99362

Dear LTC Weller:

This letter is to state the support of the Boise River 2000 Advisory Council and membership for the continued investigation identified in the Corps of Engineers' (Corps) Lower Boise River and Tributaries Reconnaissance Study. The Boise River 2000 group will act as a catalyst to attempt to develop financial support for sponsorship of appropriate future efforts to plan for the mutipurpose use of the Boise River.

The Boise River 2000 group is an organizations comprised of citizens, user groups, and government entities along the Boise River corridor who have all signed a Memorandum of Understanding which allows coordination and collaboration on activities related to the future of the Boise River and adjacent lands. The area of interest of this group consists of the water and related land resources from Luck Peak Dam downstream to its confluence with the Snake River. This group is guided by an Advisory Council charged with the formulation and general administration of policy. I have enclosed information detailing the membership and the by-laws of the organization.

Mr. Mathew Laws of your staff met with the Boise River 2000 group on February 16, 1995 and gave a presentation of the various ways the Corps could support our efforts and provide quality service your District has a reputation for. It is the hope of the Advisory Council that we can work closely with the Corps in the years ahead to develop a basin partnership that brings all users of the resources of the Boise River together in development of a framework plan for the future that everyone will be proud of.

Sincerely,

William C. Clayton
Chairman

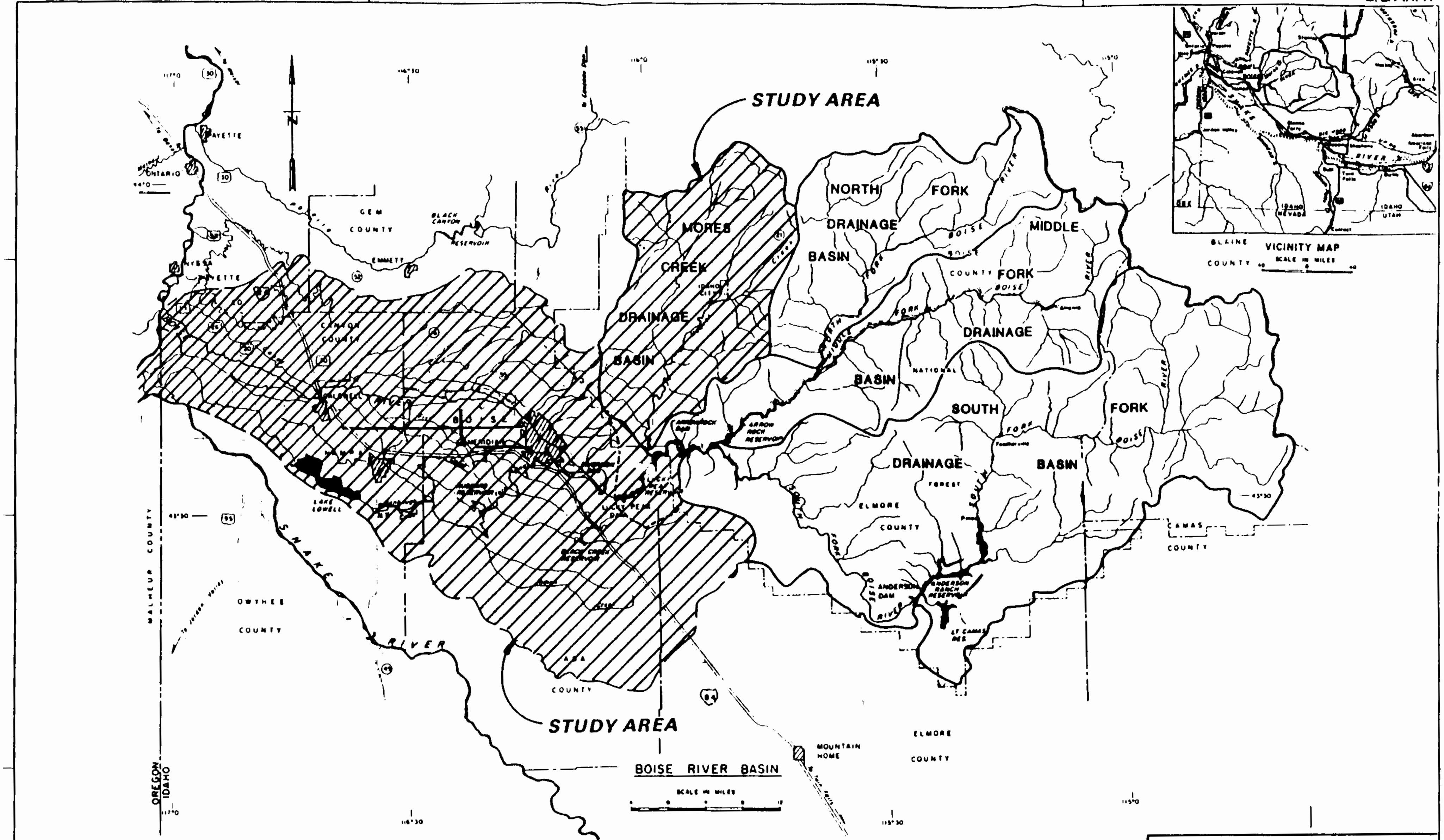
Post Office Box 46 ◆ Star, Idaho ◆ (208) 286-7801

Exhibit 4

PLATES

CORPS OF ENGINEERS

U.S. ARMY



BOISE RIVER BASIN IDAHO

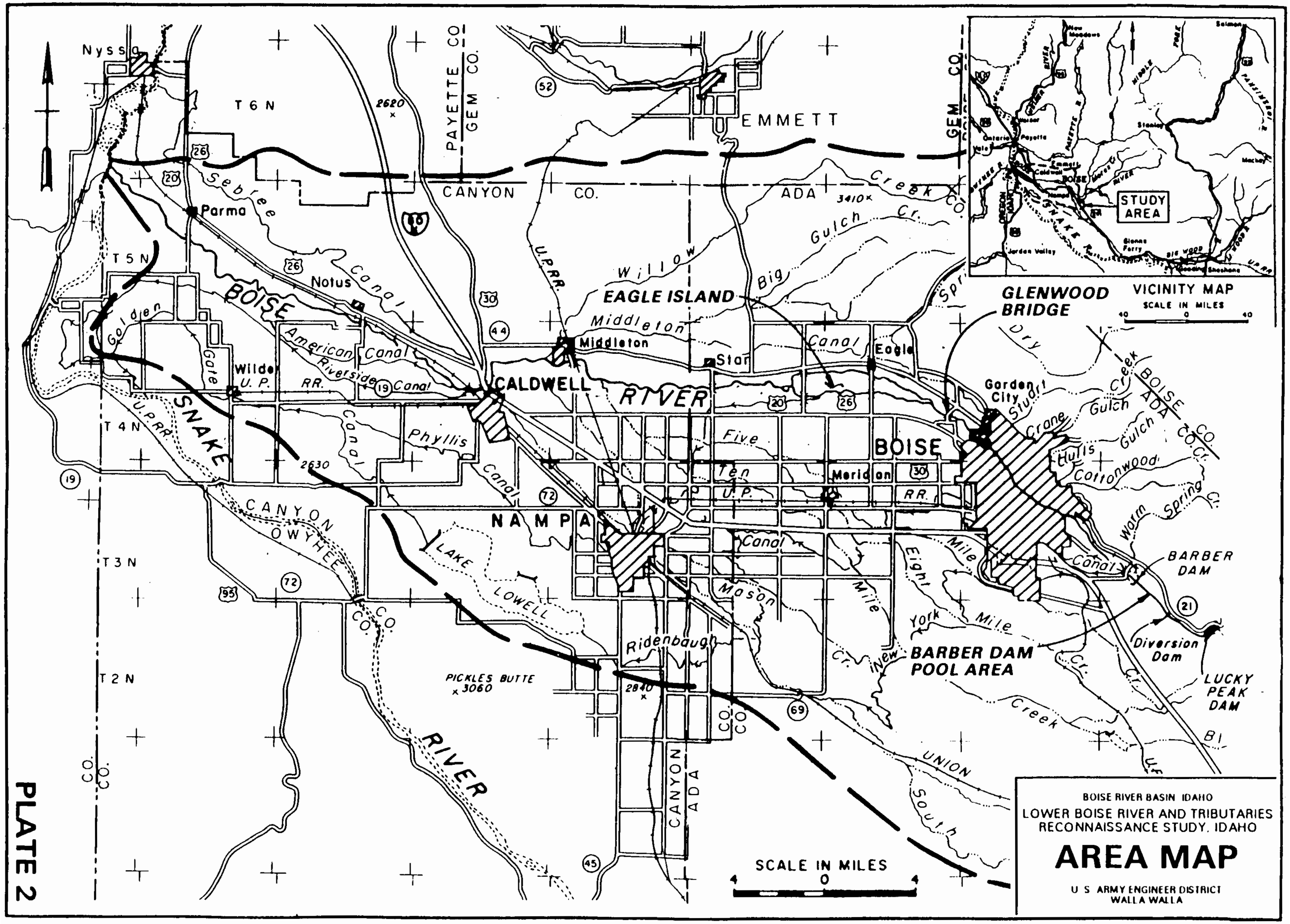
LOWER BOISE RIVER AND TRIBUTARIES
RECONNAISSANCE STUDY, IDAHO

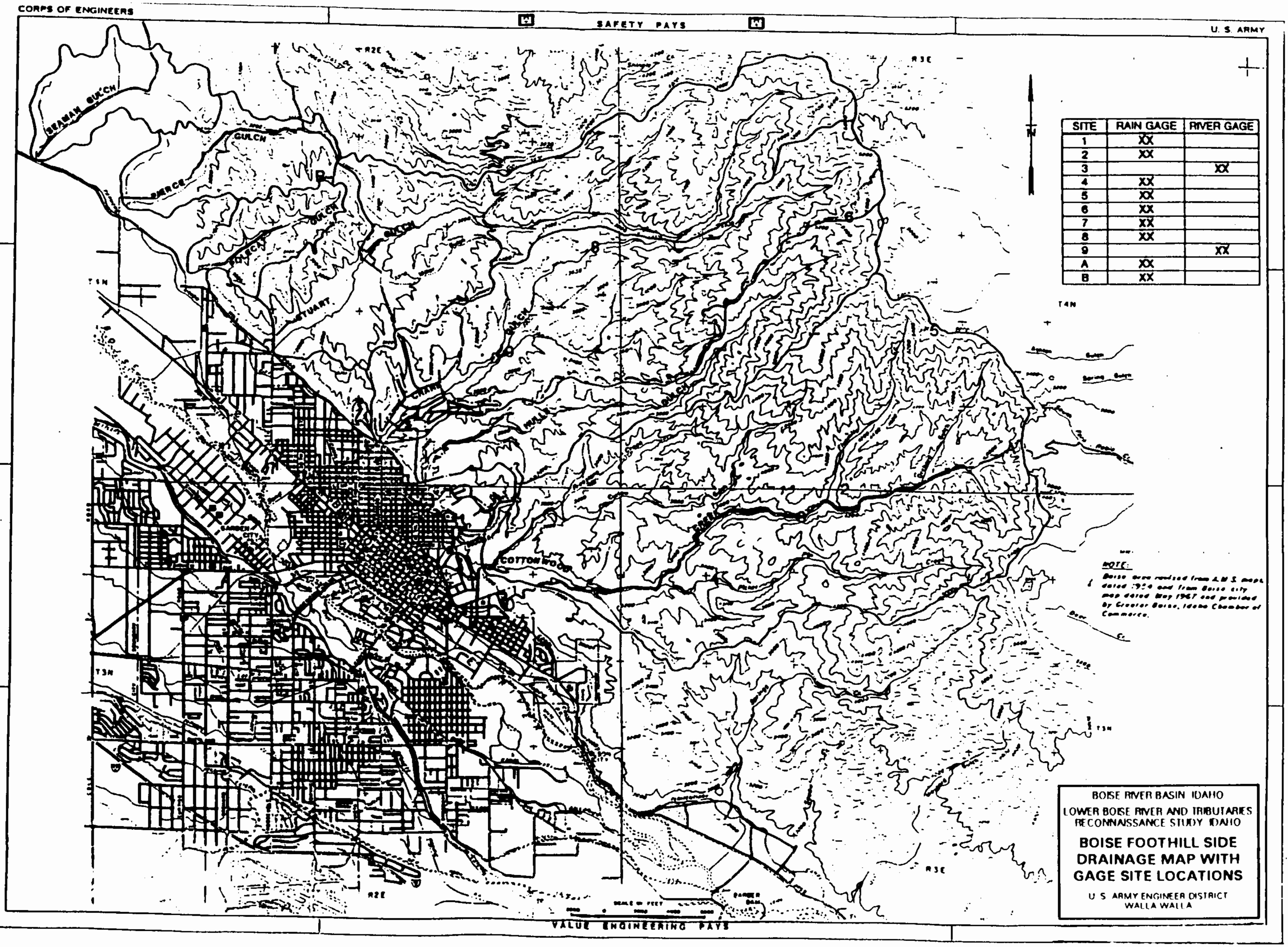
STUDY AREA AND VICINITY MAP

U S ARMY ENGINEER DISTRICT
WALLA WALLA

PLATE 1

VALUE ENGINEERING PAYS


BOISE RIVER BASIN IDAHO
LOWER BOISE RIVER AND TRIBUTARIES
RECONNAISSANCE STUDY, IDAHO
AREA MAP
U S ARMY ENGINEER DISTRICT
WALLA WALLA
SCALE IN MILES
4 0 4
VICINITY MAP
SCALE IN MILES
40 0 40
STUDY AREA
GLENWOOD BRIDGE
EAGLE ISLAND
BARBER DAM POOL AREA
BARBER DAM
Diversion Dam
LUCKY PEAK DAM
Nyssa
Parma
Notus
Wilder
CALDWELL
Middleton
Star
Eagle
Garden City
BOISE
Meridian
NAMPA
EMMETT
BOISE RIVER
SNAKE RIVER
PAYETTE CO.
GEM CO.
CANYON CO.
ADA CO.
BOISE CO.
OWYHEE CO.
T6N
T5N
T4N
T3N
T2N
PICKLES BUTTE
x 3060
2620
2630
2840
3410
PLATE 2



SITE	RAIN GAGE	RIVER GAGE
1	XX	
2	XX	
3		XX
4	XX	
5	XX	
6	XX	
7	XX	
8	XX	
9		XX
A	XX	
B	XX	

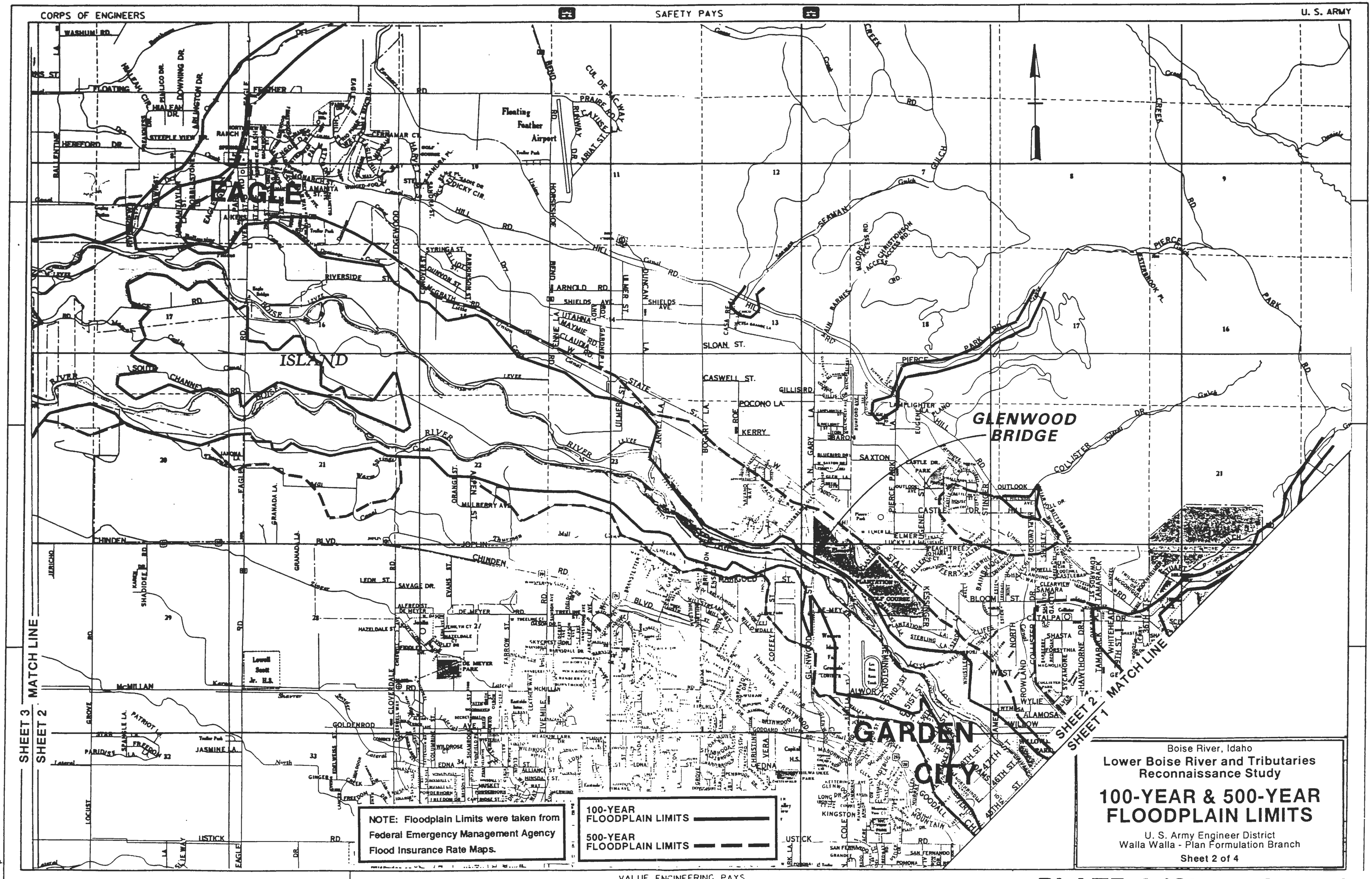
PLATE 3

CORPS OF ENGINEERS SAFETY PAYS U. S. ARMY

VALUE ENGINEERING PAYS

REFERENCE FILES ATTACHED

PLATE 4 (Sheet 1 of 4)



REFERENCE FILES ATTACHED

PLATE 4 (Sheet 2 of 4)

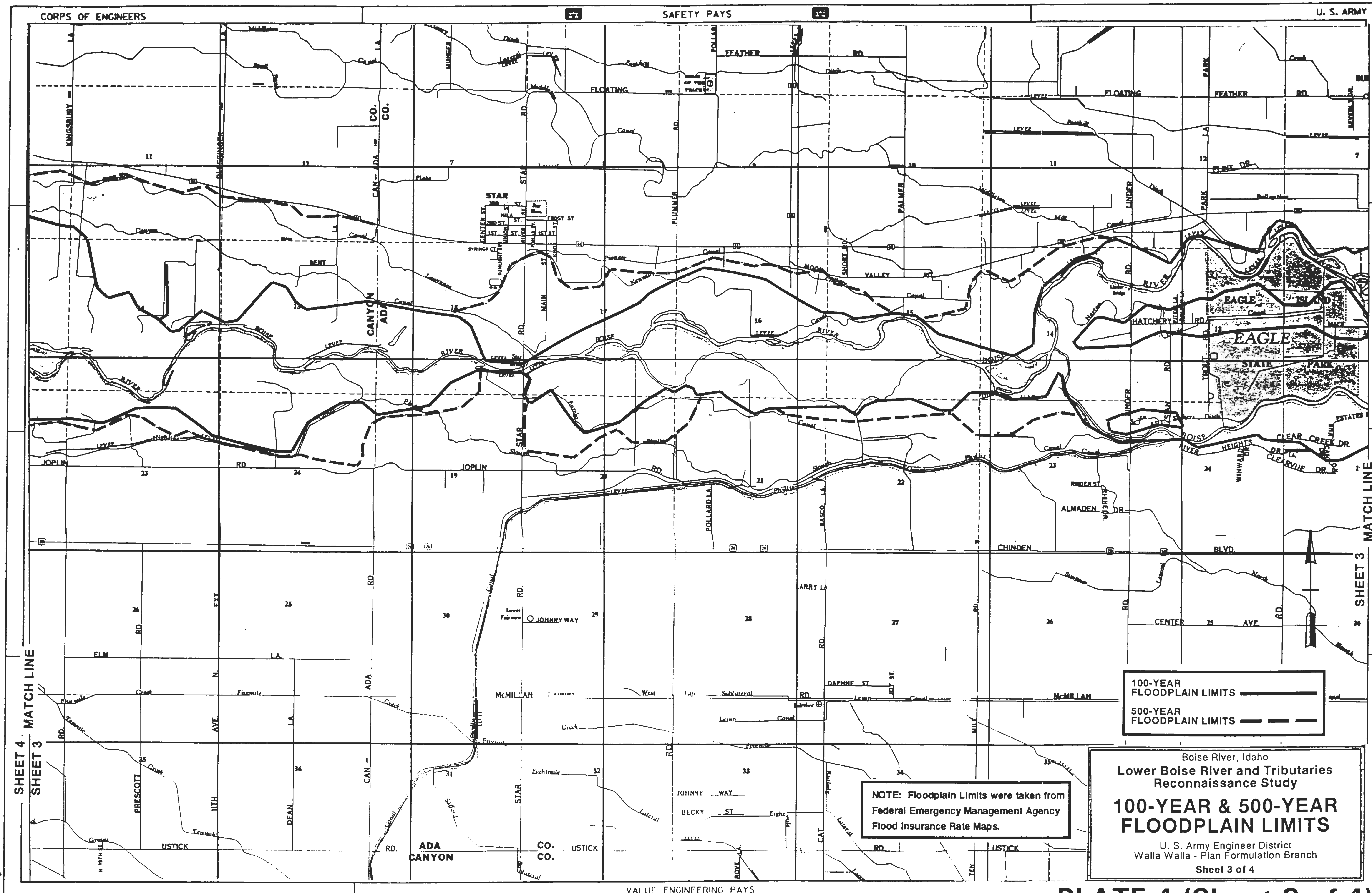
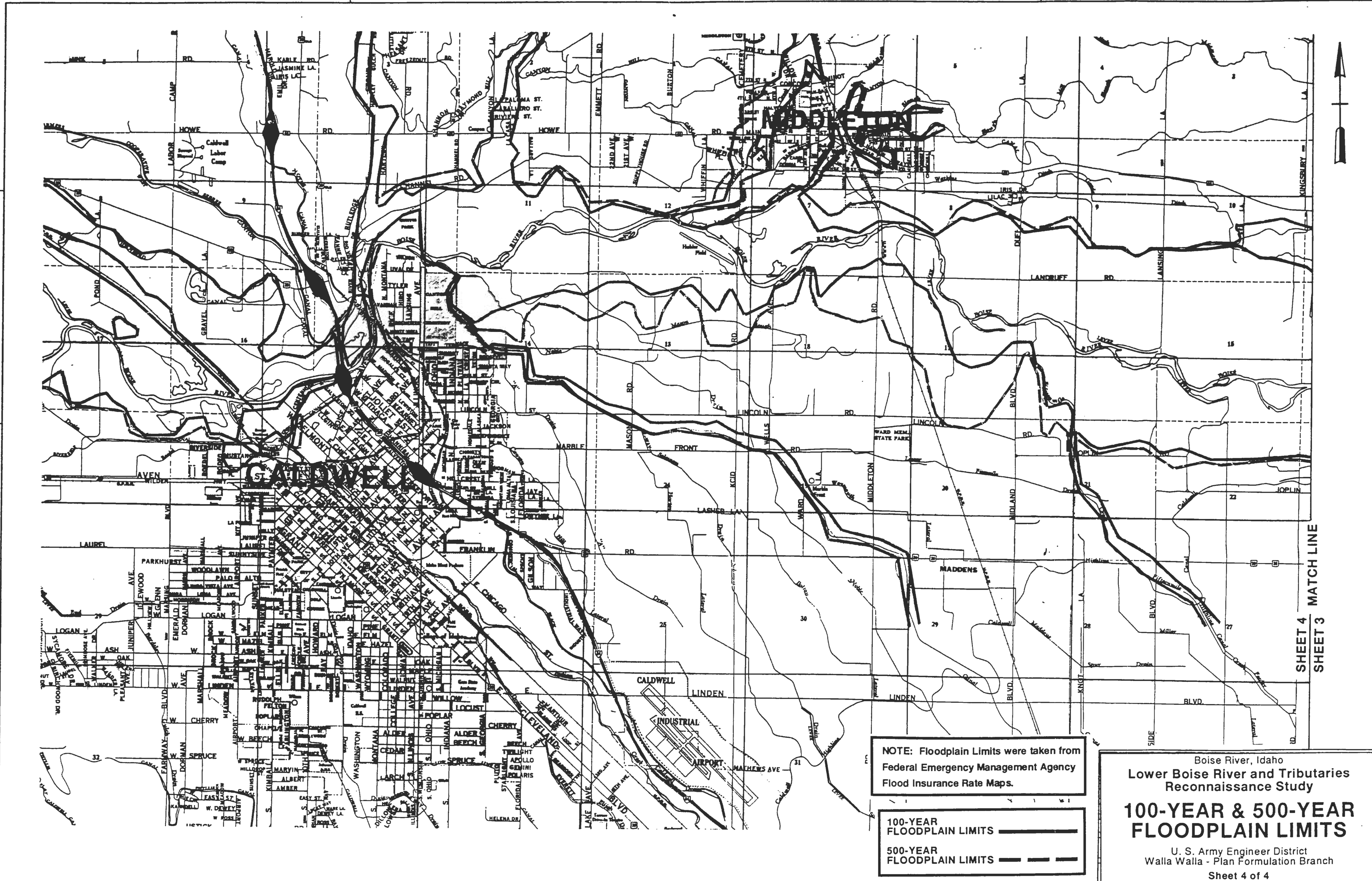


PLATE 4 (Sheet 3 of 4)



NOTE: Floodplain Limits were taken from Federal Emergency Management Agency Flood Insurance Rate Maps.

100-YEAR FLOODPLAIN LIMITS

500-YEAR FLOODPLAIN LIMITS

Boise River, Idaho

Lower Boise River and Tributaries Reconnaissance Study

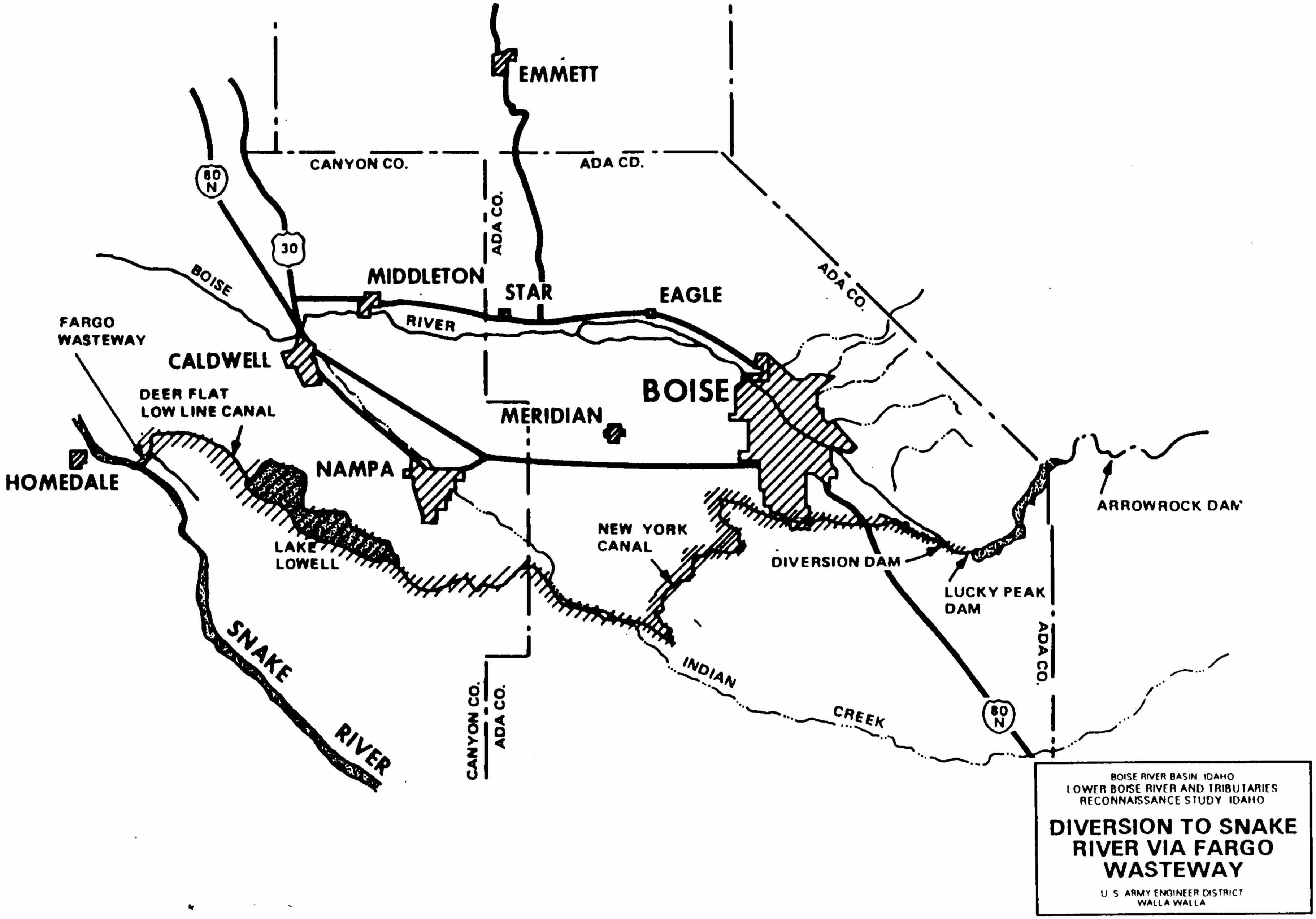
100-YEAR & 500-YEAR FLOODPLAIN LIMITS

U. S. Army Engineer District
Walla Walla - Plan Formulation Branch

Sheet 4 of 4

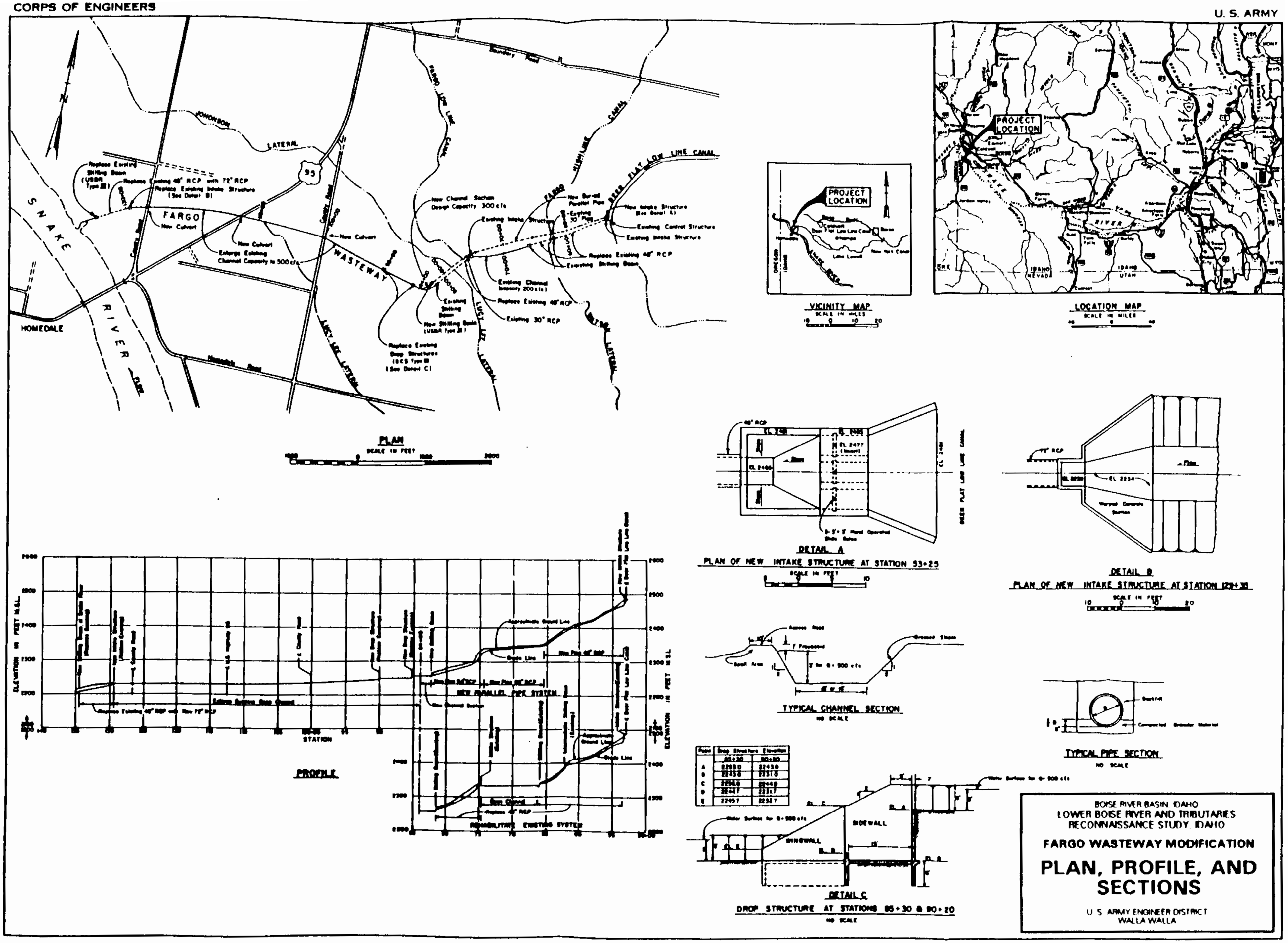
PLATE 4 (Sheet 4 of 4)

PLATE 5


EMMETT
CANYON CO.
ADA CO.
ADA CO.
80 N
30
BOISE
MIDDLETON
STAR
EAGLE
RIVER
ADA CO.
FARGO WASTEWAY
CALDWELL
BOISE
DEER FLAT LOW LINE CANAL
MERIDIAN
HOMEDALE
NAMPA
NEW YORK CANAL
ARROWROCK DAM
LAKE LOWELL
DIVERSION DAM
LUCKY PEAK DAM
SNAKE
INDIAN
ADA CO.
CANYON CO.
ADA CO.
CREEK
80 N
RIVER
BOISE RIVER BASIN, IDAHO
LOWER BOISE RIVER AND TRIBUTARIES
RECONNAISSANCE STUDY IDAHO
DIVERSION TO SNAKE RIVER VIA FARGO WASTEWAY
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA

CORPS OF ENGINEERS

U. S. ARMY



Point	Drop Structure Elevation	
	85+30	90+20
A	22950	22410
B	22430	22310
C	22560	22440
D	22447	22317
E	22457	22347

BOISE RIVER BASIN, IDAHO
LOWER BOISE RIVER AND TRIBUTARIES
RECONNAISSANCE STUDY, IDAHO

FARGO WASTEWAY MODIFICATION

PLAN, PROFILE, AND SECTIONS

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA

PLATE 6

APPENDIX A

PLANNING AID LETTER

PLANNING AID REPORT

LOWER BOISE RIVER BASIN STUDY, IDAHO

PREPARED FOR

U.S. ARMY CORPS OF ENGINNERS
WALLA WALLA DISTRICT

BY

U.S. FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
BOISE, IDAHO

FEBRUARY 24, 1995

I. BACKGROUND AND AUTHORITIES

This Planning Aid Letter was prepared by the Idaho State Office of the U.S. Fish and Wildlife Service (Service) under the authority of the Fish and Wildlife Coordination Act of 1958 (Public Law 85-624), at the request of the U.S. Army Corps of Engineers (Corps). This document contributes biological resource information to the Corps' Lower Boise River and Tributaries Reconnaissance Study (Study). The purpose of the Reconnaissance Study is to identify issues, concerns, and opportunities in the areas of flood control, water quality, and the environemnt. The Study will be used by the Corps to determine whether to proceed from the reconnaissance level on to the feasibility phase of the planning process for the Lower Boise River Basin. Feasibility studies would focus on concerns or problems identified at the Reconnaissance level, and working together with a local cost-sharing partner the Corps would evaluate the implications of implementing solutions.

There are three major storage projects on the Boise River: Anderson Ranch Dam on the South Fork Boise River, and Arrowrock and Lucky Peak Dams on the main Boise River. The primary functions of the Boise River projects are irrigation storage and flood control. The U.S. Bureau of Reclamation (Bureau) and the Corps operate the three Boise River storage projects as a unit and have signed a Memorandum of Agreement giving the Bureau primary responsibility for regulating streamflow releases. Regulation of the projects is a joint effort among the Bureau, Corps, and the Boise River Watermaster (U.S. Army Corps of Engineers 1983). The Corps has the lead responsibility for flood control and the ramping rates associated with high flow events (Rick Wells, pers. comm.). Appendix C shows a diagram of the Boise River diversions and drains below Lucky Peak Reservoir.

The scope of this report is the 64-mile stretch of the Boise River from Lucky Peak Dam in Ada County downstream to its confluence with the Snake River in Canyon County ; the reach is referred to in this report as the Lower Boise River. It also includes limited information about the More's Creek subbasin, which flows into Lucky Peak Reservoir above the dam, and Hull's Gulch subbasin, a tributary in Ada County. This report summarizes existing information about the fish and wildlife resources of the Lower Boise River basin, provides information about factors influencing the condition of those resources, and identifies opportunities for improving fish and wildlife habitat.

II. FISH AND WILDLIFE RESOURCES

A. Fish

Historically, the Boise River supported one of the most valuable fisheries in the region (USDI FWS 1974). Large runs of salmon and steelhead entered the river each year to spawn. Over the past 100 years, aquatic habitat has been altered, eliminating anadromous runs and affecting resident fish species. The anadromous fish were eliminated from the Boise River as a result of a series of water development projects. The first of these projects was Barber Dam, downstream from the present Lucky Peak project, built in 1908. This was followed by the construction of Diversion Dam, Arrowrock Dam, Anderson Ranch Dam, and Lucky Peak Dam. Anadromous runs were eliminated entirely by construction of the three-dam Hell's Canyon complex on the Snake River in the 1960s.

A variety of fish species now occupy the Lower Boise River. The Idaho Department of Fish and Game (Department) stocks hatchery rainbow trout (*Oncorhynchus mykiss*) in the river from Barber Park downstream to Star (Kaltenecker et al. 1994). Hatchery rainbow trout are locally and seasonally abundant, and native rainbow trout and brown trout are uncommon. A strain of native rainbow trout, known as redband trout (*O. mykiss gibbsi*) is a Category 2 (C2) candidate for listing under the Endangered Species Act; they may occur below Lucky Peak dam. Bull trout (*Salvelinus confluentus)* are listed as a C1 species and are known to occur in the More's Creek subbasin. Other game fish species present include mountain whitefish (*Prosopium williamsoni*) and brown trout (*Salmo trutta*). Non-game fish species present include suckers (*Catostomus spp.*), chiselmouth chubs (*Arocheilus alutaceus*), and northern squawfish (*Ptychocheilus oregonensis*). Sampling by the Department has shown that mountain whitefish and nongame fish are most numerous in the Boise River below Barber Dam.

Appendix B includes a complete list of fish species known to occur in the Boise River from Lucky Peak Dam to the mouth.

B. Birds

More than 150 species of birds use habitat associated with the Boise River. Bird species present during the course of a year range from eagles to hummingbirds. This is an important breeding and wintering area for a variety of waterfowl species, including mallard (*Anes platyrhynchos*), Canada goose (*Branta canadensis*), and wood duck (*Aix sponsa*). Some species are year-round residents while others are migratory and present only during part of the year. Many species that nest here, such as the tree swallow (*Tachycineta bicolor*), are neotropical migrants traveling as far south as Central and South America for the winter (Idaho Wildlife 1992). Species like the bald eagle (*Haliaeetus leucocephalus*) occur in the Lower Boise River drainage as winter residents. Other species use it as a stopover during fall migration from as far north as Alaska and the Northwest Territories, en route to areas further south, and then again during spring migration on their return flight to northern breeding grounds.

Several rare and sensitive avian species have been observed within the Boise River drainage downstream of Lucky Peak Dam (IDFG, CDC 1994). The peregrine falcon (*Falco peregrinus anatum*, listed endangered) is known to nest in the Nampa area, and peregrines have been observed along the Boise River and in Hull's Gulch. The trumpeter swan (*Cygnus buccinator*), northern goshawk (*Accipiter gentilis*), and loggerhead shrike (*Lanius ludovicianus*), all candidates for listing under the Endangered Species Act , have been observed in the Lower Boise river drainage (Kirk Bates, pers. comm.). Records show that mountain quail (*Oreortyx pictus*), also a candidate species, may occur in the More's Creek subbasin (IDFG, CDC 1994).

Great blue herons (*Ardea herodias*) commonly occur along the river throughout the year. Herons breed in large communal nesting sites called rookeries. Three rookeries have been identified along the Lower Boise River. One is within Boise city limits, on the South bank near the eastern end of Park Center Boulevard and the Wood Duck Island subdivision (IDFG, CDC 1994). Another is located on Eagle Island, and another near the community of Star (Sather-Blair and Blair 1983).

Appendix II includes a complete list of avian species known to occur in the lower Boise River basin and in the More's Creek subbasin.

Bald Eagle Wintering Population Bald eagles spend winter months along the Lower Boise River. The bald eagle is a Federally listed endangered species. In July 1994, the U.S. Fish and Wildlife Service proposed upgrading the species to threatened throughout much of its range; as of February 1995 no final decision had been made on the proposal. Up to thirty-five individuals are present during winter months along the Lower Boise River. It is not known where these wintering eagles breed, although there are nesting territories in the Boise River drainage: at Lake Lowell in Canyon County and around Anderson Ranch Reservoir on the South Fork of the Boise River. Winter habitat use along the Lower Boise River includes communal night roosting and use of daytime perches for loafing and foraging.

Jensen (1981) was the first to study numbers and distribution of bald eagles wintering along a 30 kilometer (km) stretch of the Boise River from More's Creek Bridge downstream to the Broadway Avenue Bridge. A maximum of twelve eagles were observed during the winter of 1980-1981. Jensen was also the first to observe and document communal roosting by eagles in the Barber Pool area between Diversion Dam and Barber Dam. During the winter of 1982-1983, Reynolds et al. (1985) studied the winter density of bald eagles on the 14 km stretch of the Boise River from the Lucky Peak Dam downstream to Walnut Street in Boise. On thirty-one surveys, 148 sightings of bald eagles were noted, with a maximum of ten eagles seen on any one survey day. Distribution of eagles was not uniform along the river. Eagles were first observed on the river in late November, and numbers peaked in late January and February. As Jensen (1981) had noted five years earlier, Barber Pool was an important communal night roost, as were areas located somewhere within the foothills north of Lucky Peak Dam, possibly near Schooner Gulch or the Robie Creek Drainage.

Spahr (1990) conducted an intensive study of wintering bald eagles along the Lower Boise River during the winters of 1987-1988 and 1988-1989. She studied eagle numbers and distribution, perch locations, foraging habits, and the responses of eagles to human activities. The study area encompassed Boise River habitat between Glenwood Bridge and Lucky Peak Dam. Spahr noted that bald eagles perched throughout the study area, but preferred to perch near river pools in areas of low human development where many suitable perches were available. Predictors of eagle use of a river reach were the number of available perches, the number of commercial buildings, the river habitat type, and the river width. She found that eagles perched in areas where the river was widest and only developed on one side, concluding that these areas provide the widest buffers from human activity. She also concluded that bald eagles were attracted to areas with high numbers of perches because these well-vegetated areas provided a visual buffer from human activity. Spahr speculated that eagles avoided more developed areas because of higher levels of human activity. During both winters of Spahr's study, eagles were first observed along the Boise River in early November with high counts of twenty and twenty-five eagles occurring in late January and early February. By late March, all eagles departed. Approximately 65% of the wintering population was composed of adult eagles. She also documented the importance of the Barber Pool area as a communal night roost. The largest roost count she recorded was on February 8, 1989 when seventeen eagles were observed in the roost area.

In a study conducted for the Boise River Bald Eagle Task Force, Kaltenecker and others observed wintering bald eagles along the Boise River during the winter of 1993 and 1994 (Kaltenecker et al. 1994). They further documented the importance of Barber Pool as a communal night roost, and documented similar patterns of use as past studies. The highest daily count was 28 eagles during the first week of February 1994. The authors of the study noted changes in use of daytime habitat compared to what Spahr observed during winters of 1987 - 1989, potentially associated with residential development that occurred between the times of the two studies.

Bald eagles wintering along the Lower Boise River depend on a variety of fish, birds, and mammals for forage (Spahr 1990, Kaltenecker et al. 1994, Kaltenecker pers. comm.). Spahr noted for the first time the importance of hatchery-released rainbow trout in their diet. They have been observed preying on a variety of other fish, as well, such as: brown trout, mountain whitefish, and rough fish including suckers, chubs, and squawfish. Waterfowl are also taken by bald eagles on the Boise River and Kaltenecker notes that mule deer carcasses are used opportunistically as a food source by bald eagles wintering along the Boise River.

C. Mammals

At least 37 species of mammals are known to occur within the lower Boise River basin, ranging in size from the vagrant shrew (*Sorex vagrans*) to Rocky Mountain elk (*Cervus canadensis*). Some species such as the beaver (*Castor canadensis*), mink (*Mustela vison*), and river otter (*Lutra canadensis*), are directly dependent on the river for food and live in association with the river and side channels. Other species, including striped skunk (*Mephitis mephitis*) and porcupine (*Erithizon dorsatum*) are year-round residents of the riparian forests. Still others, such as mule deer (*Odocoileus hemionus*) are partially or periodically dependent on the river and associated riparian areas for water, shelter, and forage, also using the surrounding farmlands, grass and shrub habitats, including the Boise foothills.

Rare and sensitive mammals known or suspected to occur in the Lower Boise River valley include the spotted bat (*Euderma maculatum*) (Sather-Blair and Blair 1983), and Townsend's big-eared bat (*Plecotus townsendii*), both candidates for Federal listing. In the More's Creek subbasin there have been probable sightings of the gray wolf (*Canis lupus*), listed endangered, and the wolverine (*Gulo gulo luscus*), a C2 species (IDFG CDC 1994).

Appendix B includes a complete list of mammalian species known to occur in the Lower Boise River basin and in the More's Creek subbasin.

D. Reptiles and Amphibians

A variety of species of reptiles and amphibians can be found throughout the Lower Boise River basin (Sather-Blair and Blair 1983). Amphibians are associated with a variety of moist environments, including streams, ponds, and marshes, and the Lower Boise River drainage likely supports a number of species of frogs and toads including bull frog (*Rana cateskeiana*), leopard frog (*Rana pipiens*) and Western toad (*Bufo boreas*). Reptiles known or suspected to occur along the Lower Boise River include Western garter snake (*Thamnophis elegans*), common garter snake (*Thamnophis sitalis*), sagebrush lizard (*Sceloporus graciosus*) and Western fence lizard (*Sceloporus occidentalis*).

Appendix B includes a complete list of reptile and amphibian species known to occur in the lower Boise River basin and in the More's Creek subbasin.

E. Vegetative Communities

The typical, and historic, vegetative community adjacent to the Lower Boise River is black cottonwood (*Populus trichocarpa*) forest (Kaltenecker et al. 1994). Many areas of the black cottonwood forest are classified by the Service's National Wetlands Inventory (Cowardin 1979) as palustrine forested wetlands, other areas are classified as forested uplands. Functions and values provided by palustrine, forested wetlands include: ground water recharge, ground water discharge, flood storage, reduced flood peaks, increased flow duration, shoreline anchoring, sediment trapping, nutrient retention and removal, food chain support, habitat for fish and wildlife, and active and passive human recreation (Sather and Smith 1984). Alder (*Alnus* spp.), willow (*Salix* spp.), birch (*Betula* spp.), hawthorn (*Crataegus* spp.), and other shrub species commonly dominate the understory of the black cottonwood forest. Russian olive (*Elaeagnus angustifolia*) are locally abundant and silver maple (*Acer saccharinum*) are occasionally observed. The Lower Boise River riparian community also includes temporarily and seasonally flooded emergent wetlands, typically vegetated with sedges (*Carex* spp.), rush (*Juncus* spp.), spikerush (*Eleocharis* spp.), cattail (*Typha* spp.), and bulrush (*Scirpus* spp.) (Tiedemann 1994b).

Much of the Boise River riparian zone has been significantly altered by human activity, and is dominated by non-native, weedy species or has been converted to landscaping. The introduction of exotic, weedy plant species has altered vegetative communities of the riparian area. Non-native plants often outcompete native species because they lack natural controls, and the changed character of the plant community often adversely affects native fish and wildlife species. In some areas along the Lower Boise River, non-native plants have replaced the native flora. Exotics presently causing concern are Russian olive, reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicaria*), and false indigo (*Amorpha fruticosa*) (Brown 1990).

Appendix B includes a complete list of tree, shrub, and other plant species found within the Lower Boise River basin.

F. Fish and Wildlife Resources of the Tributaries

Seven adjacent dry-gulch tributaries in the Boise Front Range drain through narrow canyons onto alluvial fans and then into the Boise River from the north. Most of these tributary streams supported trout populations before the 1920s, but are now intermittent streams (Sather-Blair and Blair 1983). Water from tributary streams is diverted for domestic and agricultural use. Residential development has occurred within and around most of the gulches, and all of the alluvial fans have been developed. Three rare plant species are found in the Boise Front Range: Aase's onion (*Allium aaseae*), Mulford's milkvetch (*Astragalus mulfordiae*), and slick-spot peppergrass (*Lepidium papilliferum*) (Moseley et al. 1992).

Hulls Gulch, which terminates north of Eighth Street in the city of Boise, was subject of a biological assessment by the Service in 1989 (USDI-FWS 1989). The Service completed an inventory of the major vegetative cover types of the privately owned lower portion of the drainage, and delineated 6.7 hectares of wetlands. The report described a relatively rich avifauna and cataloged other vertebrate species of the area (see Appendix B). Since the time of that report, a portion of Lower Hull's Gulch has been purchased by the Audubon Society for preservation, and the remainder has or will be developed for residential housing. The upper portion of the drainage is Bureau of Land Management property managed for recreation and livestock grazing.

More's Creek flows into Luck Peak Reservoir, just upstream of the area discussed in this report. A portion of the More's Creek drainage is impounded by the Lucky Peak Project. Appendix B includes a list of animal species known or suspected to occur in the More's Creek drainage, as well as a list of plant community associations that have been identified there. While More's Creek is upstream of the study area, this information is being provided because it may be representative of the upper reaches of other side drainages in the Lower Boise River. Additionally, because the drainage has had some effects from the Corps project, it might be appropriate to consider it among mitigation opportunities.

III. PRESENT CONDITIONS AND FUTURE DEMAND TRENDS

Human presence in the Lower Boise River valley during the last 150 years has significantly altered fish and wildlife habitat. Operation and construction of the Boise River storage projects is one of a number of human activities that has reduced the quality and quantity of aquatic and terrestrial habitat associated with the river and its tributaries. Flow timing and volumes have been regulated by the storage projects, and much of the river's water is diverted for agriculture, resulting in changed quality and quantity of the aquatic resource. Development, in the form of residential, public, and commercial structures, as well as facilities for transportation and recreation have converted much habitat to human use. The river's floodplain has been altered and constricted by both development and dikes and levees constructed for flood protection. Vegetative communities have been converted to agricultural use, and other areas have been invaded by non-native plants. The net result of these human activities is a reduction in the amount and quality of habitat available to native fish and wildlife.

A. Effects of Flow Regulation

Flows in the Lower Boise River differ significantly from what occurred before human alteration of the river. Operation of the Lucky Peak Project and the other two upstream dams involves regulating the timing and rate of flows, and high flows occur with far less frequency than they did historically. Flows are further influenced by numerous diversions of water from the river for agriculture and other human uses. The effect of flow regulation is the elimination or near elimination of channel-flushing flows and movement of streambed material. The dams and diversion structures preclude movement of bed material downstream. Additionally, with reduced and regulated flows islands and riparian areas do not experience scouring floods, and side channels have been reduced in extent or dewatered entirely.

Aquatic Habitat From a fishery perspective, flow is key to determining the quantity and suitability of fish habitat. Water temperature and chemical integrity, well-vegetated stream banks and islands, relatively stable water flow, instream cover, and clean gravel substrate are essential components of healthy fish-bearing streams. Side channels are important for trout rearing and spawning habitat (Sather and Smith 1984). All of these habitat components have been affected by flow regulation in the Lower Boise River. Lower streamflows during spring and summer months can affect water quality, including increasing temperatures. Reduced flows and inadequate scouring of banks and islands leads to reduced plant growth. This results in less available hiding cover for fish, reduced shading leads to increased water temperature, and amounts of organic matter input are diminished. Eliminating or reducing flushing flows results in increased cobble embeddedness and precludes periodic movement of sediment and debris out of the stream system. Lower overall flows result in diminished side channel habitat, and therefore reduces the amount of spawning and rearing habitat for cold water fish species. Finally, dams and diversion structures represent physical barriers for movement of fish, which isolates populations and prevents recruitment from other parts of the drainage. The overall result of flow alteration, from a fishery perspective, is diminished suitability of the river for self-sustaining cold water fish populations (IDFG 1988, City of Boise and CH2M Hill 1992).

Riparian Plant Communities Flow regulation has significantly altered plant communities on islands, river banks, and along side channels. Black cottonwood communities historically predominated in the Boise River floodplain, interspersed with emergent wetlands and higher elevation uplands (see the description in Section II.E., above). Throughout much of the Lower Boise River drainage, the black cottonwood community persists only in very narrow bands, in the area between average high flows and dikes, levees, or other confining structures. In general, these areas are extremely narrow with steep banks and limited understory, and they provide very limited habitat value. Extent, quality, and long-term health of the riparian plant communities of the Lower Boise River have been diminished because high flow events have been greatly attenuated by operation of the three upstream storage projects, and because dikes and levees have constricted the floodplain.

High flow channels historically contributed to the diversity of habitat in the floodplain and increased the amount of edge habitat between the aquatic community and adjacent upland areas. These "ecotones" between different habitats provide for higher wildlife diversity and density (Odum 1971). Reduced frequency and intensity of flood flows has reduced and eliminated flow into side channels. Dikes and levees have restricted flood flows to the main river channel, isolating side channels from river flows and effectively drying them (Stacy 1993). As a result, plant communities dependent upon periodic wet conditions and scouring of the substrate have been eliminated or significantly reduced. Wetland functions and values have been eliminated from much of the floodplain and the amount of available habitat is greatly decreased (Tiedemann 1994b).

Cottonwoods and associated plant species evolved in an environment with periodic floodflows that scoured and saturated streambank and island soils. Prior to flow regulation, the Boise River periodically flooded large areas adjacent to the river channel. These flood events promoted development and maintenance of the riparian plant communities by scouring and exposing soils in the floodplain, and moving cobbles and sands to develop new islands and bars in the river (Findorff and Reichmuth 1991). These flood flows also created hydrologic conditions to which native species have adapted: saturation of exposed soils, followed by a gradually receding water level. Exposed soils were thus successfully colonized by cottonwood. Older, larger trees were generally able to withstand flood flows, resulting in forests with mixed age classes. Other riparian plants species associated with native black cottonwood communities (willow, birch, hawthorn) are all maintained and regenerated within this natural hydrologic regime.

Operation of three storage projects on the Boise River has moderated flood events to the degree that the system no longer creates an environment promoting regeneration of the riparian forest. Black cottonwood seeds are extremely small, are wind- or water-borne, and germination requires the wet, scoured surfaces provided by high flows. In the absence of natural flood flows, seeds from black cottonwood trees generally do not encounter suitable conditions for their germination and maturation. Thus, sexual reproduction is reduced or precluded (Tiedemann 1994b, Kaltenecker et al. 1994). Black cottonwood trees do reproduce vegetatively by sprouting from their bases, but vegetatively-produced progeny tend to be less vigorous and may not grow to be as large as sexually produced trees (Tiedemann pers. comm.).

The long term viability of the native riparian plant community is threatened by the absence of the periodic floodflows. Sexual reproduction and the associated evolution and migration of adaptive characteristics are absolute requirements for the long term survival of communities and of species (Rittenhouse 1993). In the long term, failure to reproduce sexually will result in reduced capability to withstand changes in the environment such as insect infestations, microbial diseases, and competition from invading species. In the near term, habitat value of the riparian area is compromised where older age class trees are not being replaced by vigorous, sexually-produced progeny. This is a significant issue for perching birds including bald eagles, and for all species dependent on the black cottonwood forest for hiding and thermal cover.

B. Effects of Past Development in and Adjacent to the Floodplain

Both the mainstem Lower Boise River and its tributaries have been significantly affected by development. Conversion of lands to residential, commercial, public, and agricultural uses have had the effect of constricting the floodplain and limiting availability of lands for other uses. Virtually all of the alluvial fans at the downstream extremes of the side drainages have been converted to human use. Much of the historic riparian habitat has been eliminated, and in most places remaining available habitat exists only in narrow bands along the channels, adjacent to areas of human activity. In addition, because of the risk of damage to property in the flood fringe, there are limits to the options for release of flows from the upstream storage projects. In the tributary drainages, flood events are likely to result in property damage, both from flows of water and from movement of sediment and debris out of the gulches into the valley.

C. Water Quality

Water quality in the Lower Boise River has been adversely affected by various point and non-point sources of pollution. Among activities affecting water quality are irrigated agriculture, livestock grazing, urban runoff, and municipal and industrial point source discharges. Flow regulation has affected the capacity for dilution and flushing of pollutants, including sediment. The State of Idaho identified sediments as causing water quality problems in the Lower Boise River (IDHW-DEQ 1988). Sediment sources include irrigation return water, urban stormwater runoff, construction site erosion, cropland runoff, livestock operations, streambank erosion, and municipal and industrial effluent (CH2M Hill 1992). The waste treatment facilities operated by the City of Boise contribute nutrients to the waters of the Boise River (IDFG 1988). Two river reaches, Star to Notus and Notus to the Snake River are listed as water quality limited because of a failure to meet water quality standards for nutrients, sediment, bacteria, and temperature (IDHW, DEQ, Idaho Water Quality Status Report 1994). Changes in the quality of water in the river has limited its suitability for supporting designated beneficial uses, including cold water biota.

D. Future Development Trends

Projections of future growth in Ada and Canyon Counties anticipate a continuing high rate of population increase. Continued population growth will result in increased pressure and impacts on the Lower Boise River system from development, more public use for recreation, additional sources of pollutants, and changes in land and water use.

Much of the as-yet undeveloped land adjacent to the Lower Boise River is privately owned. Properties near the river are extremely desirable for residential and commercial development. Given this, continued development in and adjacent to the floodplain can reasonably be expected. This will further decrease the quality and quantity of riparian aquatic habitat. Continued development will also increase the numbers and value of properties vulnerable to damage from a flood events, further limiting options for operation of the Boise River storage projects. Water quality will potentially be compromised by new, additional point- and non-point sources. Indirect effects of continued development include increased disturbance of wildlife in remaining habitat, from occupants of adjacent habitat and from generally increasing recreational use of the river.

Development will also continue in areas that are not immediately adjacent to the river, and that development also has potential to adversely affect values associated with the Lower Boise River and its tributaries. New development eliminates upland habitats, affecting wildlife species that are associated with multiple communities. Population increases associated with this development increase recreational pressure on the river. Associated with all new development are potential contributions of non-point source pollutants, and the risk of depleting groundwater within the aquifer. Further, building in the foothills and on benches along the river can affect amounts and timing of surface runoff, leading to accelerated erosion and movement of pollutants.

Several transportation projects are proposed for the Boise River corridor. The Idaho Department of Transportation has the approval to build a bridge over the Boise River to connect Interstate 84 with State Highway 21, crossing the Boise upstream of Barber Pool, immediately below the Diversion Dam. Two other crossings over the Boise River have been proposed, one at the west end and one at the east end of Park Center Boulevard in the City of Boise. Ada County Highway District is conducting a "Bench to Valley" transportation study that includes consideration of a new bridge crossing the somewhere in the western part half of Ada County. Bridges represent a structural interruption of riparian habitat and can affect wildlife movement along the corridor. In addition, with the exception of the West Park Center crossing, all the proposed bridges are very likely to facilitate increased, accelerated development of property that is presently undeveloped.

Idaho Department of Parks and Recreation is developing a general development plan to better define Eagle Island State Park's purpose. The park is currently self-supporting through revenues from grazing and a recreational water slide on the site. Options for the future involve a campground, a racetrack, equestrian trails, a golf course, an urban refuge area, Greenbelt expansion and bald eagle/ bird sanctuary (Frank Boteler, pers. comm.). Decisions about management of this area could either adversely or beneficially affect fish and wildlife habitat, depending on the outcome of the planning process.

Efforts by State and Federal agencies may result in improvement of water quality in the Lower Boise River. The Lower Boise River Water Quality Plan, released in November 1992 by the City of Boise and CH2M Hill, puts forward a long term plan to maintain water quality and address environmental concerns. The U. S. Geologic Survey (USGS) is conducting water quality monitoring in the lower reach of the river, with a long-term objective of developing plans for reducing inflow of pollutants into the reach (William Mullins, USGS, pers. comm.). In cooperation with the USGS, Idaho Department of Health and Welfare's Division of Environmental Quality (DEQ) is conducting a Boise-Meridian Impact Area Study focusing on the Boise City and urban planning area. The work involves analysis of hydrogeological conditions, ground water quality, and historic and current land and water use practices, along with investigation of the nature, extent and movement of contaminants into the system (IDHW-DEQ 1994). If these efforts are carried through, there is reason to expect that water quality conditions could improve.

IV. DATA GAPS AND RESEARCH NEEDS

There are few reports of descriptive or quantitative studies of fish and wildlife resources of the Lower Boise River. Except for bald eagles and some game fish, no population data are available for fish and wildlife resources of the area. Most fish and wildlife assessment work has been confined to the Boise City urban area, associated with transportation and urban development proposals. Most of these reports are descriptive rather than quantitative or analytic. Condition and use of fish and wildlife habitat from Eagle Island downstream has not been described or evaluated. In assembling information for this report, the Service noted that there is no site-specific information about fish and wildlife and their habitats in Canyon County. For the entire Lower Boise River area, there is no quantitative information about types and amounts of fish and wildlife habitat.

Mapping The Service advocates a comprehensive assessment of the extent and condition of riparian and aquatic habitats associated with the river and side drainages throughout the study area. The first step toward meeting this objective should be development of maps of existing riparian and riverine habitat using the Corps' most recent existing aerial photography for the Lower Boise River drainage. Other existing resources that should be employed are National Wetland Inventory maps and Ada and Canyon County soil survey maps, as well as Natural Resource Conservation Service land use maps. Maps developed should include identification of habitat types, an initial assessment of the quality of habitat, and ownership of lands with existing or potential value for fish and wildlife. This reconnaissance-level effort is an essential first step in developing a comprehensive description of existing habitat and would provide a basis for prioritizing more detailed study. To be most useful, this information should be incorporated into a Geographic Information System, along with data suggested below under Aquatic Resources, Wildlife, Wintering Bald Eagles, and Vegetative Communities.

Aquatic Resources There is limited information about status and distribution of game and non-game fish of the Lower Boise River. Fish survey work for the entire reach would be useful for understanding existing and potential aquatic habitat resources of the Lower Boise River. Ideally, this work should be coupled with ongoing water quality assessment work being conducted by other State and Federal agencies. Surveys of benthic macroinvertebrates, periphyton (attached algae), and aquatic macrophytes should be considered to evaluate the food chain and cycling of nutrients by the stream biota. These lower organisms are excellent riverine health indicators. Ideally, annual monitoring should follow an initial inventory to provide trend information about the Boise River's biological health. Fish spawning studies (e.g., intragravel dissolved oxygen, cobble embeddedness, measurement of substrate composition, and use of artificial substrates) would be warranted (City of Boise and CH2M Hill 1992).

We strongly recommend an Instream Flow Incremental Methodology (IFIM) study be conducted to provide information about structure and distribution of aquatic habitat in the Lower Boise river. Results would provide a basis for determining appropriate streamflow for protection and enhancement of fish and wildlife habitat and aquatic life.

Wildlife Survey work should be completed for several categories of fish and wildlife resources throughout the Lower Boise River drainage. Surveys should be conducted to estimate density and distribution of birds--including waterfowl, songbirds, and raptors-- large and small mammals, reptiles, and amphibians. These studies should encompass all seasons of the year in order to identify seasonal use and distribution of wildlife. Work could be prioritized by identifying indicator species for each of the major habitat types associated with the Lower Boise River. The Service's Habitat Evaluation Procedure (HEP) is a valuable tool for quantifying wildlife habitat resources. We recommend identifying key habitats and employing HEP to evaluate the quality and extent of habitat resources associated with the Lower Boise River.

Wintering Bald Eagles There is ongoing monitoring of wintering bald eagle use of the Boise River from Lucky Peak Dam to Eagle Island. Work in the Boise urban area has been facilitated by accessibility to the river from roadways and recreational pathways. Downstream of the eastern extreme of Eagle Island, most surveys have been conducted from fixed wing aircraft, and there is some indication that these aerial surveys underestimate numbers of birds using this part of the river. Downstream of Eagle Island, only occasional survey work has been done. The Service suggests that more intensive work would provide useful information about use by wintering bald eagles and the potential for expanded distribution.

Bald eagle use of the communal roost in the Barber Pool area should be monitored before, during, and after construction of the I-84 State Highway 21 bridge and the Surprise Valley development. Monitoring should continue for at least five winter seasons after the bridge and development are completed in order to detect lag responses caused by secondary effects from the projects. In addition, there is evidence that wintering eagles that use the Boise river during the daytime may roost upstream of Barber Pool. Work should be conducted to determine locations of these additional roosting areas.

More extensive work could be done to provide detailed information about the Boise River wintering bald eagle population. Additional information could be useful for providing an understanding of the potential numbers of wintering populations and the factors outside the Boise

River drainage that influence numbers of birds that winter here. Little is known about where these wintering birds breed. Also, wintertime movements of these birds have not been determined; age distribution studies indicate that many wintering eagles may commute in and out of the area through the winter. Marking studies and radio-telemetry studies would be appropriate ways to develop this information.

Plant Communities The Service has completed National Wetland Inventory maps of the Lower Boise River based primarily on aerial photography and some ground truthing. Small portions of the riparian plant communities of the study area have been inventoried for specific projects. Complete mapping is needed to characterize the vegetative communities adjacent to the river and in undeveloped portions of the side drainages. This work should identify major cover types, verify wetland status, and evaluate community condition with respect to habitat quality and presence of invasive exotic plants. Vegetative community mapping should be closely tied to work suggested under "Wildlife" above.

V. RECOMMENDATIONS

The Service has identified a number of opportunities for restoration, enhancement, and protection of fish and wildlife resources of the Lower Boise River. Our recommendations are based on present understanding of the fish and wildlife resources of the project area; these opportunities should be revisited after completion of studies evaluating the present status of those resources. Further, none of the suggested actions is mutually exclusive; there is considerable overlap among the actions proposed below. Work undertaken to improve riparian habitat will positively affect aquatic habitat, for instance. Likewise, efforts to improve the black cottonwood community will benefit wintering bald eagles. A comprehensive approach to habitat restoration might include both aquatic and riparian components.

We recommend that any habitat improvement or protection project undertaken as a result of this study include a public education component. The Corps should work together with other agencies to develop a program to inform the public about the rationales for any mitigation work undertaken, and the benefits that are expected from the work.

A. Riparian Habitat Mitigation

Issue: Riparian habitat associated with the Lower Boise River has been eliminated and degraded through human development and management of flows. Actions by the Corps of Engineers that have directly affected riparian habitat include management of flows from the three upstream dam projects and construction of dikes and levees for flood protection. Much of the habitat loss is irretrievable, but there are opportunities to increase the value of existing habitat and to protect remaining riparian areas from further degradation.

Scope: Ideally, all remaining riparian habitat from Lucky Peak Dam to the mouth of the Boise River should be protected from degradation and loss. The most aggressive approach to this issue would be to seek protection and enhancement of all riparian areas that have not been permanently converted to other uses. Alternatively, work could be focused on a specific site or sites identified as important for fish and wildlife, or with high potential for restoration and protection of riparian functions and values. Between these two approaches are a range of opportunities. For instance, the Corps could identify and focus on public land available for protection and enhancement, or public and private properties could be selected to provide a continuous corridor of habitat along the Lower Boise River. Because site-specific information about the present condition of riparian habitat throughout the drainage is incomplete, it is not possible to provide a complete list of potential sites. Decisions about where to implement remedial work should be based on results of studies identified in the previous section. Two sites that have been identified at this time are the area between Diversion and Barber Dams and Eagle Island State Park.

Actions: One or a combination of the following approaches would result in protection, restoration, and/or enhancement of riparian habitat along the Lower Boise River.

- **Manage releases from Lucky Peak to provide periodic flows adequate for flushing and scouring of banks, islands, and side channels.** Flows should be of sufficient volume to provide water to side channels and to scour banks and bars, and timing of flows and ramping should provide the hydric conditions necessary for regeneration of the black cottonwoods and maintenance of associated plants in the riparian community. Flushing flows should be of sufficient frequency to promote maintenance of a diverse-age cottonwood forest. Analysis of this option should include determination of potential effects on property and development of a plan to mitigate for those impacts.

- **Restore and enhance riparian plant communities that are presently degraded.** A variety of restoration actions should be employed singly and in combination, tailored to the needs and constraints of specific sites. Hydrology could be restored to areas that have been dewatered because of flow management or construction of dikes and levees. Examples of hydrologic work include reactivating side channels by removing barriers or restoring site contours, diversion or impoundment of water in specific areas like the Barber Pool. Aggressive removal of exotic species should be pursued in locations where those plants are outcompeting native species. Planting programs should be considered where communities have been degraded because of human activities, including flow alteration. Particularly in the event that flow-related solutions are precluded, then intentional planting of black cottonwood should be employed to ensure long-term viability of these communities. Only native species should be used, and monitoring programs should be implemented to assure success of planting efforts.

- **Protect remaining riparian habitat from elimination and degradation from conversion to human use.** Two general strategies, used singly or in combination, should be considered. First, secure property that is privately owned with potential for development. Property could be purchased outright from landowners and managed by a public or private entity. Alternatively, protective easements could be acquired from willing landowners, and protection of those properties overseen by a public or private agency. Second, appropriate public properties should be managed for specific fish and wildlife habitat values. A comprehensive management plan should be developed for all secured riparian lands, focusing on providing for continuity and linkage among riparian habitat areas through the drainage. The plan should emphasize fish and wildlife values and provide for other, compatible uses.

B. Aquatic Habitat Mitigation

Issue: A number of human-related factors have degraded aquatic resources in the Lower Boise River. Among those factors is flow regulation from the three upriver storage projects. Effects of this regulation include reduced flow volume and duration, the failure to move sediment and debris out of the system, and diminished water quality related to lower flows. The dams themselves preclude migration of fish and movement of organic material downstream. A variety of other human-caused problems combined with these effects from operation of the Boise River storage projects have resulted in degraded habitat quality and changes in fish populations in the river. Few self-sustaining cold water fish populations remain in the Lower Boise River. Warm water species have replaced the native resident species. Physical components of the system appear to have been degraded: shading and cover from riparian vegetation have been reduced, cobble embeddedness has increased, and side channel habitat has been reduced or eliminated.

Scope: The scope of aquatic and fishery enhancement and restoration work should be determined based on quantitative studies of important components of the aquatic ecosystem. Based on existing information, the aquatic system from the community of Star downstream to the mouth of the river is the most degraded. However, opportunities for enhancement exist throughout the drainage.

Actions: A number of management actions could be undertaken to improve aquatic habitat throughout the Lower Boise River. Several agencies are presently involved with projects aimed at improving water quality (see Section III.D.); any effort by the Corps to remediate for aquatic habitat problems should be planned and carried out in cooperation with those agencies. One or more of the following actions should be considered to contribute to restoration of the aquatic ecosystem.

- **Provide flows to contribute to improvement of water quality and aquatic habitat.** Minimum flow needs should be determined through a combination of investigations, including IFIM, to achieve aquatic habitat objectives for structure and water quality. Appropriate levels and schedules of flow releases should be determined to help achieve water quality objectives, and to move sediment and pollutants downstream.

- **Manage instream woody debris to achieve an appropriate balance between fish cover needs, organic input, and sufficient movement of sediments out of the system.**

- **Remediate the effects of reduced flows and resulting reduced dilution and flushing capacity, by improving the quality of water returning to the Boise River via drains and tributaries.** Point and non-point pollution sources should be identified along with opportunities to improve the quality of water flowing into the river. One option for return flow treatment is the development of wetlands and other vegetative communities where solids can settle out of water before it flows into the Boise River. Some wetlands provide treatment by removing contaminants from return flows before they reach the river.

C. Wintering Bald Eagle Mitigation

Issue: Loss of habitat and human disturbance may limit the Lower Boise River's carrying capacity for wintering bald eagles. Numbers of wintering eagles in the Boise Valley have not increased at the same rate as numbers of breeding eagles in the Northwest. Cumulative effects of development activities has been identified as a concern for continued recovery of the species. Management of the three Boise River storage projects affects wintering eagles in several ways. The Barber Pool roosting area has been identified as critically important to the population; the vegetative community there has been degraded by reduced flows and less frequent flooding. Long-term viability of the roost may be in question. Likewise, degradation and loss of riparian habitat has reduced the number and quality of daytime perch sites for bald eagles. Finally, water quality changes that affect bald eagles when fish abundance and availability are limited.

Scope: At this time, information about the Boise River wintering eagle population is confined to the reach between Lucky Peak Dam and Eagle Island. Based on that information, eagle management work would be confined to the same area. However, there is anecdotal and historical information about eagles occurring along the Boise downstream from eagle island to the mouth. The Service suggests further investigations to determine whether, and to what extent, eagles use the river downstream of Eagle Island, and that work be completed to determine whether there is potential for expansion downstream.

Actions: A number of management actions could be undertaken to improve and protect the area's wintering eagle population.

- **Develop a comprehensive management plan for the Barber Pool night roosting area.** The plan should protect the roost site from disturbance by humans and assure the long-term viability of the black cottonwood community there. This plan should be developed and implemented in cooperation with the Idaho Department of Parks and Recreation, which manages most of the land in the Barber Pool area. Because of hydrologic changes there, regeneration of black cottonwoods and associated plants has been severely affected. Opportunities for restoration of hydrology through impoundment of water or increased flows should be considered. Further, active revegetation of the site is needed. Planting of black cottonwoods should be undertaken as well as establishing understory vegetation that provides visual screening from disturbance. Undeveloped property in and near the pool, including land on benches above the river, should be protected from development that has the potential to disturb roosting eagles.

- **Enhance and protect daytime bald eagle perching sites.** Important components of day perch sites are availability of large trees and buffers from human disturbance--generally a combination of distance from buildings and roadways and the presence of understory vegetative cover. Large perch trees should be protected from, and management of the black cottonwood forest should be undertaken to assure long-term availability of perch trees. Perch sites can be enhanced or, potentially, created by establishing understory vegetation that serves as a visual buffer from human activity. Relatively large, contiguous blocks of riparian habitat should be preserved.

- **Develop a plan to maintain a sufficient and diverse source of prey for wintering bald eagles.** Fish appear to be a primary food item, so efforts should be undertaken to assure protection of this resource. Restoration of the fishery downstream of Star may increase the suitability of the lower reach of the river for wintering eagles. Other prey, particularly waterfowl, depend on both the aquatic and riparian components of the Lower Boise River, and these resources should be managed to protect waterfowl and other wildlife.

VI. REPORT AUTHORS

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APPENDICES

APPENDIX A
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APPENDIX B
SPECIES LISTS

LISTED AND PROPOSED ENDANGERED
AND THREATENED SPECIES AND CANDIDATE SPECIES,
THAT OCCUR WITHIN THE LOWER BOISE RIVER BASIN

DATE: February 22, 1995
PROJECT NAME: LOWER BOISE RIVER BASIN
SPECIES LIST NO. FWS 1-4-95-SP-38

LISTED SPECIES	**COMMENTS/LOCATION INFORMATION**
Bald eagle (LE) (Haliaeetus leucocephalus)	Wintering area
Peregrine falcon (LE) (Falco peregrinus anatum)	
CANDIDATE SPECIES	
Interior redband trout (C2) (Oncorhynchus mykiss sp.)	Immediately downstream of Lucky Peak
Townsend big-eared bat (C2) (Plecotus townsendii)	Collected in Boise
Northern goshawk (C2) (Accipiter gentilis)	
Aase's onion (C1) (Allium aaseae)	Boise area
Mulford's milkvetch (C1) (Astragalus mulfordiae)	Boise area
Slick spot peppergrass (C1) (Lepidium papilliferum)	Boise area

Source: Idaho Department of Fish and Game - Conservation Data Center

ANIMAL AND PLANT SPECIES THAT OCCUR ALONG THE BOISE RIVER

Mammals

Vagrant shrew
(Sorex vagrans)

Merriam's shrew
(Sorex merriami)

Little brown bat
(Myotis lucifugus)

Yuma brown bat
(Myotis yumanensis)

Long-eared brown bat
(Myotis evotis)

California brown bat
(Myotis californicus)

Silver-haired bat
(Lasionycteris noctivagans)

Big brown bat
(Eptesicus fuscus)

Hoary bat
(Lasiurus cinereus)

Spotted bat
(Euderma maculatum)

Nuttall's cottontail
(Sylvilagus nuttallii)

Black-tailed jackrabbit
(Lepus californicus)

Yellow-bellied marmot
(Marmota flaviventris)

Townsend's ground squirrel
(Spermophilus townsendii)

Fox squirrel
(Sciurus niger)

Townsend's pocket gopher
(Thomomys townsendii)

Northern pocket gopher
(Thomomys talpoides)

Beaver
(Castor canadensis)

Deer mouse
(Peromyscus maiculatus)

Montane meadow mouse
(Microtus montanus)

Long-tailed meadow mouse
(Microtus longicaudus)

Muskrat
(Ondatra zibethicus)

Norway rat
(Rattus norvegicus)

House mouse
(Mus musculus)

Porcupine
(Erethizon dorsatum)

Coyote
(Canis latrans)

Red Fox
(Vulpes fulva)

Raccoon
(Procyon lotor)

Shorttail weasel
(Mustela erminea)

Longtail weasel
(Mustela frenata)

Mink
(Mustela vison)

Badger
(Taxidea taxus)

Striped skunk
(Mephitis mephitis)

River otter
(Lutra canadensis)

Mule deer
(Odocoileus hemionus)

Bobcat
(Lynx rufous)

Rocky Mountain elk
(Cervus Canadensis)

(Continued)
Source: Sather-Blair and Blair 1983.

Aniamls and Plants of the Lower Boise River, continued.

Birds

Violet-green swallow
(Tachycineata thalassina)

Tree swallow
(Tachycinata bicolor)

Bank swallow
(Riparia riparia)

Northern rough-winged swallow
(Steligidopteryx serripennis)

Cliff swallow
(Hirunda pyrrhonota)

Black-billed magpie
(Pica pica)

Clark's nutcracker
(Nucifraga columbiana)

Common raven
(Corvus corax)

American crow
(Corvus brachyrhynchos)

Black-capped chickadee
(Parus atricapillus)

Mountain chickadee
(Parus gambeli)

Dipper
(Cinclus mexicanus)

White-breasted nuthatch
(Sitta carolinensis)

Red-breasted nuthatch
(Sitta canadensis)

Brown creeper
(Certhia americana)

House wren
(Troglodytes sedon)

Marsh wren
(Cistothorus palustris)

American robin
(Turdus migratorius)

Townsend's solitaire
(Myadestes townsendi)

Hermit thrush
(Catharus guttatus)

Swainson's thrush
(Catharus ustulatus)

Mountain bluebird
(Sialia currucoides)

Golden-crowned kinglet
(Regulus satrapa)

Ruby-crowned kinglet
(Regulus calendula)

Blue-gray gnatcatcher
(Polioptila caerulea)

Bohemian waxwing
(Bombycilla garrulus)

Cedar waxwing
(Bombycilla cedrorum)

Northern shrike
(Lanius excubitor)

Loggerhead shrike
(Lanius ludovicianus)

European starling
(Sturnus vulgaris)

Solitary vireo
(Vireo solitarius)

Warbling vireo
(Vireo gilvus)

Black and white warbler
(Dendroica nigrescenns)

Orange-crowned warbler
(Vermivora celleta)

Yellow warbler
(Dendroica coronata)

Yellow-rumped warbler
(Dendroica coronata)

Yellowthroat
(Geothlypis trichas)

Yellow-breasted chat
(Icteria virens)

McGillivray's warbler
(Oporornis tolmiei)

Wilson's warbler
(Wilsonia pusilla)

Nashville warbler
(Vermivora ruficapilla)

House sparrow
(Passer domesticus)

Western meadowlark
(Sturnella neglecta)

Yellow-headed blackbird
(Xanthocephalus xanthocephalus)

Red-winged blackbird
(Agelaius phoeniceus)

Brewer's blackbird
(Euphagus cyanocephalus)

Brown-headed cowbird
(Molothrus ater)

Northern oriole
(Icterus galbula)

(Continued)
Source: Sather-Blair and Blair 1983. B3

Aniamls and Plants of the Lower Boise River, continued.

Western tanager

(Piranga ludoviciana)

Black-headed grosbeak
(Pheucticus melanocephalus)

Evening grosbeak
(Coccothraustes vespertinus)

Lazuli bunting
(Passerina amoena)

Cassin's finch
(Carpodacus cassinii)

House finch
(Carpodacus mexicanus)

Pine siskin
(Carduelis pinus)

American goldfinch
(Carduelis tristis)

Green-tailed towhee
(Pipilo chlorurus)

Rufous-sided towhee
(Pipilo erythrophthalmuis)

Savannah sparrow
(Passerculus sandwichensis)

Lark sparrow
(Chondestes grammacus)

Dark-eyed junco
(Junco hyemalis)

Chipping sparrow
(Spizella arborea)

Song sparrow
(Melospiza melodia)

White-crowned sparrow
(Zonotrichia leucophrys)

Common loon

(Gavia immer)

Eared grebe
(Podiceps nigricollis)

Western grebe
(Aechmophorus occidentalis)

Pied-billed grebe
(Podilymbus podiceps)

Double-crested cormorant
(Phalacocorax auritus)

Tundra swan
(Oolor buccinator)

Canada goose
(Branta canadensis)

Mallard
(Anes platyrhynochos)

Pintail
(Anas acuta)

American wigeon
(Anas americanus)

Cinnamon teal
(Anes cyanoptera)

Green-winged teal
(Anas crecca)

Wood duck
(Aix sponsa)

Redhead
(Aythya americana)

Canvasback
(Aythya valisinneria)

Lesser scaup
(Aythya affinis)

Common goldeneye

(Continued)
Source: Sather-Blair and Blair 1983. B4

Aniamls and Plants of the Lower Boise River, continued.

(Bucephala clangula)

Barrows goldeneye
(Bucephala islandica)

Bufflehead
(Bucephala albeola)

Ruddy duck
(Oxyura jamaicensis)

Hooded merganser
(Lophodytes cucullatus)

Common merganser
(Mergus merganser)

Red-breasted mergemser
(Mergus serrator)

Turkey vulture
(Cathartes aura)

Northern goshawk
(Accipiter gentilis)

Cooper's hawk
(Accipiter cooperil)

Sharp-shinned hawk
(Accipiter striatus)

Northern harrier
(Circus cyaneus)

Rough-legged hawk
(Buteo lagopus)

Red-tailed hawk
(Buteo jamaicensis)

Swainson's hawk
(Buteo sawinsoni)

Ferruginous hawk
(Buteo regalis)

Golden eagle
(Aquila chryseatos)

Bald eagle
(Haliaeetus leuocephalus)

Osprey
(Pandion haliaetus)

Merlin
(Falco colunbarius)

Prairie falcon
(Falco mexicanus)

Peregrine falcon
(Falco peregrinus anatum)

American kestrel
(Falco sparverius)

California quail
(Callipepla californica)

Bobwhite
(Colinus virginianus)

Gray partridge
(Perdix perdix)

Ring-necked pheasant
(Phasianus colchicus)

Snowy egret
(Egretta thula)

Common egret
(Casmerodius albuus)

Great blue heron
(Ardea herodias)

Black-crowned night heron
(Nycticorax nycticorax)

Virginia rail
(Rallus limicola)

Sora
(Prozana carolina)

American coot
(Fulica americana)

Long-billed curlew
(Numenius americanus)

Killdeer
(Charadrius vociferus)

Spotted sandpiper
(Actitis macularia)

Willet
(Catoptrophorus semipalmatus)

Greater yellowlegs
(Tringa melanoleuca)

Lesser yellowlegs
(Tringa flavipes)

Solitary sandpiper
(Tringa solitaria)

Least sandpiper
(Calidris minutilla)

Western sandpiper
(Calidris mauri)

Wilson's phalarope
(Phalaropus tricolor)

Long-billed dowitcher
(Limnodromus scolopaceus)

Common snipe
(Gallinago gallinago)

California gull
(Larus californicus)

Herring gull
(Larus argentatus)

Ring-billed gull

(Continued)
Source: Sather-Blair and Blair 1983. B5

Aniamls and Plants of the Lower Boise River, continued.

(Larus delawarensis)

Bonaparte's gull
(Larus philadelphia)

Forster's tern
(Sterna forsteri)

Mourning dove
(Zenaida macroura)

Rock dove
(Columba livia)

Common barn-owl
(Tyto alba)

Northern pygmy owl
(Glaucidium gnoma)

Long-eared owl
(Asio otus)

Northern saw-whet owl
(Aegolius acadicus)

Western screech-owl
(Otus kennicottii)

Great horned owl
(Bubo virginianus)

Common nighthawk
(Chordeiles minor)

Broad-tailed hummingbird
(Selasphorus platycercus)

Calliope hummingbird
(Stellula calliope)

Anna's hummingbird
(Calypte anna)

Black-chinned hummingbird
(Archilochus alexandri)

Rufous hummingbird
(Selasphorus rufus)

Belted kingfisher
(Ceryle alcyon)

Northern flicker
(Colaptes auratus)

Lewis' woodpecker
(Melanerpes lewis)

Yellow-bellied sapsucker
(Sphyrapicus varius)

Hairy woodpecker
(Picoides villosaus)

Downy woodpecker
(Picoides pubescens)

Eastern kingbird
(Tyrannus tyrannus)

Western kingbird
(Tyrannus verticalis)

Say's phoebe
(Sayornix saya)

Willow flycatcher
(Empidonax traillii)

Dusky flycatcher
(Empidonax hammondii)

Hammond's flycatcher
(Empidonax hammondii)

Western flycatcher
(Empidonax verticalis)

Western wood-peewee
(Contopus sordidulus)

Horned lark
(Eremophila alpestris)

Barn swallow
(Hirunda rustica)

Reptiles

Western fence lizard
(Sceloporus occidentalis)

Sagebrush lizard
(Sceloporus graciosus)

Western skink
(Eumeces skiltonianus)

Rubber boa
(Charina bottae)

Racer
(Coulber constrictor)

Striped whipsnake
(Masticophis taeniatus)

Great Basin gopher snake
(Pituophis melanoleucus)

Western garter snake
(Thamnophis elegans)

Common garter snake
(Thamnophis sittalis)

Western rattlesnake
(Crotalus viridus)

(Continued)
Source: Sather-Blair and Blair 1983. B6

Aniamls and Plants of the Lower Boise River, continued.

Amphibians

Long-toed salamander
(Ambystoma macrodactylum)

Great Basin spadefoot
(Spea intermontanus)

Western toad
(Bufo boreas)

Woodhouse toad
(Bufo woodhousei)

Pacific tree frog
(Hyla regilla)

Striped chorus forg
(Pseudacris triseriata)

Bullfrog
(Rana cateskeiana)

Leopard frog
(Rana pipiens)

Fish

Mountain whitefish
(Prosopium williamsoni)

Rainbow trout
(Salmo gairdneri)

Steelhead trout
(Salmo gairdneri)

Brown trout
(Salmo trutta)

Chiselmouth
(Acrocheilus alutaceus)

Northern squawfish
(Ptychocheilus oregonensis)

Longnose dace
(Rhinichthys cataractae)

Speckled dace
(Rhinichthys osculus)

Redside shiner
(Richardsonius balteatus)

Bridgeslip sucker
(Catostoomus columbianus)

Mosquito fish
(Gambusia affinis)

Bluegill
(Lepomis macrochiurus)

Largemouth bass
(Micropterus salmoides)

Black crappie
(Pomoxis nigromaculatus)

Mottled sculpin
(Cottus bairdi)

Tui chub
(Gila bicolor)

Largescale sucker
(Catostomus macrocheilus)

Mountain sucker
(Catostomus platyrhynchus)

Brown bullhead
(Ictalurus nebulosus)

Channel catfish
(Ictalurus punctatus)

Tadpole madtom
(Noturus gyrinus)

Pumpkinseed
(Lepomis gibbosus)

Smallmouth bass
(Micropterus dolomieus)

Yellow perch
(Perca flavescens)

(Continued)
Source: Sather-Blair and Blair 1983. B7

Aniamls and Plants of the Lower Boise River, continued.

Plants

Poison Ivy
(Rhus radicans)

Milkweed
(Asclepias speciosa)

Tarweed
(Amsinckia lycopsoides)

Yarrow
(Achillea millefolium)

Burdock
(Arctium minus)

Sagebrush
(Artemisia lidleyana)

Sagebrush
(Artemisia tridentata)

Everlasting
(Antennaria stenophyllla)

Aster
(Aster campestris)

Balsam-root
(Balsamorphiza sagittata)

Bachelor's button
(Centaurea cyanus)

Chaenactis
(Chaenactis douglasii)

Gray rabbitbrush
(Chrysothamnus nauseosus)

Green rabbitbrush
(Chrysothamnus viscisiflorus)

Canada thistle
(Cirsium arvense)

Bull thistle
(Cirsium vulgare)

Poverty weed
(Iva axillaris)

Prickly lettuce
(Lactuca serriola)

Goldenrod
(Solidago species)

Goat's beard
(Tragopogen dubius)

Pepper grass
(Lepidium perfoliatum)

Jim Hill mustard
(Sisymbrium altissmum)

Filaree
(Erodium cicutarium)

Blue bunch wheatgrass
(Agropyron specatum)

Rattlesnake brome
(Bromus brizaeformmis)

Cheat
(Bromus tectorum)

Wall barley
(Hordeum leporinum)

Timothy
(Phleim pratenses)

Bulbous bluegrass
(Poa bulbosa)

Green foxtail
(Setaria viridis)

Rush
(Juncus xiphioides)

Locoweed
(Astragalus species)

Honey locust
(Gleditsia)

Alfalfa
(Medicago sativa)

White sweet clover
(Melilotus alba)

Asparagus
(Asparagus officinalis)

Willow herb
(Epilobium paniculatum)

Common plantain
(Plantago major)

Wild buckwheat
(Erigonum species)

Knotweed
(Polygonum aviculare)

Yellow dock
(Rumex crispus)

Clematis
(Clematis ligusticifolia)

Antelope brush
(Purshia tridentata)

Wild rose
(Rosa nutkana)

Black cottonwood
(Populus trichocarpa)

Coyoe willow
(Salix exigua)

Whiplash willow
(Salix lasiandra)

McKenzie willow
(Salix rigida)

(Continued)
Source: Sather-Blair and Blair 1983. B8

Aniamls and Plants of the Lower Boise River, continued.

Golden currant
(Ribes aureum)

Mullein
(Verbascum thapsus)

Bittersweet
(Solanum dulcamara)

Cattail
(Typha latifolia)

Desert parsley
(Lomatium dissectum)

Puncture vine
(Tribulus terrestris)

Silver maple
(Acer saccharinum)

Black locust
(Robinia pseudoacacia)

White alder
(Alnus rhombifolia)

Box elder
(cer negundo)

Siberian elm
(Ulmus pumila)

Green ash
(Praxinus pennsylvanica)

Catalpa
(Catalpa speciosa)

Black hawthorn
(Crataegus douglasii)

Russian olive
(Elaeagnus angustifolia)

Silverberry
(Elaeagnus commutata)

Serviceberry
(Amelanchier alnfolia)

False indigo
(Amorpha fruticosa)

Smooth sumac
(Rhus glabra)

Poison Ivy
(Toxicodendron radicans)

Nightshade
(Solanum dulcamara)

Bulrush
(Scirpus spp.)

Sedge
(Carex spp.)

Horsetail
(Equisetum spp.)

Duckweed
(Lemna spp.)

LISTED AND PROPOSED, ENDANGERED AND THREATENED, CANDIDATE, AND COMMON SPECIES THAT OCCUR WITHIN THE MORES CREEK SUBBASIN

DATE: February 22, 1995
PROJECT NAME: MORES CREEK SUBBASIN
SPECIES LIST NO. FWS 1-4-95-SP-47

LISTED SPECIES	COMMENTS/LOCATION INFORMATION
Bald eagle (LE) (*Haliaeetus leucocephalus*)	Wintering area
Gray wolf (LE) (*Canis lupus*)	Probable sighting Experimental, non-essential population

CANDIDATE SPECIES	COMMENTS/LOCATION INFORMATION
Interior redband trout (C2) (*Oncorhynchus mykiss sp.*)	Wild population
Northern goshawk (C2) (*Accipiter gentilis*)	
Mountain quail (C2) (*Oreortyx funereus*)	
Bull trout (C1) (*Salvelinus confluentis*)	Wild population
Wolverine (C2) (*Gulo gulo luscus*)	Probable sighting
Ibapah wavewing (3c) (*Cymopterus ibapensis*)	
Douglas' wavewing (C2) (*Cymopterus douglassii*)	
Slick spot peppergrass (C2) (*Lepidium papilliferum*)	

(Continued)
Source: IDFG-CDC. 1995.

Plant and Animal Species of the More's Creek Subbasin, continued

Other Species

Western grebe
(Aechmophorus occidentalis)

Flammulated owl
(Otus funereus)

Boreal owl
(Aegolius funereus)

White-headed woodpecker
(Picoides albolarvatus)

Fringed myotis
(Myotis thysanodes)

Yellowstone draba
(Draba incerta)

Tall swamp onion
(Allium validum)

Giant helleborine
(Epipactis gigantea)

Oregon bentgrass
(Agrostis oregonsis)

PLANT ASSOCIATIONS

Thermal springs aquatic community

Mountain big sagebrush/bluebunch wheatgrass
(Artemisia trientata ssp vaseyana/agropyron spicatum)

Mountain big sagebrush/Idaho fescue
(Arteisia tridentata ssp. vaseyana/Festuce idahoensis)

Ponderosa pine/antelope bitterbrush
(Pinus ponderosa/Purshia tridentata)

Ponderosa pine/mountain snowberry
(Pinus ponderosa/Symphoricarpos malvaceus)

Douglas fir/elk sedge, ponderosa pine phase
(Pseudotsuga menziesii/Carex geyeri/Pinus ponderosa)

Douglas fir/mountain ninebark
(Pesudotsuga menziesii/Physicarpus malvaceus)

Douglas fir/white spiraea, pinegrass phase
(Pseudotsuga menziesii/Spiraea betulifolia/Calamagrostis rubescen)

Douglas fir/common snowberry
(Pseudotsuga menziesii/Symphoricarpos albus)

Douglas fir/mountain snowberry
(Pseudotsuga menziesii/Symphoricarpos oreophilus)

Source: IDFG-CDC 1995.   B11

ANIMAL AND PLANT SPECIES OF THE HULL'S GULCH SUBBASIN

Mammals

Masked shrew
(Sorex cinereus)

Merriam's shrew
(Sorex merriami)

Dusky shrew
(Sorex obscurus)

Northern water shrew
(Sorex palustris)

Vagrant shrew
(Sorex vagrans)

California myotis
(Myotis californicus)

Long-eared myotis
(Myotis evotis)

Little brown myotis
(Myotis lucifugus)

Small-footed myotis
(Myotis subulatus)

Fringed myotis
(Myotis thysanodes)

Long-legged myotis
(Myotis volans)

Yuma myotis
(Myotis yumanensis)

Silver-haired bat
(Lasionycteris noctivagans)

Hoary bat
(Lasiurus cineereus)

Big brown bat
(Eptesicus fuscus)

Western big-eared bat
(Plecotus townsendii)

Black bear
(Ursus americansus)

Raccoon
(Procyon lotor)

Shorttail weasel
(Mustela erminea)

Longtail weasel
(Mustela frenata)

Mink
(Mustela vison)

Badger
(Taxidea taxus)

Spotted skunk
(Silogale putorius)

Striped skunk
(Mephitis mephitis)

Coyote
(Canis latrans)

Red fox
(Vulpes fulva)

Mountain lion
(Felis concolor)

Bobcat
(Lynx rufus)

Yellow-bellied marmot
(Marmota flaviventris)

Townsend's ground squirrel
(Citellus townsendi)

Golden-mantled squirrel
(Citellus laateralis)

Forest chipmunk
(Eutamias minimus)

Yellow pine chipmunk
(Eutamias amoenus)

Fox squirrel
(Sciurus niger)

Northern pocket gopher
(Thomomys talpoides)

Great Basin pocket mouse
(Perognathus parvus)

Ord's kangaroo rat
(Dipodomys ordi)

Montain vole
(Microtus montanus)

Western harvest mouse
(Reithrodontomys megalotis)

Deer mouse
(Peromyscus maiculatus)

Meadow vole
(Microtus pennsylvanicus)

Richardson vole
(Microtus richardsoni)

House mouse
(Mus musculus)

Porcupine
(Erethizon dorsatum)

Beaver
(Castor canadensis)

(Continued)
Source: USFWS, 1989.

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Animals and Plants of Hull's Gulch, continued.

Snowshoe hare
(Lepus americanus)

Blacktail jackrabbit
(Lepus californicus)

Mountain cottontail
(Sylvilagus nuttalli)

Pygmy rabbit
(Brachylagus idahoensis)

Rocky mountain elk
(Cervus canadensis)

Mule deer
(Odocoileus hemionus)

Birds

Great blue heron
(Ardea herodias)

Mallard
(Anes platyrhynochos)

Cinnamon teal
(Anes cyanoptera)

Turkey vulture
(Cathartes aura)

Bald eagle
(Haliaeetus leuocephalus)

Northern harrier
(Circus cyaneus)

Sharp-shinned hawk
(Accipiter striatus)

Cooper's hawk
(Accipiter cooperil)

Northern goshawk
(Accipiter gentilis)

Red-tailed hawk
(Buteo jamaicensis)

Golden eagle
(Aquila chryseatos)

American kestrel
(Falco sparverius)

Merlin
(Falco colunbarius)

Peregrine Falcon
(Falco peregrinus anatum)

Prairie Falcon
(Falco mexicanus)

Gray Partridge
(Perdix perdix)

Ring-necked pheasant
(Phasianus colchicus)

California quail
(Callipepla californica)

White pelican
(Pelecanus erythrorhynchus)

Virginia rail
(Rallus limicola)

American coot
(Fulica americana)

Killdeer
(Charadrius vociferus)

Spotted sandpiper
(Actitis macularia)

Common snipe
(Gallinago gallinago)

Ring-billed gull
(Larus delawarensis)

California gull
(Larus californicus)

Rock dove
(Columba livia)

Mourning dove
(Zenaida macroura)

Common barn-owl
(Tyto alba)

Western screech-owl
(Otus kennicottii)

Great horned owl
(Bubo virginianus)

Northern pygmy owl
(Glaucidium gnoma)

Long-eared owl
(Asio otus)

Northern saw-whet owl
(Aegolius acadicus)

Common nighthawk
(Chordeiles minor)

Black-chinned hummingbird
(Archilochus alexandri)

Anna's hummingbird
(Calypte anna)

Calliope hummingbird
(Stellula calliope)

Rufous hummingbird
(Selasphorus rufus)

(Continued)
Source: USFWS, 1989.

Animals and Plants of Hull's Gulch, continued.

Belted kingfisher
(Ceryle alcyon)

Lewis' woodpecker
(Melanerpes lewis)

Red-naped sapsucker
(Sphyrapicus varius nuchalis)

Downy woodpecker
(Picoides pubescens)

Hairy woodpecker
(Picoides villosaus)

Northern flicker
(Colaptes auratus)

Olive-sided flycatcher
(Contopus borealis)

Western wood-peewee
(Contopus sordidulus)

Willow flycatcher
Empidonax traillii)

Say's phoebe
(Sayornix saya)

Western kingbird
(Tyrannus verticalis)

Tree swallow
(Tachycinata bicolor)

Violet-green swallow
(Tachycineata thalassina)

Northern rough-winged swallow
(Steligidopteryx serripennis)

Bank swallow
(Riparia riparia)

Cliff swallow
(Hirunda pyrrhonota)

Barn swallow
(Hirunda rustica)

Steller's jay
(Cyanocitta stelleri)

Blue jay
(Cyanocitta cristata)

Clark's nutcracker
(Nucifraga columbiana)

Black-billed magpie
(Pica pica)

American crow
(Corvus brachyrhynchos)

Common raven
(Corvus corax)

Black-capped chickadee
(Parus atricapillus)

Mountain chickadee
(Parus gambeli)

Red-breasted nuthatch
(Sitta canadensis)

Brown creeper
(Certhia americana)

Rock wren
(Salapinctes obsoletus)

House wren
(Troglodytes sedon)

Winter wren
(Troglodytes troglodytes)

Golden-crowned kinglet
(Regulus satrapa)

Ruby-crowned kinglet
(Regulus calendula)

Blue-gray gnatcatcher
(Polioptila caerulea)

Townsend's solitaire
(Myadestes townsendi)

American robin
(Turdus migratorius)

Sage thrasher
(Oreoascoptes montanus)

Bohemian waxwing
(Bombycilla garrulus)

Cedar waxwing
(Bombycilla cedrorum)

Northern shrike
(Lanius excubitor)

Loggerhead shrike
(Lanius ludovicianus)

European starling
(Sturnus vulgaris)

Solitary vireo
(Vireo solitarius)

Warbling vireo
(Vireo gilvus)

Orange-crowned warbler
(Vermivora celleta)

Nashville warbler
(Vermivora rufucapilla)

Yellow warbler
(Dendroica coronata)

Yellow-rumped warbler
(Dendroica coronata)

McGillivray's warbler
(Oporornis tolmiei)

(Continued)
Source: USFWS, 1989.

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Animals and Plants of Hull's Gulch, continued.

Wilson's warbler
(Wilsonia pusilla)

Yellow-breasted chat
(Icteria virens)

Western tanager
(Piranga ludoviciana)

Black-headed grosbeak
(Pheucticus melanocephalus)

Lazuli bunting
(Passerina amoena)

Rufous-sided towhee
(Pipilo erythrophthalmuis)

American tree sparrow
(Spizella arborea)

Chipping sparrow
(Spizella arborea)

Lark sparrow
(Chondestes grammacus)

Fox sparrow
(Passerella iliaca)

Song sparrow
(Melospiza melodia)

White-crowned sparrow
(Zonotrichia leucophrys)

Harris' sparrow
(Zonotrivhis uerula)

Dark-eyed junco
(Junco hyemalis)

Red-winged blackbird
(Agelaius phoeniceus)

Western meadowlark
(Sturnella neglecta)

Yellow-headed blackbird
(Zanthocephalus zanthocephalus)

Brewer's blackbird
(Euphagus cyanocephalus)

Brown-headed cowbird
(Molothrus ater)

Northern oriole
(Icterus galbula)

Cassin's finch
(Carpodacus cassinii)

House finch
(Carpodacus mexicanus)

Red crossbill
(Loxia curvirostra)

Pine siskin
(Carduelis pinus)

American goldfinch
(Carduelis tristis)

Evening grosbeak
(Coccothraustes vespertinus)

House sparrow
(Passer domesticus)

Reptiles

Longnose leopard lizard
(Gambelia wislizenii)

Short-horned lizard
(Phymosoma douglassi)

Sagebrush lizard
(Sceloporus graciosus)

Western fence lizard
(Sceloporus occidentalis)

Side-blotched lizard
(Uta stanburiana)

Western skink
(Eumeces skiltonianus)

Racer
(Coulber constrictor)

Ringneck snake
(Diadophis punctatus)

Gopher snake
(Pituophis melanoleucus)

Wandering garter snake
(Thamnophis elegams vagrens)

Common garter snake
(Thamnophis sittalis)

Striped whipsnake
(Masticophis taeniatus)

Rubber boa
(Charina bottae)

Western rattlesnake
(Crotalus viridus)

(Continued)
Source: USFWS, 1989.

Animals and Plants of Hull's Gulch, continued.

Amphibians

Long-toed salamander
(Ambystoma macrodactylum)

Western toad
(Bufeo boreas)

Pacific treefrog
(Hyla regilla)

Striped chorus frog
(Pseudacris triseriata)

Bullfrog
(Rana catesbeiana)

Northern leopard frog
(Rana pipiens)

Plants

Ephrium crested wheatgrass
(Agropyron cristatum)

Tegmar intermediate wheatgrass
(Agropyron intermedium)

Western wheatgrass
(Agropyron smithii)

Goldar bluebunch wheatgrass
(Agropyron spicatum)

Red threeawn
(Aristida longiseta)

Great Basin wildrye
(Elymus cinereus)

Covar sheep fescue
(Festuca)

Indian ricegrass
(Oryzopsis hymenoides)

Sandberg's bluegrass
(Poa sandbergii)

Bottlebrush squirreltail
(Sitanion hystrix)

Sand dropseed
(Sporobolus cryptandrus)

Sherman big blue grass

Creeping foxtail

Common yarrow
(Achiellea millefolium)

Louisiana sage
(Artemesia ludoviciana)

Arrowleaf balsamroot
(Balsamorphiza sagittata)

Shaggy fleabane
(Erigeron pumilus)

Blue flax
(Linm perenne ssp. lewisii)

Birds foot trefoil
(Lotus corniculatus)

Palmar penstemon
(Penstemon)

Penstemon sp.
(Penstemon sp.)

Small burnett
(Sanguisorba minor)

Globemallow
(Sphaeralcea)

White clover
(Trifolium repens)

Aase's onion
(Allium aaseae)

Mulford's milkvetch
(Astragalus mulfordiae)

Montane peppergrass
(Lepidium)

Serviceberry
(Amelanchier)

Sagebrush
(Artemesia tridentata ssp. tridentata)

Four-wing saltbrush
(Atriplex confertifolia)

Spiny hopsage
(Atriplex spinosa)

Hackberry
(Celtis reticulata)

White rabbitbrush
(Chrysothamnus nauseosus ssp. albicaulus)

Dogwood
(Cornus)

Columbia hawthorne
(Crataegus columbiana)

(Continued)

Source: USFWS, 1989.

Animals and Plants of Hull's Gulch, continued.

Forage kochia
(Kochia americana)

Mockorange
(Phildalephus lewisii)

Bittercherry
(Prunus emarginata)

Chokecherry
(Prunus virginiana)

Bitterbrush
(Purshia tridentata)

Sumac
(Rhus)

Skunkbush
(Rhus trilobata)

Golden currant
(Ribes aureum)

Wood's rose
(Rosa woodsii)

Peach-leaf willow
(Salix amygdaloides)

Coyote willow
(Salix exigua ssp. exigua)

Golden willow
(Salix lutea)

Russian olive
(Elaeagnus angustifolia)

Juniper
(Juniperus)

Ponderosa pine
(Pinus ponderosa)

Scotch pine
(Pinus)

Black cottonwood
(Populus trichocarpa)

Douglas-fir
(Pseudotsuga menziesii)

Black willow
(Salix)

Bitterbrush
(Purshia tridentata)

Black locust
(Robinia pseudoacacia)

Cheatgrass
(Bromus tectorum)

Bulbous bluegrass
(Poa bulbosa)

Common cat-tail
(Typha latifolia)

Coyote willow
(Salix exigua)

Elm
(Ulmus ssp.)

Gray rabbitbrush
(Chrysothamnus nauseosus)

Needle-and-thread
(Stipa comata)

Norway maple
(Acer platanoides)

Pacific willow
(Salix lasiandra)

Prickly lettuce
(Lactuca serriola)

Purple loosetrife
(Lythrium salicaria)

Russian-olive
(Elaeagnus angustifolia)

Silver maple
(Acer saccharinum)

Squirrel tail
(Setanion jubatum)

Tamarisk
(Tamarix parviflora)

Tree of Heaven
(Ailanthus altissimum)

Tumble mustard
(Sisymbrium altissimum)

White sweet clover
(Melilotus alba)

Woods rose
(Rosa woodsii)

Wyoming big sagebrush
(Artemisia tridentata)

Source: USFWS 1989

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APPENDIX B

HYDROLOGY

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HYDROLOGY

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LOWER BOISE RIVER AND TRIBUTARIES
RECONNAISSANCE STUDY, IDAHO,

I. Background

The Lower Boise River and Tributaries Reconnaissance Study, Idaho, is a reconnaissance level study whose purpose is to assess water resources problems, needs, opportunities, and potential Federal interests in addressing these items. The study area includes those Boise River drainage basin lands lying between Lucky Peak Dam and the Boise River's confluence with the Snake River, a distance of approximately 60 miles, and Mores Creek, which is tributary to Lucky Peak Lake. The study was authorized by a 19 March 1954 resolution of the Senate Committee on Public Works (Upper Snake River and Tributaries). This Hydrology Appendix provides hydrologic and hydraulic support material for the Lower Boise River Study.

II. Prior Reports

This Hydrology Appendix to the Lower Boise River and Tributaries Reconnaissance Study is not intended to be an all inclusive source of hydrologic information available for the Boise River. Numerous reports having various levels of detail have been previously prepared and should be referred to as desired to obtain a comprehensive view of the Boise River system. A partial list of prior reports follows, in chronological order:

a. U.S. Army Corps of Engineers, Portland District, "The Boise River Flood - April, May, and June 1943," Portland, Oregon, August 1943.

b. U.S. Army Corps of Engineers, Portland District, "Review of Survey Report Boise River, Idaho, with a View to Control of Floods," Portland, Oregon, 2 January 1946, with appendices.

c. U.S. Department of the Interior, Geological Survey, Water Supply Paper 1048, "Discharge and Sediment Loads in the Boise River Drainage Basin, Idaho, 1939-40," S. K. Love and P. C. Benedict, Washington, DC, 1948.

d. U.S. Army Corps of Engineers, Walla Walla District, "Reservoir Regulation Manual for Boise River Reservoirs," Walla Walla, Washington, August 1956.

e. U.S. Army Corps of Engineers, Walla Walla District, "Lucky Peak Dam and Reservoir, Design Memorandum No. 6, Specific Design Memorandum, Downstream Channel Requirements," Walla Walla, Washington, 12 September 1956.

f. U.S. Army Corps of Engineers, Walla Walla District, "Boise Valley Project, Boise River, Idaho, Design Memorandum No. 1, Justification Report, Flood Control Improvements," Walla Walla, Washington, 15 October 1958.

g. U.S. Army Corps of Engineers, Walla Walla District, "Boise Valley Project, Boise River, Idaho, Design Memorandum No. 1, Justification Report, Flood Control Improvements, Supplemental Letter Report," Walla Walla, Washington, 16 November 1959.

h. Cornell, Howland, Hayes, and Merrifield for U.S. Army Corps of Engineers, Walla Walla District, "Boise Valley Flood Control Project, Boise River, Design Memorandum No. 2," Seattle, Washington, 21 June 1963.

i. U.S. Army Corps of Engineers, Walla Walla District, "Review Report on Tributaries of Boise River, Vicinity of Boise, Idaho," Walla Walla, Washington, April 1964.

j. U.S. Department of the Interior, Geological Survey, Water Resources Investigations 38-74, "Characteristics of Streamflow and Groundwater Conditions in the Boise River Valley, Idaho," C. A. Thomas and N. P. Dion, Boise, Idaho, December 1974.

k. U.S. Army Corps of Engineers, Walla Walla District, "Levee Restudy on Boise River, Ada County, Idaho," Walla Walla, Washington, January 1976.

l. U.S. Army Corps of Engineers, Walla Walla District, Ada Council of Governments, Canyon Development Council, "Boise Valley Regional Water Management Study," a Summary Report with Appendices, Walla Walla, Washington, 1977.

m. U.S. Army Corps of Engineers, Walla Walla District, "Floodplain Management Report for Boise River, Idaho," prepared for Idaho Department of Water Resources, Walla Walla, Washington, February 1979 (revised September 1982).

n. Federal Emergency Management Agency, "Flood Insurance Study, City of Boise, Idaho, Community No. 160002," 5 January 1984.

o. U.S. Army Corps of Engineers, Walla Walla District, "Water Control Manual for Boise River Reservoirs, Boise River, Idaho" (with Memorandum of Understanding of U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Boise, Idaho), Walla Walla, Washington, April 1985, with revisions.

p. Federal Emergency Management Agency, "Flood Insurance Study, City of Caldwell, Idaho, Community No. 160036," revised 30 September 1988.

q. Federal Emergency Management Agency, "Flood Insurance Study, Ada County Unincorporated Areas, Idaho, Community No. 160001," revised 17 December 1991.

r. U.S. Army Corps of Engineers, Walla Walla District, "Flood Warning/Preparedness Planning Study, Boise Foothills, Ada County, Idaho," Walla Walla, Washington, December 1992.

s. Federal Emergency Management Agency, "Flood Insurance Study, Canyon County Unincorporated Areas, Idaho, Community No. 160208," revised 3 December 1993.

III. Basin Description

a. General. The Boise River Basin has a total drainage area of approximately 4,130 square miles. It is located in southwestern Idaho and is one of the major tributaries of the Snake River, a principal branch of the Columbia River system. The Payette and Salmon River Basins are to the north, and the Sawtooth Mountains and Big Wood River Basin are located to the east. The main stem of the Snake River is to the south and west. The long basin axis trends east-west and includes large portions of Ada, Canyon, and Elmore Counties and small portions of Boise and Camas Counties. Principal streams within the Boise Basin flow in a westerly direction from the headwaters in the Sawtooth Mountains to the mouth of the Boise River, a distance of about 200 river miles. Topography and runoff characteristics naturally divide the Boise River Basin into two separate and distinctive watersheds - an upper and lower watershed.

b. Watershed Topography and Characteristics. The upper watershed consists of approximately 2,680 square miles of drainage area upstream of Lucky Peak Dam and is a fan-shaped, mountainous area which contains the headwaters of all the significant tributaries. This area is composed largely of precipitous mountains and is characterized by a highly dissected topography with deep V-shaped valleys, steep slopes, and narrow, sharp top ridges. The upper watershed ranges in elevation from 3,000 to 10,600 feet above mean sea level (MSL), and the mean elevation is approximately 5,800 feet above MSL. Principal tributaries of the Boise River are (1) South Fork - 1,310 square miles, (2) Middle Fork and North Fork - 830 square miles, (3) Mores Creek - 430 square miles, and (4) Lucky Peak Lake Local Inflows - approximately 110 square miles. These principal tributaries contain approximately 62 percent of the total area of the Boise River above its mouth. The upper watershed is characterized by sparse population and very limited development.

The lower watershed consists of approximately 1,450 square miles of drainage area below Lucky Peak Dam. This area is composed of river bottoms, terraces, and low rolling to steep hills with few distinct mountains. Adjoining the Boise River is bottom land, varying from 1 to 3 miles in width, which constitutes the normal floodplain. Adjacent to this bottom land is a series of two terraces; the first occurs at an elevation of approximately 2,500 feet above MSL and the second between 3,000 and 4,000 feet above MSL. The terraces grade upward toward the east to a ridge that cuts the basin north and south at approximately the location of Lucky Peak Dam. This ridge, known as the Boise Front, forms the boundary between the upper and lower watersheds. In contrast to the upper watershed, the lower watershed is quite heavily populated and is extensively developed. Streamflow within the lower watershed is quite limited, and the main tributaries are Indian Creek, Willow Creek, and Dry Creek. These streams, except Indian Creek, are intermittent and normally flow only during the spring and early summer months.

Plate 1 shows the Boise River Basin's primary features and locations within the basin.

c. Boise Front Drainages. The Boise Front drainages are located north and east of Boise, located on the western side of the ridge which divides the Boise River Basin into the upper and lower watersheds. Plate 2 shows the Boise Front drainages' primary features and locations. Drainage areas for the seven largest gulches are presented in Table 1.

Table 1
Drainage Areas for Seven Largest Boise Front Gulches

Gulch Name	Drainage Area (Square Miles)
Cottonwood Creek	16.5
Hulls	4.3
Crane	7.8
Stuart	9.1
Polecat	1.2
Pierce	2.0
Seaman	1.8

All seven gulches are very similar in character with respect to physical features, such as ground slopes, soil types, and vegetation, and, therefore, they will be discussed as a group rather than individually. Lands within these drainages rise abruptly upward from Boise (about 2,800 above MSL) to elevations of 5,000 to 6,000 feet above MSL in a distance of about 6 miles. Drainage ways in the gulches consist of small streambeds having only a few square feet of cross sectional area measured perpendicular to the stream's flow path, and in the canyon reaches, flows are confined to a rather narrow floodplain by steep hillsides and narrow canyon floors. Below the canyon mouths, drainage ways expand rapidly into relatively flat outwash cones that slope generally west to the Boise River floodplain.

The soils found within the lower portion of the Boise Front are composed almost entirely of sandy, lacustrine deposits of the Idaho-Payette formation. Surface soils are mostly deep sandy loam and loam with areas of clay and clay loam, and underlying materials include stratified sandy loam and coarse, sandy, and fine gravels. These soils are highly erodible and quite porous. Vegetation within the gulch areas is sparse and generally consists of sagebrush, bitterbrush, and perennial grasses.

The upper reaches of the Boise Front drainages do not contain any diversions, impoundments, levees, or other developments that could fail and cause flooding. All flooding is due to either rainfall, snowmelt, or a combination of the two causes. Due to the relatively steep slopes and narrow floodplains, runoff will quickly drain into the main drainage channel, reducing the significance of ponding and sheet flow.

IV. Climate

The climate of the Boise River Basin is characterized by hot, dry summers and moderately cold winters. The area is dominated by Pacific maritime air, considerably modified by intervening topographic barriers as it travels eastward from the ocean. Although generally deflected to the east by the Rocky Mountain barrier, polar continental air occasionally enters the area during the winter months, resulting in short periods of extremely low temperatures.

The following paragraphs discuss and outline temperature, precipitation, and snow data within the Boise River Basin.

a. Temperature. Temperatures within the Boise Basin can fluctuate dramatically from month to month and year to year. Table 2 outlines temperature extremes which have occurred at some of the key stations within the basin, which all can affect basin runoff.

Table 2
Boise River Basin Maximum and Minimum Temperature Extremes at Key Stations
(Degrees Fahrenheit [F])

	Boise Airport 1/		Idaho City 2/		Arrowrock Dam 3/		Anderson Ranch Dam 4/	
Month	Max	Min	Max	Min	Max	Min	Max	Min
Jan	63	-17	56	-38	55	-20	55	-21
Feb	71	-15	65	-35	67	-20	64	-20
Mar	81	6	76	-20	77	- 1	75	- 5
Apr	92	19	88	- 8	92	8	88	16
May	98	22	95	17	98	21	96	22
Jun	109	31	106	24	108	32	104	32
Jul	111	35	109	26	112	39	107	36
Aug	110	34	106	24	109	36	106	39
Sep	102	23	100	11	105	21	108	27
Oct	94	11	91	2	94	16	92	15
Nov	74	- 3	75	-18	73	- 6	76	- 2
Dec	65	-25	64	-27	59	-14	59	-19

1/ Period of record, 1940-1993
2/ Period of record, 1931-1993
3/ Period of record, 1916-1993
4/ Period of record, 1948-1993

b. Precipitation. Large amounts of precipitation can and do significantly affect the regulation of the Boise River reservoirs. Table 3 lists maximum 24-hour precipitation accumulations which have occurred at some of the key stations within the Boise River Basin.

Table 3
Boise River Basin Maximum 24-Hour Precipitation Accumulations at Key Stations
(Inches)

Month	Boise Airport 1/	Idaho City 2/	Arrowrock Dam 3/	Anderson Ranch Dam 4/
Jan	1.13	3.67	2.20	2.07
Feb	0.92	2.09	1.75	2.42
Mar	1.60	2.25	1.03	1.57
Apr	1.27	1.44	1.37	1.38
May	1.77	1.40	1.26	0.96
Jun	1.91	2.61	1.44	1.20
Jul	0.94	1.69	1.20	1.15
Aug	1.61	1.60	1.08	1.69
Sep	1.73	1.77	1.69	2.12
Oct	0.68	2.26	1.35	1.83
Nov	0.78	1.72	2.05	1.85
Dec	1.03	3.80	1.68	2.18

1/ Period of record, 1940-1993
2/ Period of record, 1931-1993
3/ Period of record, 1916-1993
4/ Period of record, 1948-1993

c. Snow. Snowfall and accumulation within the lower watershed are very light as compared to the upper watershed. The accumulation of snow over the upper watershed directly affects the snowmelt runoff and dictates the degree of regulation necessary and the manner in which the Boise River reservoirs are regulated. Table 4 compares some Boise River Basin snow courses for a small runoff volume and a large runoff volume year.

Table 4
Boise River Basin Upper Watershed Runoff Volume Comparison
of 1 April Snow Course Water Contents
(Inches)

Snow Course Name	1977 1/	1965 2/
Atlanta Summit	7.4	55.8
Bogus Basin	11.2	31.0
Dollarhide Summit	4.4	37.2
Galena	3.4	31.8
Galena Summit	5.8	39.4
Jackson Peak	9.2	48.0
Mores Creek Summit	10.0	47.8
Trinity Mountain	9.8	65.2
Vienna Mine	10.4	46.0

1/ Small volume year
2/ Large volume year

April through July Runoff Volume (Acre-Feet)	316,540	2,578,260

d. Climate at Boise Gulches. The climate of Boise Gulch Drainages is generally moderate. Boise, located immediately to the southwest, has a mean annual temperature of 52 degrees Fahrenheit (F), and temperatures of zero degrees (F) and 100 degrees (F) represent approximate average annual extremes. Normal annual precipitation varies from about 12 inches at Boise to about 22 inches at highest elevations in the hillside drainages. A predominance of the precipitation occurs in the winter months, with the upper parts of the gulch area generally having a winter snow cover.

General orographic rainstorms may last for several days, but precipitation intensities are not great. The maximum observed 24-hour rainfall at Boise is 2.7 inches. Summer thunderstorms produce intense rainfall occasionally over parts of these gulch areas. Data is too incomplete to indicate definite potentialities for storm amounts or maximum intensities; however, several such storms in past years have caused severe floods and imply that intensities of several inches per hour can occur for brief periods of a few minutes. The maximum observed short-duration intensity at the Boise weather station is 4.1 inches per hour for a 5-minute period. Intensities as high as 7.5 inches per hour have been reported for brief periods at other locations in southwestern Idaho and eastern Oregon.

V. Soils and Geology

The soils in the Boise Basin are of two general types, residuals and sedimentary deposits. The residuals are disintegrated granite, rhyolite, and basalt. From the standpoint of runoff, the granite soil is of major importance since it covers 90 percent of the upper watershed, and this is the portion of the basin that contributes practically the entire runoff of the Boise River.

The geology of the Boise Valley area is very complex. Southwestern Idaho has been described as being a region of broad floodplains, dissected lava plateaus, mesas, buttes, cinder cones, minor faults and faultline scarps, badland piedmont hills, and mountains of uplifted crystalline rock. The Boise Valley within this area has been described as a broad alluvial plain having low relief lying adjacent to the Boise River. The following description of the geology of the area has been abstracted from the report by Nace:

> "The Boise Valley is underlain by a trough-like, impermeable floor of ancient consolidated rocks. Within the trough, there is a great thickness of stream-and-lake-deposited sediments (Payette formation) and volcanic rocks (Owyhee rhyolite and Columbia River basalt), all having generally low permeability. Resting on these materials is a younger group of sediments - the Idaho formation - which is a lake-laid deposit. This formation is quite varied in permeability but generally is somewhat more permeable than the older sediments. The Idaho formation, consisting chiefly of clay, silt, and sand, is a source of moderately deep artesian water in the Boise and Snake River Valleys. Streams spread a thick sheet of rather permeable terrace gravel on the ancient land surface of the Idaho formation. Lava flows formed the Snake River basalt which lies on the lower part of the gravel in some places and at others is covered by the upper part of the gravel. The present course of the Snake River resulted as the river cut a deep canyon through the basalt and sediments.
>
> The Boise Valley developed by alternate stream erosion and deposition, resulting in terraces underlain by permeable younger terrace gravel and the bottom land occupied by highly permeable recent alluvium. Recent local basalt flows are interbedded with terrace gravels at a few places. The younger, variable, but more permeable deposits in the Boise Valley thus occupy a partly closed basin that was eroded in the older terrace

gravel and Idaho formation. Outflow occurs only to the westward on the surface and at shallow depth. Under natural water conditions, the water table was at shallow depth in the bottom lands and not more than 100 to 200 feet deep under the terraces and lowland slopes. Under irrigation development, with much of the irrigated area on the terraces and surface applications of large amounts of water, a great deal of water which formerly discharged in the river now enters the ground and must be discharged westward through the ground. Earth materials to the west, however, are generally less permeable than those to the east. As a result, the water table has risen to the east to develop enough hydraulic gradient to move the water westward. Consequently, drainage problems have been encountered through most of the length of the valley, and, due to the lenticular character of much of the alluvium, trouble spots still develop." 1/

VI. Streams and Streamflow Characteristics

a. Streamflow Records. Records of streamflow have been maintained for many years at several locations on the Boise River, on major tributaries, and on important diversions. In addition, natural streamflow of the Boise River at Diversion Dam has been computed by the Boise River Watermasters since the construction of the Boise River reservoirs.

b. Lower Watershed Runoff. Natural streamflow from the lower watershed constitutes only a small percentage of the total runoff from the entire Boise River Basin. Streams within the lower watershed normally contain very limited amounts of runoff, only in the spring and early summer, and flow intermittently. Occasionally thunderstorms or rapid snowmelt on frozen ground can produce high peaks and short-duration local runoffs causing local flooding and drainage problems; but these storms normally have very little impact on the Boise River flows and have little or no impact on regulation of the Boise River reservoirs.

c. Upper Watershed Runoff. Most of the natural runoff from the upper watershed results primarily from snowmelt, and high flows occur each year in the spring when temperatures are increasing and the snow melts. The annual high-water period generally begins with a gradual increase in discharge in March, culminates with a peak discharge usually between 15 April and 15 June, and terminates with a gradual recession to base flows

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1/ Nace, R. L., S. W. West, and R. W. Hower, 1957, U.S. Geological Survey, Water Supply Paper, 1576, p. 121.

during July. Low flows then normally prevail from August through February. From 1895 through 1994, natural annual runoff volumes from the upper watershed have averaged approximately 1.970 million acre-feet per year (13.78 basin inches). Approximately 78 percent of this total average annual runoff volume comes off during the March through July snowmelt period. The amount of seasonal runoff and, to a considerable extent, the peak discharge vary with the amount of water accumulated in snow on the basin. Peak snowmelt discharges are occasionally augmented by runoff from general rainstorms or thunderstorms. Occasionally rapid snowmelt on frozen ground, especially when augmented by heavy, warm rains, will produce high peak flows during the winter. Most of these winter runoff events are of short duration and limited volume.

The upper watershed contains four primary subbasin tributaries to the Boise River: (1) South Fork, (2) Middle Fork, (3) North Fork, and (4) Mores Creek. A streamgaging station called "South Fork Boise River near Featherville" records streamflows for approximately 48 percent of the South Fork subbasin drainage area. This station is located approximately 15 miles upstream of Anderson Ranch Dam and is used to monitor natural inflows into Anderson Ranch Reservoir. Most of the streamflow from the Middle and North Fork subbasin drainage areas is recorded at a gaging station called "Boise River near Twin Springs." This station is located about 2 miles upstream from the maximum flow line of Arrowrock Reservoir. Most of the streamflow from the Mores Creek subbasin drainage area is recorded at a gaging station called "Mores Creek above Robie Creek, near Arrowrock Dam." This station is located about 5 miles northwest of Arrowrock Dam.

(1) Floods and Historic Flood Flows. Natural or unregulated annual maximum daily spring snowmelt-event discharges in excess of 20,000 cfs have occurred on 10 occasions since 1895 in the Boise River at the Lucky Peak damsite. In the period of years between 1865 and 1894, which is prior to actual gaged records, five floods (based on precipitation records at Boise) are estimated to have equaled or exceeded 35,000-cfs peak discharge. Table 5 summarizes the largest runoff events.

Table 5
Maximum Mean Daily Discharges and Runoff Volumes for Largest Runoff Events on Boise River

Date	Maximum Annual Mean Daily Discharge (cfs)	April through July Runoff Volume (Million Acre-Feet)
	Measured Events	
14 June 1896	35,500	2.700
14 April 1897	29,500	1.542
18 April 1943	25,040	2.717
28 April 1952	23,430	2.269
25 May 1956	22,950	2.249
22 May 1958	21,750	1.914
23 April 1965	20,850	2.578
10 May 1928	20,710	1.590
14 May 1971	20,250	2.477
18 May 1927	20,060	1.998
	Estimated Events	
1871	43,000	--
1872	50,000	--
1874	36,000	--
1875	36,000	--
1894	35,000	--

Using (1) the observed maximum annual mean daily peak discharges for 1895 through 1976 and estimated peaks for 1865 through 1894, and (2) observed April through July runoff volumes from 1895 through 1974, the following unregulated flood frequency data had been computed for past Boise River studies and is summarized in Table 6.

Table 6
Boise River Specific Flood Frequency Data

Exceedence Probability1/ (Percent)	Average Recurrence Interval (Years)	Unregulated Annual Spring Snowmelt Peak Discharge (cfs)	Unregulated April through July Runoff Volume (Million Acre-Feet)
1	100	41,200	3.100
2	50	36,200	2.900
5	20	30,000	2.550
10	10	25,200	2.270
20	5	20,400	1.950
50	2	13,800	1.400

1/ Frequency data for unregulated streamflow and runoff volume of the Boise River at Lucky Peak Dam.

Significant winter rainstorm-snowmelt flood events occurred in the upper watershed in November 1909, December 1955, and December 1964. The December 1964 flood event had a computed instantaneous peak discharge of approximately 44,000 cfs and is estimated to have been in excess of a 100-year winter flood event. Table 7 summarizes the four largest winter flood events.

Table 7
Summary of Boise River's
Four Largest Winter Floods

Date	Unregulated Maximum Mean Daily Discharge1/ (cfs)	Duration Above 5,000 cfs (days)	Runoff Volume Above 5,000 cfs (Acre-Feet)
December 1964	27,295	7	125,000
December 1955	20,551	5	72,000
November 1909	15,200	6	52,000
December 1937	10,641	2	16,000

1/ Unregulated flow at Lucky Peak damsite.

(2) Droughts. Years of low runoff volumes from the upper watershed can critically affect irrigation within the lower watershed. Since 1895, 10 years have had annual runoff volumes of less than 1.250 million AF, as compared to an average of 1.970 million acre-feet. The 1977 drought year was the lowest runoff year of record, and the annual maximum mean daily peak discharge only reached 3,190 cfs. Table 8 summarizes annual runoff volumes and peak discharges for the 10 lowest

runoff volume years of record. Five of the lowest ten annual runoff volumes have occurred during the period 1987 through 1994 and show the long-term severity of the present drought.

Table 8
Annual Volume and Maximum Mean Daily Discharges for Ten Lowest Runoff Years

Year	October-September Annual Runoff Volume (Million AF)	Annual Maximum Mean Daily Peak Discharge1/ (cfs)
1977	0.653	3,190
1992	0.798	4,150
1994	0.860	5,490
1924	0.885	5,190
1987	0.937	5,610
1931	0.939	5,430
1991	1.006	6,320
1988	1.062	6,230
1934	1.072	6,110
1926	1.105	7,090

1/ Unregulated flow at Lucky Peak damsite.

(3) Boise System Operation. A Water Control Plan, whose objective is to define reservoir regulation procedures for joint use of the storage spaces in Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs, is presented in Chapter VII of the publication entitled, "Water Control Manual for Boise River Reservoirs," dated April 1985 (with revisions). This plan basically retains the same uses and priorities as defined in the 1953 Memorandum of Agreement, with modifications as agreed upon by all concerned parties. Storage in Lake Lowell is affected by the Water Control Plan through regulation of the upstream storage projects, but Lake Lowell is an off-stream irrigation project regulated by the Boise Project Board of Control through an operation and maintenance contract between the Board and the Bureau of Reclamation. Thus, the Water Control Plan contains no regulation criteria for Lake Lowell.

As a system, Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs normally add water to storage from the end of the irrigation season in October of any given year until the end of the annual flood control season which may range from 15 April to 1 July of any given year depending on basin conditions with respect to snowpack and predicted precipitation. During the period from October until April, water available for the Idaho Department of Fish and Game, as well as noncontracted space water, is released from Lucky Peak Lake to maintain downstream minimum wintertime flows in the Boise River.

The amount of water stored in the system and when it is stored is dependent on water rights, the amount of water available as runoff, the timing of the runoff, and the required flood control regulation. Flood control regulation during the refill period endeavors to maintain adequate flood control spaces within the reservoirs and yet refill them without exceeding 6,500 cfs as measured at the Glenwood Bridge gaging station. During low runoff years, flood control regulation during the spring snowmelt period is normally limited or not necessary, and water conservation and reservoir refill are the primary objectives. Runoff years near normal require delicate balances between flood control and refill regulation, with runoff timing and volume forecasts as the key factors for the balances. In large runoff years, maintaining adequate flood control space within the reservoirs and passing excess water through the system without unduly jeopardizing system refill are the primary objectives. After the annual spring flood season is over and until the end of the irrigation season, the reservoirs are drafted to maintain irrigation flows. Arrowrock Reservoir is drafted first to maintain the power head at Anderson Ranch Reservoir and also to maintain a desirable recreation pool level at Lucky Peak Reservoir. If the storage at Arrowrock has been used before the end of August, both Anderson Ranch and Lucky Peak Reservoirs are drafted without exceeding powerplant capacity at Anderson Ranch. After the end of August, irrigation demands are met primarily from storage in Lucky Peak Reservoir.

Flood control and irrigation are the primary uses for Anderson Ranch, Arrowrock, and Lucky Peak storage spaces. Idaho Department of Fish and Game's 50,000 acre-feet of space for streamflow maintenance and the noncontracted space for 102,000 acre-feet for streamflow maintenance and municipal and industrial uses at Lucky Peak Reservoir are also primary uses. Secondary uses include power generation at Anderson Ranch and Lucky Peak and recreation at Lucky Peak. Incidental uses include recreation at Anderson Ranch, Arrowrock, and the Lower Boise River downstream of Lucky Peak Dam, downstream water quality maintenance, and sedimentation pools within the reservoirs.

Because the Boise System is managed as a multipurpose system, it is not possible to optimize regulation for each of the separate uses. Thus, the Water Control Plan represents compromises between the various uses, and flood control use directly conflicts with all other system uses to some degree. Optimum flood control protection would require that the reservoirs be maintained empty and available to control floodwaters. But even with this type of regulation, previous studies have shown that the existing system, with the limited downstream channel capacity, would not be adequate to control large spring snowmelt volumes, events of approximately a 50-year magnitude or larger, to desirable levels of downstream flooding. Optimum irrigation use would require that the system be maintained as full as possible to provide carryover storage water for the drought years, but even this operation would not necessarily assure adequate water supplies for a series of drought years. The key Boise River system use conflict is that of flood control versus system refill. The operational flood control rule curves given in the system's Water Control Manual (referenced in II. o)define a system of operation to balance flood control risks and refill assurances and were specifically designed to minimize the impact of volume forecast errors and abnormal runoff timing sequences.

Tables 9, 10, and 11 summarize the maximum mean daily flows, maximum annual peak flows, and annual runoff volumes, respectively, for selected sites on the Boise River. Collectively, these tables illustrate how peak flows and runoff volumes can be modified by manmade projects on the Boise River. For example, during the 1983 runoff year, an inflow of 24,294 cfs to Lucky Peak Reservoir was noted, but a flow of only 9,560 cfs was noted at Glenwood Bridge gaging station, or only 39 percent of that noted inflowing to Lucky Peak Reservoir. Also during 1983, the tables show that while only 68 percent of the annual volumes noted at Lucky Peak Reservoir was also noted at Glenwood Bridge gaging station, 84 percent of the volume was noted at Parma, a gain of 16 percent. This shows the effect of irrigation diversions and return annual flood volumes.

d. <u>Boise Gulches Streamflow Characteristics</u>

(1) <u>Streamflow Characteristics</u>. Water supplies in the Boise Front Gulch areas are limited, and surface flows in most of the gulches are intermittent and occur only for a few weeks a year in the late winter and spring or following severe rainstorms. Runoff from the gulch areas is not regularly measured; however, some sporadic streamflow records exist for Cottonwood Creek.

(2) <u>Flood Characteristics</u>. Floods in the gulch areas originate from two primary causes: (1) high intensity thunderstorm rainfall usually during the summer months, and (2) a combination of general storm rainfall and snowmelt with frozen ground conditions in the winter and early spring. Floods from

the thunderstorms do not occur as frequently as those from general rain and snowmelt conditions but are far more severe.

Thunderstorm floods have occurred on the Boise Front during the period from March through September. However, thunderstorm floods can occur at any time of the year. Winter storm floods generally occur during the months of January through March. Prolonged moderate rainfall can also occur at any time of the year, but precipitation usually occurs as snow during the winter months. Snowmelt flooding and flooding due to a combination of snowmelt and rainfall can occur any time there is significant snow cover.

The slower peaking winter general rain and snowmelt flood event may occur on all of the Boise Front drainages during the same timeframe. The quicker peaking thunderstorm flood events will likely occur on two or three of the drainages at one time. Peaks for both of these types of floods do occur in a rather short time, i.e., from 15 minutes to 6.5 hours. Both types of floods carry high sediment loads, especially the thunderstorm floods.

Both winter and thunderstorm floods have been recorded in newspaper accounts and from field surveys starting in the early 1870's through 1965. The reliability of most of the recorded flood peaks is very poor, but records do establish dates of occurrence. A U.S. Department of Agriculture Boise River Survey Report of 1940 contains estimates of floods for the years between 1871 and 1938. These estimates were based on a study of newspaper accounts and some analyses of accompanying weather and damages. A review of these estimates indicates considerable question as to magnitude, but they do establish dates of past occurrences.

VII. Channel Morphology and Sedimentation

Within the study reach, between Lucky Peak Dam and the Snake River, the Boise River flows in a steep channel formed of material which can be easily eroded and transported by the river (an "alluvial" river). There is a noticeable change in the average stream slope at Eagle Island with the average slope upstream of Eagle Island being about 13 feet per mile and downstream of Eagle Island about 8 feet per mile. In most reaches downstream of Boise, the channel cross sections continuously change shape in response to erosive forces of water as material is eroded or deposited by the river. The banks, composed mainly of silts and sands and some gravel, erode easily at high flow, sloughing into the channel. Depending upon the quantity of flow present and the size of the material, some of the material is transported completely out of the basin, some may be left at the slough site, and the remainder is at least temporarily deposited on bars, on islands, or becomes a part of a moving sand dune in the downstream reach. As a consequence of this activity, the thalweg (lowest point in the channel - low streambed) may change with time at a given location. At a specific site, the thalweg may be several feet higher (or lower) at the end of one season as compared to the previous season.

Based on the slope of the channel and the dominant or formative discharge, most segments of the Boise River fall in the braided category. Bank full discharge is considered to be the formative discharge for the Boise River, i.e., the discharge where most channel shaping takes place. A braided channel is shallow and wide, the banks are unstable and sometimes poorly defined, and in most reaches there are two or more channels that cross each other, giving the riverbed a braided appearance at low flow. Braided channels are frequently associated with easily eroded, shallow, sandy bank material. Severe lateral cutting of banks occurs as a result of the formation of alternative bar deposits in the channel bed. A change of channel alignment, natural or man-caused, often results in the creation of significant channel changes and adjustment both upstream and downstream from the alteration. Since a braided river is the most unstable of all channel forms, continual maintenance will be necessary if a well-defined incised (entrenched) channel is required.

Even prior to man's modification of the Boise River system (reduction of flood peaks, cutoff of meanders, removal of brush from the banks, significant increase in groundwater levels, removal of gravel) the river was extremely unstable. Where the river leaves the mountains, large quantities of silt, sediment, gravel, and cobble were carried out into the valley when flood flows occurred. Much of this material settled out in bars, on islands, or on the bed causing much channel shifting and inundation of the valley floor during flood stage and leaving the channel choked with bars and deposits as the flow receded. If these deposits were less erodible than the sandy banks, the next significant flood would erode the banks rather than the bars and thus cause significant lateral shifting of the channel.

Starting in the mid-1860's, some artificial constraints were imposed on the Boise River. A series of canals, drains, temporary diversion dams, channel alterations (primarily cutoffs of meander loops which caused a steepening of the reach), and material removal from the channel have occurred. Also, large storage reservoirs were constructed on the upper reaches of the river. As a result of this construction, maximum peak flows have been reduced by as much as 50 percent, the period of high flow has been extended from 2 to 3 months to 4 to 6 months, and all large sediment from upland watersheds is trapped in the reservoirs. These changes have significantly altered the characteristics of the river. The system is now part river, part canal, and part drain, with a discharge which varies from mile to mile along the channel and from week to week depending on annual yield from the watershed and irrigation demands.

VIII. Flood Frequencies

a. Boise River Flood Frequencies. As part of the Boise Valley Regional Water Management Study conducted in the 1970's (referenced in paragraph II. 1), a series of discharge frequency curves were developed with various diversion rates to the Snake River with and without increased storage in Lucky Peak. Following is a partial listing of the combinations considered in that report, this partial listing being the two alternatives also considered for the present Lower Boise River Study.

(1) Present operation and reservoir pool (base condition).

(2) Present pool + 500 cfs diverted to the Snake River.

The procedure used to develop the flood frequencies involved the use of observed floods and large, specific frequency floods. These floods were routed through the Boise River Reservoir and Diversion System to define a regulated frequency curve for each of the alternative conditions. The observed floods, regulated since 1955, were used to define the lower more frequent flood portion of the frequency curve, and regulated annual peak discharges found by routing large, specific frequency floods were used to define the upper portion of the curve. Before the floods could be routed through the system, flood routing criteria were developed based on (1) natural inflow volumes from 1 January-31 March, (2) reservoir release and diversion volumes from 1 January-31 March, (3) reservoir release and diversion flows from 1 April-31 July, (4) critical beginning reservoir system flood control space on 1 January, and (5) resulting 1 April reservoir system flood control space. Regulated peak discharges for the large floods were then determined by limiting Boise River flows at Boise to 6,500 cfs channel capacity until the reservoirs were full and spilled inflow.

Specific frequency floods used in the analysis were the 50-year, 100-year, 200-year, 500-year, and 1,000-year

1 April-31 July floods. These floods have natural peak discharges and volumes which correspondence to those in Table 12.

Table 12
Boise River at Boise Specific Frequency Flood
Peak Discharge and Volume Summary

Specific Frequency Floods
(Boise River at Boise)

Return Interval (year)	Exceedence Probability (in percent)	Unregulated Peak (cfs)	April-July Volume (1,000 A.F.)
50	2	37,500	2,870
100	1	42,500	3,100
200	0.5	48,000	3,330
500	0.2	55,500	3,560
1,000	0.1	61,000	3,750

The natural 1 January-31 March reservoir system inflow volume for each specific frequency flood was derived through correlation of unregulated 1 January-31 March inflow volumes vs. unregulated 1 April-31 July inflow volumes since 1895. The resulting inflow volumes for each specific frequency flood are shown in Table 13.

Table 13
Boise River Specific Frequency Flood Inflow Volume Summary

Return Interval (years)	1 April-31 July Inflow Volume (1,000 A.F.)	1 January-31 March Inflow Volume (1,000 A.F.)
50	2,870	550
100	3,100	600
200	3,330	670
500	3,560	700
1,000	3,750	700

The reservoir releases, to the channel through Boise from 1 January-31 March, used in the analysis were (1) minimum releases during the first week in January, (2) increase releases to 4,000 cfs during the following week and hold releases at 4,000 cfs until the first week in February, and then (3) increase releases to 6,500 cfs channel capacity through the end of March. Therefore, the total reservoir release volume through Boise for the 1 January-31 March period is approximately 930,000 acre-feet. In addition to this volume, approximately 40,000 acre-feet of water is normally diverted from the Boise River to Lake Lowell during this same period; thus, the total reservoir release volume (from 1 January-31 March) used in the analysis is 970,000 acre-feet for the base condition. The 1 January-31 March release volume of 970,000 acre-feet was increased by 52,000 acre-feet to represent variable diversions to the Snake River of up to a maximum rate of 500 cfs.

Reservoir releases significantly increase during and after April for irrigation diversions. Table 14 lists irrigation diversions and total reservoir releases used in the analysis for the 1 April-31 July period for the alternative conditions. Diversions from the Boise River to the New York Canal were limited to 3,000 cfs during this period since flows much larger than this would require additional diversion facilities at Diversion Dam and increased channel capacity of the New York Canal throughout its entire reach.

Table 14
Lucky Peak Reservoir Release and Diversion Schedule
(1 April-31 July)

	1 April-31 July Releases from Lucky Peak			
Condition	Boise River at Boise (cfs/day)	New York Canal (cfs/day)	Diversions Between Diversion Dam and Boise (cfs/day)	Total Release (cfs/day)
(Base Condition - no flow to Snake River)				
April	6,500	1,500	400	8,400
May	6,500	2,600	500	9,600
June	6,500	2,700	600	9,800
July	6,500	2,800	600	9,900
(Divert 500 cfs to Snake River)				
April	6,500	2,000	400	8,900
May	6,500	3,000	500	10,000
June	6,500	3,000	600	10,100
July	6,500	3,000	600	10,100

Beginning reservoir system storage and available flood control space are critical factors in determining regulated Boise River flood discharges. The 1 January system storage and resulting available flood control space are a function of irrigation releases during the previous year and the fall and winter inflows. Since 1955, the historical 1 January available flood control space has ranged from approximately 150,000 to 700,000 acre-feet as compared to the system total of 988,000 acre-feet. A frequency curve defining the 1 January available Boise River Reservoir flood control space since 1955 was developed, and the results are shown in Table 15.

Table 15
System Flood Control Space Exceedence Probability

1 January Available System Flood Control Space (1,000 A.F.)	Exceedence Probability (percent)
160	98
260	75
430	50
560	25
820	2

Reservoir system flood control space for 1 April was then computed for the base condition (existing projects) for each of the five values from the 1 January available space frequency curve and each of the six specific frequency floods. After the 1 April flood control spaces were computed for the base condition, 1 April flood control space values were then computed for condition of diverting 500 cfs to the Snake River.

After all of the flood routing criteria and initial conditions had been defined, the specific frequency floods were routed through the reservoir system.

Five regulated peak discharges, one for each of the five initial 1 January available system flood control storages, were determined by the flood routing for each specific frequency flood condition. These five regulated peak discharges were then weighted to determine the average regulated peak discharge for each specific frequency condition.

The average expected regulated peak discharge above Diversion Dam for each specific frequency flood and alternative condition was estimated by computing the area under each of the five regulated peak discharges vs. 1 January available system flood control space frequency curve. Table 16 is an example of the averaging technique used.

Table 16
Frequency Curve Averaging Technique Illustration

(1,000 AF)	1 January Available System Flood Control Space Occurrence Probability: Probability	Change	50-Year Existing Project Regulated Peak Discharge Above Diversion Dam (cfs)	Average (cfs)	Estimated Peak Col 3xCol 5
(1)	(2)	(3)	(4)	(5)	(6)
160	.02	.02	20,200	20,000	404
260	.25	.23	17,800	19,000	4,370
430	.50	.25	15,000	16,400	4,100
560	.75	.25	9,900	12,400	3,100
820	.98	.23	9,900	9,900	2,277
		.02		9,900	198
		1.00			14,449

Using the resultant regulated peak discharges above Diversion Dam, peak discharges below Diversion Dam and at Boise were then computed by subtracting the diversion discharges from the Boise River peak discharges. For the above example, the 50-year regulated peak discharge at Boise is 14,449 cfs minus 2,700 cfs diversion at the New York Canal for June minus 600 cfs diversions between Diversion Dam and Boise for approximately 11,000 cfs at Boise. Diversion schedules are shown on Table 14. Final results are shown on Table 17 for the base (existing projects) condition and diverting 500 cfs to the Snake River.

Table 17
Boise River Peak Discharges for Base Condition and Diversion of 500 cfs

Average Return Interval (Years)	Exceedence Probability (Percent)	Natural (cfs)	Base Condition (cfs)	Divert 500 cfs (cfs)
Peak Discharges below Diversion Dam				
2	50	14,300	5,650	5,650
5	20	21,200	7,800	7,200
10	10	26,200	8,200	7,200
20	5	31,100	8,400	7,200
50	2	37,700	12,000	10,000
100	1	42,900	17,600	14,700
200	0.5	48,400	24,200	20,500
500	0.2	55,800	35,000	29,500
1,000	0.1	61,500	44,000	37,000

Table 17 (continued)
Boise River Peak Discharges for Base Condition
and Diversion of 500 cfs

Peak Discharges at Boise

Average Return Interval (Years)	Exceedence Probability (Percent)	Natural (cfs)	Base Condition (cfs)	Divert 500 cfs (cfs)
2	50	14,300	4,850	4,850
5	20	21,200	7,000	6,500
10	10	26,000	7,200	6,500
20	5	31,000	7,200	6,500
50	2	37,500	11,000	9,400
100	1	42,500	16,600	14,200
200	0.5	48,000	23,700	20,000
500	0.2	55,500	34,800	29,200
1,000	0.1	61,000	44,000	37,000

Charts 1 and 2 show the Flood Flow Frequency Curves developed.

b. Boise Gulches Flood Frequencies. Both a thunderstorm peak discharge frequency curve and a winter peak discharge frequency curve were developed for each of the seven drainages studied. Based on the derived thunderstorm and winter peak discharge frequency curves, annual peak discharge frequencies were then derived by compositing the thunderstorm and winter peak discharge frequencies. All peak discharges have been bulked to include the effect of sediment.

(1) Thunderstorm Frequencies. Thunderstorm peak discharges for the 25-, 50-, and 100-year intervals were computed by: (1) deriving Snyder 15-minute unit hydrographs for each of the seven gulches; (2) deriving the 25-, 50-, and 100-year thunderstorm precipitation (15-minute intervals) using procedures described in "National Oceanic and Atmospheric Administration, Atlas 2 (Precipitation-Frequency Atlas of the Western United States)," Volume V - Idaho; and (3) runoff hydrographs were computed using the derived data in Hydrologic Engineering Center (HEC) computer program HEC-1. Constant loss rates of 0.84 inches/hour. 0.64 inches/hour, and 0.60 inches/hour were used for the 25-, 50-, and 100-year thunderstorm floods, respectively. The 10- and 20-year thunderstorm events were drawn to reflect the infrequent occurrence of thunderstorm floods.

(2) Winter Frequencies. Winter peak discharges were computed by (1) deriving Snyder 30-minute unit hydrographs for each of the seven gulches;(2) using the 2-, 5-, 10-, 25-, 50-, and 100-year winter rain and snowmelt derived previously for "Hydrology - Cottonwood Creek Dam and Stuart Gulch Dam and Reservoir - Boise, Idaho;" and then (3) runoff hydrographs were computed using the derived data in HEC computer program HEC-1. Constant loss rate of 0.20 inches/hour was used for all storms and gulches, and it was assumed that there would be a 20-percent chance of having these loss conditions at the time of the storm. Therefore, the flood frequencies were adjusted by the equation [P(flood)=P(rain) X 0.20], to account for the loss conditions.

(3) Composite Frequencies. Thunderstorm and winter peak discharge frequency curves were composited using the equation shown below to derive the annual peak discharge frequencies for each gulch and discharge. The purpose of a composite frequency curve is to provide the annual peak discharge for specific frequency flood events, where the flood events are exclusively independent.

$$P3 = P1 + P2 - (P1P2)/100$$

where P1 = Thunderstorm flood peak discharge exceedence probability (percent)

P2 = Winter flood peak discharge exceedence probability (percent)

P3 = Composited annual peak discharge exceedence probability (percent)

The thunderstorm, winter peak, and annual peak (composite) discharge frequency curves are shown on Charts 3 through 5, respectively.

IX. Boise River Basin Federal Project Descriptions

a. Anderson Ranch Dam. Anderson Ranch Dam, located about 30 miles northeast of Mountain Home, Idaho, on the South Fork Boise River, was authorized for construction by the Secretary of the Interior under the provision of Section 9 of the Reclamation Act of 1939. It is located approximately 124 river miles above the mouth of the Boise River and is the most upstream reservoir within the system. The findings of feasibility used as a basis for the authorization are given in House Document 916 which states in part: "The capacity of Anderson Ranch Reservoir amounting to 500,000 acre-feet will be utilized as follows: flood control, 212,500 acre-feet; irrigation development, 212,500 acre-feet; power development, 45,000 acre-feet; silt control, 30,000 acre-feet." Although it is stated in the document that the capacity of Anderson Ranch Reservoir will amount to 500,000 acre-feet, a survey of the reservoir area made in February 1946 determined the total storage capacity to the top of spillway gates (elevation 4,196) to be 493,000 acre-feet. Present approved plans provide for 418,000 acre-feet to be used for irrigation and flood control and the remaining 75,000 acre-feet to be dead storage for the production of power, maintenance of permanent pools for the preservation and propagation of fish and wildlife, and silt control. Construction of Anderson Ranch Dam was started in 1941 and completed in 1950. It is rolled earth and rockfill embankment having a structural height of 456 feet and a crest length of 1,350 feet. Its crest width is 40 feet and provides an area for a gravel roadway across the dam. The drainage area above Anderson Ranch Reservoir is approximately 980 square miles. The project's spillway is a concrete-lined chute in the left abutment controlled by two radial gates having a total capacity of 20,000 cubic feet per second with full pool. The outlet works consists of a concrete-lined tunnel of 20-foot diameter in the left abutment with penstocks to the powerhouse and five 72-inch hollow-jet outlet valves. Anderson Ranch Dam was designed for a total of three generating units, and presently two units are installed and operating and the third unit is planned for the future. The reservoir pool level behind the Anderson Ranch Dam normally fluctuates between pool elevations of 4,039.6 and 4,196 feet above mean sea level. Recreation areas on Anderson Ranch project lands are administered by the U.S. Forest Service as part of the Boise National Forest under a Memorandum of Agreement with the U.S. Bureau of Reclamation dated 19 January 1970. Plate 1 shows the location of the Anderson Ranch project.

b. Arrowrock Dam. Arrowrock Dam, located on the Boise River, about 4 miles below the junction of the North and South Forks and about 22 miles upstream from Boise, Idaho, was completed by the Bureau of Reclamation in 1917 and raised 5 feet in 1937. It is located approximately 75 river miles upstream of the mouth of the Boise River and is approximately 49 river miles downstream of Anderson Ranch Dam. The drainage area above Arrowrock Dam is about 2,210 square miles of which 980 square miles is above Anderson Ranch Dam. Arrowrock Dam is a thick arch concrete structure having a structural height of 350 feet, a hydraulic height of 257 feet, and a crest length of 1,150 feet. Its crest width is 16 feet and provides for a road across the dam. Maximum base width of the dam is 223 feet.

The project's spillway is located in a granite cut at the right side of the dam and is a gated and lined side channel approximately 800 feet long. The effective crest of the spillway is controlled by six drum gates, each being 62 feet long, 6 feet high, and separated by 6-foot wide piers. The crest of the spillway weir is at 3,210 feet MSL. The maximum spillway capacity at a maximum reservoir elevation of 3,219.75 is 40,000 cfs. The live storage capacity of Arrowrock Dam is 285,000 acre-feet. Although no flood control space was originally authorized in Arrowrock Reservoir, Region 1 of the Bureau of Reclamation and the Walla Walla District, Corps of Engineers, with concurrence of irrigation interests, have agreed that the entire live storage space will be operated in the joint interests of irrigation and flood control coordinated with Anderson Ranch and Lucky Peak reservoirs. The project's outlet works consist of two horizontal rows of ten discharge outlets in each row and five low-elevation sluice gates. The outlet works are designed for a maximum discharge, under emergency conditions, of 21,800 cfs at the normal reservoir pool elevation of 3,216 feet MSL. The normal maximum discharge capacity is 10,200 cfs.

Arrowrock Dam presently has no power generating units installed but was designed so that power facilities could be added in the future. Power generation potential at Arrowrock project was substantially reduced by Lucky Peak project's construction because Lucky Peak's pool backs up on the downstream face of Arrowrock Dam, thus reducing Arrowrock's effective hydraulic head.

Arrowrock's pool elevation normally fluctuates between 2,974 and 3,216 feet MSL. Recreation areas on Arrowrock project lands are administered by the U.S. Forest Service as part of the Boise National Forest under a Memorandum of Agreement with the Bureau of Reclamation dated 30 July 1952. Plate 1 shows the location of the Arrowrock project.

c. Lucky Peak Dam. Lucky Peak Dam and Reservoir project for flood control, irrigation, and other water uses was authorized by Public Law 526, Seventy-ninth Congress, Second Session, approved 24 July 1946. The dam was completed by the Corps of Engineers in 1955 and dedicated in June 1955. Lucky Peak Dam is a rolled earth and gravel embankment with a central impervious core extending from its base to the top of the dam. The dam has a structural height of 340 feet, a hydraulic height of 238 feet, and a crest length of 1,700 feet. The dam crest is at elevation 3,078 feet MSL and is 30 feet wide, providing a roadway across the dam. The dam is located on Boise River about

10 miles southeast of Boise and approximately 10 river miles downstream from Arrowrock Dam. A drainage area of 2,650 square miles is tributary to the project. About 470 square miles of the total is tributary to Boise River below Arrowrock Dam. A survey since completion of the dam shows the reservoir has a capacity of 307,000 acre-feet below the spillway crest (elevation 3,060). Of the total capacity, 279,000 acre-feet will be active capacity for multiple-purpose use, and about 28,000 acre-feet below elevation 2,905 will comprise the minimum storage pool. The uncontrolled freecrest spillway is 600 feet in length with an unlined channel. The spillway is located south of the dam, is 600 feet long, and made of reinforced concrete. Its crest is at elevation 3,060 feet MSL. Discharges over the spillway are uncontrolled, and at the maximum pool elevation of 3,072 feet MSL, the discharge would be approximately 93,300 cfs. The outlet works consist of a 23-foot steel-lined concrete tunnel with manifold controlled by six slide gates and one hollow-jet valve. The project's outlet works are designed for a discharge of 35,000 cfs at normal pool elevation of 3,055 feet MSL and a discharge of 15,900 CFS at a minimum pool of 2,905 feet MSL. The tunnel inlet structure is equipped with two gates for emergency use and maintenance of the manifold. Lucky Peak Reservoir's pool level normally fluctuates between elevation 2,905 and 3,055 feet MSL. The auxiliary bypass system consists of an intake structure, a steel lined conduit 12 feet in diameter and 2,435 feet long, and an outlet works. The system's design discharge at a pool elevation of 3,055 feet above MSL is approximately 5,860 cfs. In 1988, a three-unit powerhouse having a total installed capacity of 103 megawatts was added to the Lucky Peak projects. Two vertical shaft Kaplan hydraulic turbine generator units rated at 46 megawatts each and one vertical shaft Kaplan hydraulic turbine generator unit rated at 11.5 megawatts are installed and operating at the powerplant. The total hydraulic capacity of the powerhouse and auxiliary outlet works ranges from approximately 6,740 cfs at a pool elevation of 2,905 feet above MSL to approximately 11,470 cfs at a pool elevation of 3,055 feet above MSL, these two elevations representing the elevations of the top of the active conservation pool and the normal full pool, respectively. Recreation developments on project lands are the responsibility of the Corps of Engineers, with cooperation by the Idaho Department of Parks and Recreation. Plate 1 shows the location of the Lucky Peak project.

d. Diversion Dam. Diversion Dam, built by the U.S. Bureau of Reclamation, is on the Boise River about 2 miles downstream from Lucky Peak dam site and is used to divert water to the New York Canal for irrigation of the Boise Irrigation Project. Diversion Dam is a rubble concrete weir-type structure with an earthfill section on each abutment protected by a concrete retaining wall on the upstream face. Its overall length is approximately 500 feet. The spillway has a structural height of 46 feet, a hydraulic height of 35 feet, and a crest length of 216 feet, excluding the 30-foot logway. Its crest elevation is 2,812.24 feet MSL and capacity is 40,000 cfs. Diversion Dam has no effect on flood control except for the reduction in floodflows by the amount of diversion to the New York Canal. The New York Canal diverts an average of 1,365 second-feet during March and 2,820 second-feet from 1 April through July. These diversion discharges were considered dependable for reduction of flows below Diversion Dam in the reservoir regulation plan described herein for all floods below 35,000 cubic feet per second. Diversion Dam has a minimal recreational use demand. Plate 1 shows the location of Diversion Dam.

e. Lake Lowell. Lake Lowell is an off-river reservoir located 21 miles southwest of Boise, Idaho, on the plateau between the Boise and Snake Rivers. Lake Lowell is formed by three earth embankments. Construction was completed, and storage began in 1908. The reservoir at normal pool has a usable capacity of 177,000 acre-feet allocated exclusive to irrigation. Lake Lowell is fed by the New York Canal. Lake Lowell is a high recreational use area having fishing, boating, and picnicking facilities. Plate 1 shows the location of Lake Lowell.

X. Boise River Reservoir System Operation and Memorandum of Agreement

From 1953 until the date of final approval of the Water Control Manual in 1985, the Boise River reservoirs were regulated under terms of a Memorandum of Agreement between the Department of the Army and the Department of the Interior. This agreement committed the existing irrigation reservoirs (Arrowrock and Anderson Ranch) to a flood control operation with Lucky Peak Reservoir. The agreement was made upon completion of Lucky Peak Reservoir to protect existing irrigation use of Anderson Ranch and Arrowrock Reservoirs during flood control regulation and to commit the space in Lucky Peak Reservoir to irrigation as well as flood control use. Important features of the Memorandum of Agreement included:

a. Commitment of 983,000 acre-feet of space in the three reservoirs (Anderson Ranch, Arrowrock, and Lucky Peak) to use for flood control and irrigation. This was essentially all of the active space in the reservoirs.

b. Specification of flood space parameter curves to be used from 1 January to 31 July with agreed-upon forecasts of runoff to determine evacuation requirements.

c. Protection of space allocations in Arrowrock, Anderson Ranch, and Lake Lowell against water loss as a result of flood control operations.

d. Provision for coordination and agreement on runoff forecasts.

e. Specification of a maximum regulated flow objective to 6,500 cfs below Diversion Dam at the Glenwood Bridge gaging station during the reservoir refill period. This flow could be made if diversion rates assumed in the derivation of the flood control space parameter curves were not made.

f. Provision of evacuation and refill sequence among the three reservoirs.

g. Provision for releases during the refill period greater than 6,500 cfs below Diversion Dam at the Glenwood Bridge gaging station when forecasts of runoff required more than 983,000 acre-feet to be provided for flood control. Those increased releases would be specified by the Chief of Engineers (U.S. Army Corps of Engineers) after consultation with the Commissioner of Reclamation.

h. Provision for maintaining Lucky Peak Lake full as long as possible after the flood control season or until 15 September for recreation purposes. This would be done by releasing Arrowrock water first for downstream irrigation uses.

i. Provisions for modifications of the regulating plan with respect to allowable releases and space requirements for flood control upon agreement of the Chief of Engineers and Commissioner of Reclamation or their authorized representatives. Such modification would take place only after consultation with the Idaho Reclamation Engineer, Boise River Watermaster, and Boise Board of Control Manager.

The document dated April 1985 entitled, "Water Control Manual for Boise River Reservoirs" (with revisions) should be consulted for a comprehensive discussion of the Memorandum of Agreement.

XI. Effects of Boise River Projects on Flow Magnitudes

Storage reservoirs created by the Anderson Ranch, Arrowrock, and Lucky Peak Dams have modified the Boise River's flow characteristics through the Lower Boise River study reach covered by this report. Plate 3 compares the unregulated and regulated maximum, minimum, and average mean daily flows for the period 1955 through 1994. The maximum mean daily curves represent the single largest mean daily flow experienced on any given day, over the entire period of record. The minimum mean daily curves represent the single smallest mean daily flow experienced on any given day, over the entire period of record. The average mean daily curves represent the average mean daily flow experienced on any given day and was computed by averaging the mean daily flows on any given day over the entire period of record.

a. Unregulated Flows. The unregulated flow values for all plots were computed based on the daily changes in storage at the three upstream Federal projects: (1) Anderson Ranch, (2) Arrowrock, and (3) Lucky Peak sites. The daily average flow value derived from the total daily storage changes at the three projects was added to the measured mean daily outflow value from Lucky Peak Reservoir to give an unregulated mean daily flow value for any given day. Travel time and channel routing effects were neglected in the computations. The unregulated flow values were computed by the United States Bureau of Reclamation at Boise, Idaho.

b. Regulated Flows. The regulated flows for all plots were obtained from measurements taken at the United States Geological Survey (USGS) gaging station numbered 13202000, "Boise River near Boise, Idaho." The values utilized were mean daily flow values for any given day.

TABLE 9
BOISE RIVER ANNUAL MAXIMUM MEAN DAILY FLOW SUMMARY
ARROWROCK RESERVOIR DOWNSTREAM TO PARMA

YEAR	BOISE RIVER ARROWROCK RELEASES	BOISE RIVER LUCKY PEAK INFLOW	BOISE RIVER LUCKY PEAK OUTFLOW	BOISE RIVER GLENWOOD BRIDGE	BOISE RIVER PARMA
1896	---	35500	---	---	---
1899	---	19000	---	---	---
1900	---	11960	---	---	---
1901	---	12700	---	---	---
1902	---	8190	---	---	---
1903	---	16800	---	---	---
1906	---	8710	---	---	---
1908	---	10600	---	---	---
1909	---	16000	---	---	---
1911	---	15100	---	---	---
1912	14000	15600	---	---	---
1913	14000	---	---	---	---
1914	11500	11300	---	---	---
1915	3240	6227	---	---	---
1916	13100	16550	---	---	---
1917	11000	17848	---	---	---
1918	11800	12601	---	---	---
1919	12100	11580	---	---	---
1920	6700	9623	---	---	---
1921	16200	18739	---	---	---
1922	14300	18174	---	---	---
1923	9300	11950	---	---	---
1924	3400	5186	---	---	---
1925	13600	14350	---	---	---
1926	3990	7094	---	---	---
1927	14300	20061	---	---	---
1928	17600	20710	---	---	---
1929	6490	9374	---	---	---
1930	7050	7559	---	---	---
1931	4090	5434	---	---	---
1932	12600	13580	---	---	---
1933	11400	12508	---	---	---
1934	3950	6110	---	---	---
1935	8990	9501	---	---	---
1936	15100	19790	---	---	---
1937	5450	7705	---	---	---
1938	14400	19286	---	---	---

TABLE 9 (Continued)
BOISE RIVER ANNUAL MAXIMUM MEAN DAILY FLOW SUMMARY
ARROWROCK RESERVOIR DOWNSTREAM TO PARMA

YEAR	BOISE RIVER ARROWROCK RELEASES	BOISE RIVER LUCKY PEAK INFLOW	BOISE RIVER LUCKY PEAK OUTFLOW	BOISE RIVER GLENWOOD BRIDGE	BOISE RIVER PARMA
1939	7250	8413	---	5300	---
1940	8960	9866	---	6100	---
1941	8090	8861	---	5330	---
1942	8860	10690	---	6900	---
1943	18800	25040	---	20500	---
1944	6840	7632	---	3870	---
1945	9080	11644	---	7080	---
1946	12500	18812	---	10800	---
1947	11300	13838	---	8390	---
1948	11800	15260	---	9500	---
1949	8410	12829	---	5710	---
1950	9380	13673	---	6720	---
1951	10200	14065	---	7510	---
1952	9380	23429	---	7790	---
1953	10100	14790	---	8110	---
1954	8870	14660	---	6030	---
1955	12966	10478	5110	1740	---
1956	18181	22949	9470	6840	---
1957	11649	16930	10600	6870	---
1958	12294	21745	10000	6320	---
1959	6923	9040	5390	1800	---
1960	7681	11842	8200	5710	---
1961	9330	7830	5360	1560	---
1962	8730	11343	5320	1540	---
1963	9582	11480	9820	5870	---
1964	9640	10938	7230	4630	---
1965	13474	27294	11600	7170	---
1966	5553	8225	4960	1760	---
1967	10601	15598	5270	1640	---
1968	9035	7048	5130	1800	---
1969	11694	15935	8660	5280	---
1970	13016	14847	8500	5030	---
1971	13832	20253	10800	6850	---
1972	12359	19559	10200	6710	---
1973	5094	9555	4760	1460	---
1974	13326	18469	10820	7460	---
1975	13685	20618	10500	6680	---

TABLE 9 (Continued)
BOISE RIVER ANNUAL MAXIMUM MEAN DAILY FLOW SUMMARY
ARROWROCK RESERVOIR DOWNSTREAM TO PARMA

YEAR	BOISE RIVER ARROWROCK RELEASES	BOISE RIVER LUCKY PEAK INFLOW	BOISE RIVER LUCKY PEAK OUTFLOW	BOISE RIVER GLENWOOD BRIDGE	BOISE RIVER PARMA
1976	8051	13732	8500	5730	---
1977	3384	3190	3870	1230	---
1978	7055	11896	7240	5460	5590
1979	5286	9622	4820	1560	4810
1980	10374	12958	9180	5620	5430
1981	9500	9710	9500	6830	6860
1982	13493	19194	10700	7350	7530
1983	15697	24294	13200	9560	9140
1984	8795	22538	10500	6900	7190
1985	8510	9834	4750	2360	3130
1986	15699	18000	11500	7960	7720
1987	7724	5609	4020	1470	2400
1988	8340	6234	3830	939	1260
1989	9792	13438	8680	6130	6780
1990	6449	7970	3870	875	1730
1991	6850	6320	3880	968	1640
1992	3896	4149	3860	830	1070
1993	9210	16723	9860	6560	6530
1994	---	---	---	1211	1237

NOTES:

1. SOURCE OF ALL DATA IS RESERVOIR CONTROL SECTION, HYDROLOGY BRANCH, U.S. ARMY CORPS OF ENGINEERS, WALLA WALLA DISTRICT DATA BASE, WALLA WALLA, WASHINGTON.

2. MEAN DAILY FLOW VALUES GIVEN IN CUBIC FEET PER SECOND (CFS).

TABLE 10
BOISE RIVER ANNUAL PEAK DISCHARGES AT USGS GAGE SITES

YEAR	BOISE RIVER NEAR BOISE	BOISE RIVER AT GLENWOOD BRIDGE	BOISE RIVER AT PARMA
1895	7880	---	---
1896	35500	---	---
1897	29500	---	---
1898	7960	---	---
1899	19000	---	---
1900	12000	---	---
1901	13900	---	---
1902	8190	---	---
1903	16800	---	---
1904	19700	---	---
1905	6260	---	---
1906	8710	---	---
1907	17000	---	---
1908	10600	---	---
1909	16000	---	---
1910	16600	---	---
1911	15100	---	---
1912	15600	---	---
1913	13300	---	---
1914	11300	---	---
1915	3650	---	---
1916	15100	---	---
1938	---	13000	---
1939	---	5300	---
1940	---	6350	---
1955	9860	---	---
1956	9490	---	---
1957	10600	---	---
1958	10000	---	---
1959	5390	---	---
1960	8200	---	---
1961	5360	---	---
1962	5320	---	---
1963	9820	---	---
1964	7230	---	---
1965	11600	---	---
1966	4960	---	---
1967	5270	---	---
1968	5130	---	---

TABLE 10 (Continued)
BOISE RIVER ANNUAL PEAK DISCHARGES AT USGS GAGE SITES

YEAR	BOISE RIVER NEAR BOISE	BOISE RIVER AT GLENWOOD BRIDGE	BOISE RIVER AT PARMA
1969	8660	---	---
1970	8500	---	---
1971	10800	---	---
1972	10200	---	7840
1973	4760	---	1550
1974	10800	---	6990
1975	10500	---	7190
1976	8500	---	5680
1977	3870	---	1610
1978	7240	---	5670
1979	4280	---	6040
1980	9180	---	5460
1981	9500	---	7300
1982	10700	7630	7670
1983	13200	9840	9240
1984	10500	6950	7280
1985	4750	2420	3230
1986	11500	8030	7800
1987	4020	1540	2440
1988	3830	1000	1320
1989	8680	6130	6860
1990	3870	959	2070
1991	3880	1030	1870
1992	3860	1120	1220
1993	9650	6730	6610
1994	---	1640	---

NOTES:

1. SOURCE OF ALL DATA IS UNITED STATES GEOLOGICAL SURVEY (USGS) WATER RESOURCES DIVISION OFFICE IN BOISE, IDAHO. DATA WAS RECEIVED VIA COMPUTER AND WAS NOT OBTAINED FROM PUBLISHED USGS WATER SUPPLY PAPERS.

2. GAGE NUMBERS AND NAMES ARE:

(a) BOISE RIVER NEAR BOISE, IDAHO; GIVEN UNDER USGS NUMBER 13202000. PUBLISHED AS "NEAR HIGHLAND" 1905-1915; AND AS "BELOW MOORE CREEK, NEAR ARROWROCK" 1916.

(b) BOISE RIVER AT GLENWOOD BRIDGE, IDAHO; GIVEN UNDER USGS NUMBER 13206000. PUBLISHED AS "AT STRAWBERRY GLEN BRIDGE NEAR BOISE" 1938-1940.

(c) BOISE RIVER AT PARMA, IDAHO; GIVEN UNDER USGS NUMBER 13213000.

3. ANNUAL PEAK DISCHARGE VALUES ARE GIVEN IN CUBIC FEET PER SECOND (CFS).

TABLE 11
BOISE RIVER ANNUAL DISCHARGE VOLUMES

YEAR	BOISE RIVER NEAR BOISE	DIVERSIONS BETWEEN LUCKY PEAK AND GLENWOOD BRIDGE	BOISE RIVER AT GLENWOOD BRIDGE	BOISE RIVER AT PARMA GAGE
1896	3274000	---	---	---
1898	1511000	---	---	---
1899	2907000	---	---	---
1901	1971000	---	---	---
1902	1468000	---	---	---
1903	2251000	---	---	---
1906	1688000	---	---	---
1908	1830000	---	---	---
1909	2727000	---	---	---
1910	2737000	---	---	---
1911	2477000	---	---	---
1912	2461000	---	---	---
1913	2044000	---	---	---
1914	2116000	---	---	---
1915	1178000	---	---	---
1916	2571000	---	---	---
1939	---	---	413800	---
1940	---	---	600800	---
1953	2106000	---	---	---
1954	2123000	---	---	---
1955	1392000	---	---	---
1956	2929000	---	---	---
1957	2497000	---	---	---
1958	2440000	---	---	---
1959	1572000	---	---	---
1960	1952000	---	---	---
1961	1406000	---	---	---
1962	1586000	---	---	---
1963	1771000	---	---	---
1964	1802000	---	---	---
1965	3449000	---	---	---
1966	1686000	---	---	---
1967	1662000	---	---	---
1968	1490000	---	---	---
1969	2387000	---	---	---
1970	2129000	---	---	---
1971	3383000	---	---	---

TABLE 11 (Continued)
BOISE RIVER ANNUAL DISCHARGE VOLUMES

YEAR	BOISE RIVER NEAR BOISE	DIVERSIONS BETWEEN LUCKY PEAK AND GLENWOOD BRIDGE	BOISE RIVER AT GLENWOOD BRIDGE	BOISE RIVER AT PARMA GAGE
1972	3160000	---	---	2315000
1973	1563000	---	---	590900
1974	2994000	---	---	1999000
1975	2509000	---	---	1569000
1976	2168000	---	---	1325000
1977	1110000	---	---	449300
1978	1857000	---	---	949400
1979	1453000	---	---	530700
1980	1818000	---	---	1036000
1981	1589000	---	---	799700
1982	2928000	---	---	2212000
1983	3351000	1125000	2296000	2820000
1984	2911000	1148000	1857000	2267000
1985	1734000	1195000	643800	908000
1986	2784000	1221000	1644000	2042000
1987	1335000	987300	392800	637000
1988	1119000	844100	307100	431300
1989	1593000	1159000	499300	733000
1990	1185000	942600	309600	479400
1991	1221000	939200	312400	495300
1992	825400	573600	260100	333500
1993	1596000	1046000	565500	828600
1994	1386000	---	398900	523200

NOTES:

1. SOURCE OF ALL DATA IS UNITED STATES GEOLOGICAL SURVEY (USGS) WATER RESOURCES DIVISION OFFICE IN BOISE, IDAHO. DATA WAS RECEIVED VIA COMPUTER AND WAS NOT OBTAINED FROM PUBLISHED USGS WATER SUPPLY PAPERS.

2. GAGE NUMBERS AND NAMES ARE:

(a) BOISE RIVER NEAR BOISE, IDAHO; GIVEN UNDER USGS NUMBER 13202000. PUBLISHED AS "NEAR HIGHLAND" 1905-1915 AND AS "BELOW MOORE CREEK, NEAR ARROWROCK" 1916.

TABLE 11 (Continued)
BOISE RIVER ANNUAL DISCHARGE VOLUMES

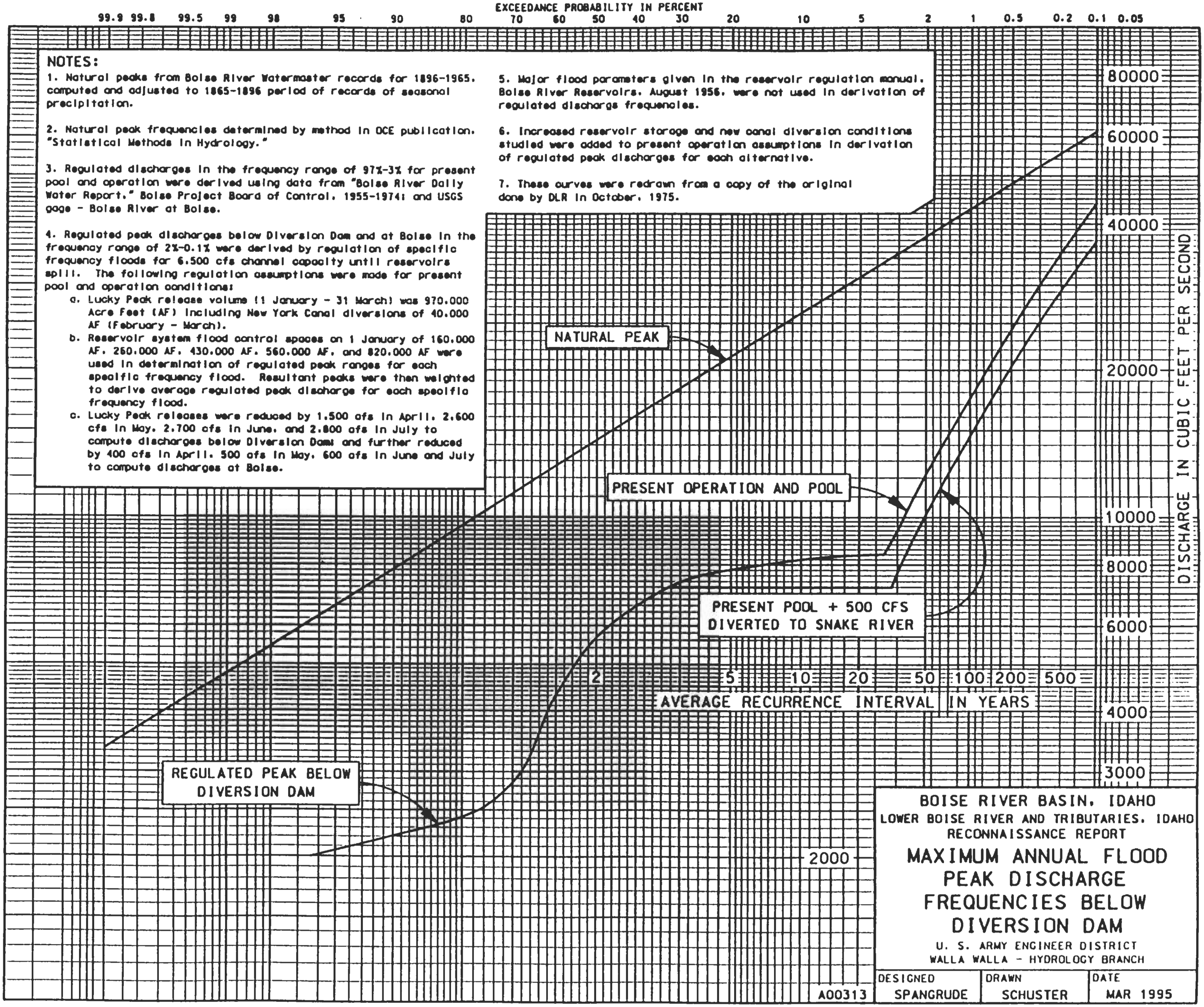
(b) DIVERSIONS FROM BOISE RIVER GIVEN UNDER USGS NUMBER 13205995.

(c) BOISE RIVER AT GLENWOOD BRIDGE, IDAHO; GIVEN UNDER USGS NUMBER 13206000. PUBLISHED AS "AT STRAWBERRY GLEN BRIDGE NEAR BOISE" 1938-1940.

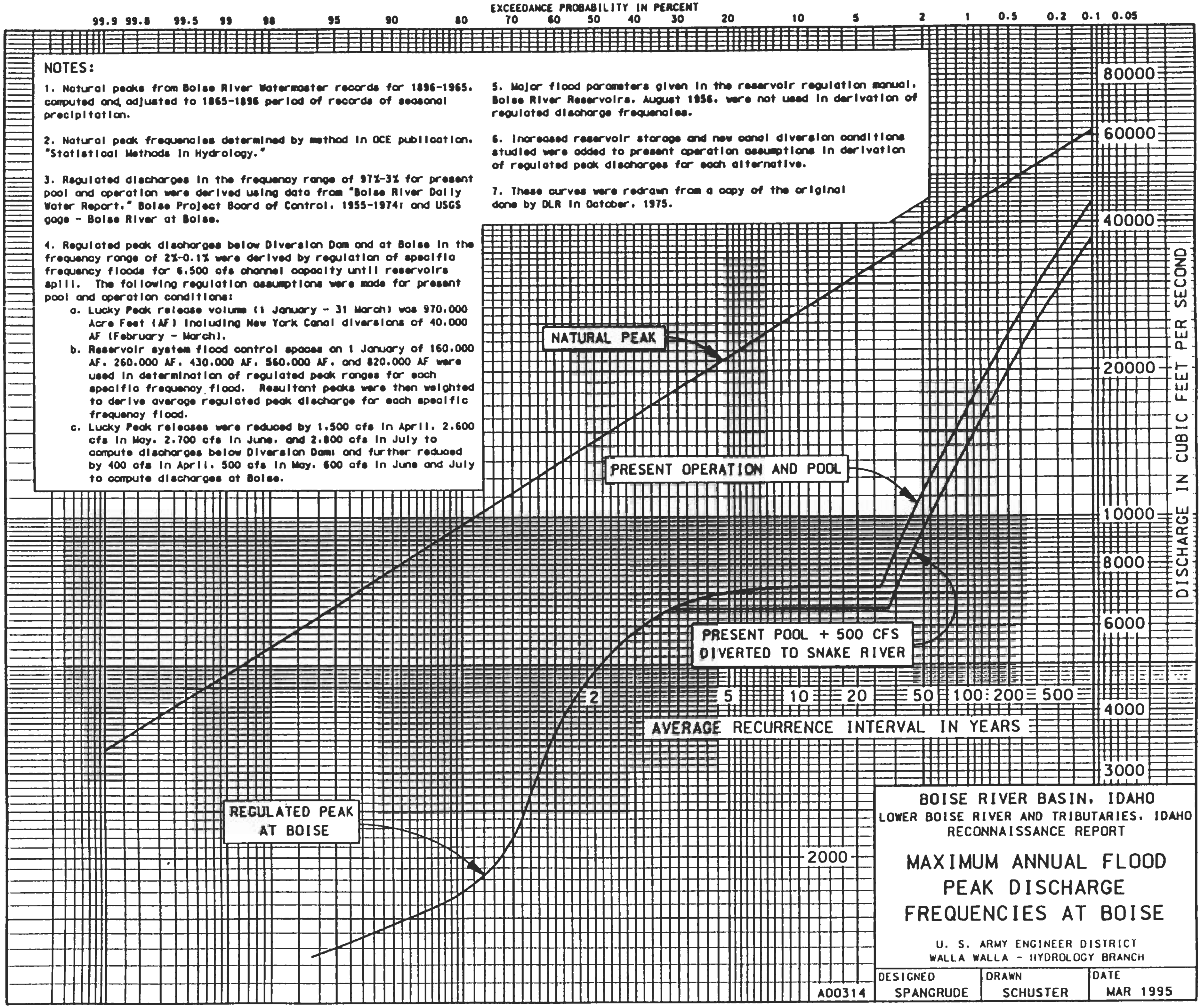
(d) BOISE RIVER AT PARMA, IDAHO; GIVEN UNDER USGS NUMBER 13213000.

3. ANNUAL DISCHARGE VOLUMES ARE GIVEN IN ACRE FEET.

APPENDIX B CHART 1



APPENDIX B CHART 2



NOTES:

1. Natural peaks from Boise River Watermaster records for 1896-1965, computed and adjusted to 1865-1896 period of records of seasonal precipitation.

2. Natural peak frequencies determined by method in OCE publication, "Statistical Methods in Hydrology."

3. Regulated discharges in the frequency range of 97%-3% for present pool and operation were derived using data from "Boise River Daily Water Report," Boise Project Board of Control, 1955-1974; and USGS gage - Boise River at Boise.

4. Regulated peak discharges below Diversion Dam and at Boise in the frequency range of 2%-0.1% were derived by regulation of specific frequency floods for 6,500 cfs channel capacity until reservoirs spill. The following regulation assumptions were made for present pool and operation conditions:
   a. Lucky Peak release volume (1 January - 31 March) was 970,000 Acre Feet (AF) including New York Canal diversions of 40,000 AF (February - March).
   b. Reservoir system flood control spaces on 1 January of 160,000 AF, 260,000 AF, 430,000 AF, 560,000 AF, and 820,000 AF were used in determination of regulated peak ranges for each specific frequency flood. Resultant peaks were then weighted to derive average regulated peak discharge for each specific frequency flood.
   c. Lucky Peak releases were reduced by 1,500 cfs in April, 2,600 cfs in May, 2,700 cfs in June, and 2,800 cfs in July to compute discharges below Diversion Dam; and further reduced by 400 cfs in April, 500 cfs in May, 600 cfs in June and July to compute discharges at Boise.

5. Major flood parameters given in the reservoir regulation manual, Boise River Reservoirs, August 1956, were not used in derivation of regulated discharge frequencies.

6. Increased reservoir storage and new canal diversion conditions studied were added to present operation assumptions in derivation of regulated peak discharges for each alternative.

7. These curves were redrawn from a copy of the original done by DLR in October, 1975.

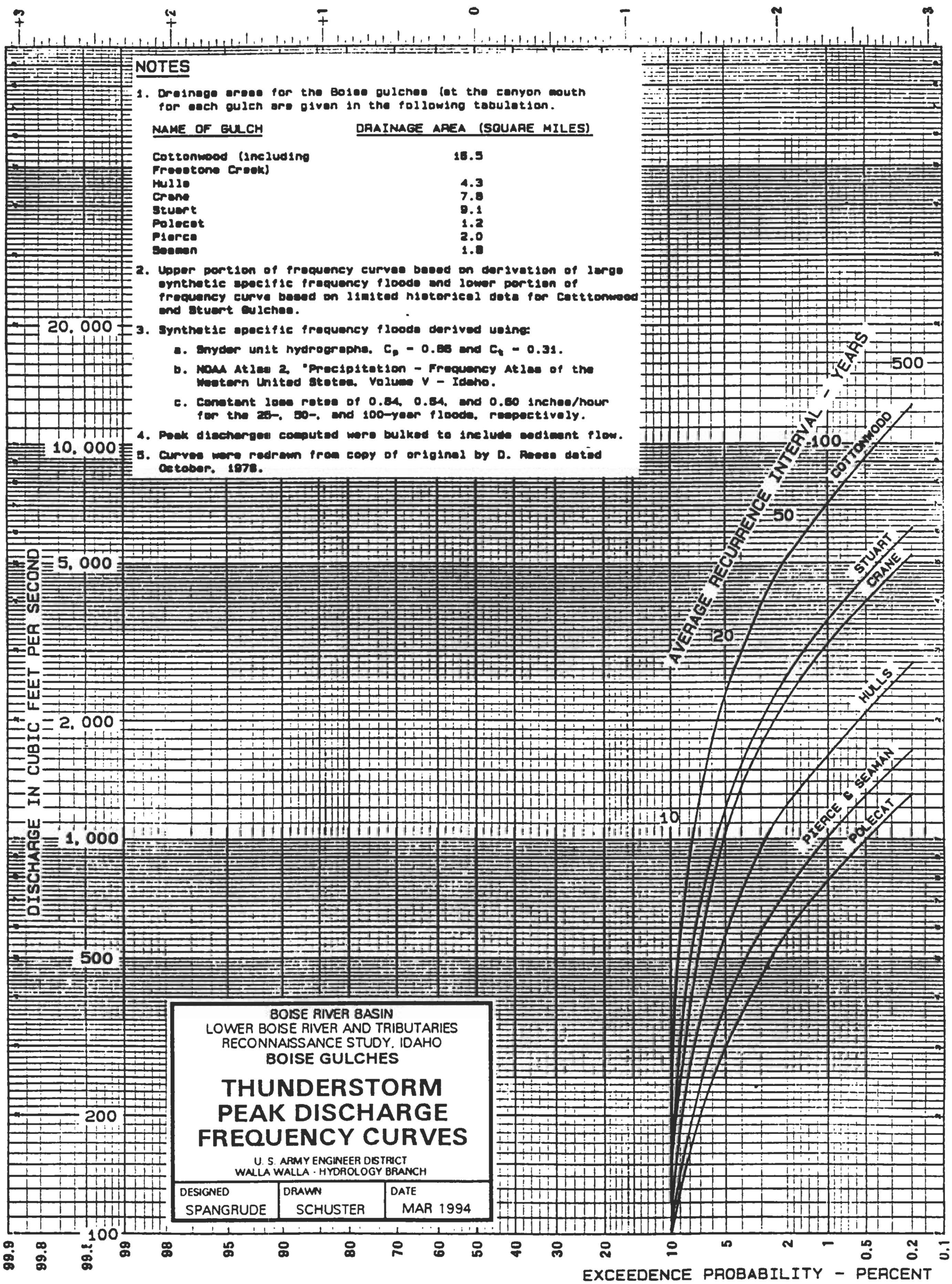
BOISE RIVER BASIN, IDAHO
LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
RECONNAISSANCE REPORT

MAXIMUM ANNUAL FLOOD PEAK DISCHARGE FREQUENCIES AT BOISE

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

DESIGNED	DRAWN	DATE
SPANGRUDE	SCHUSTER	MAR 1995

A00314



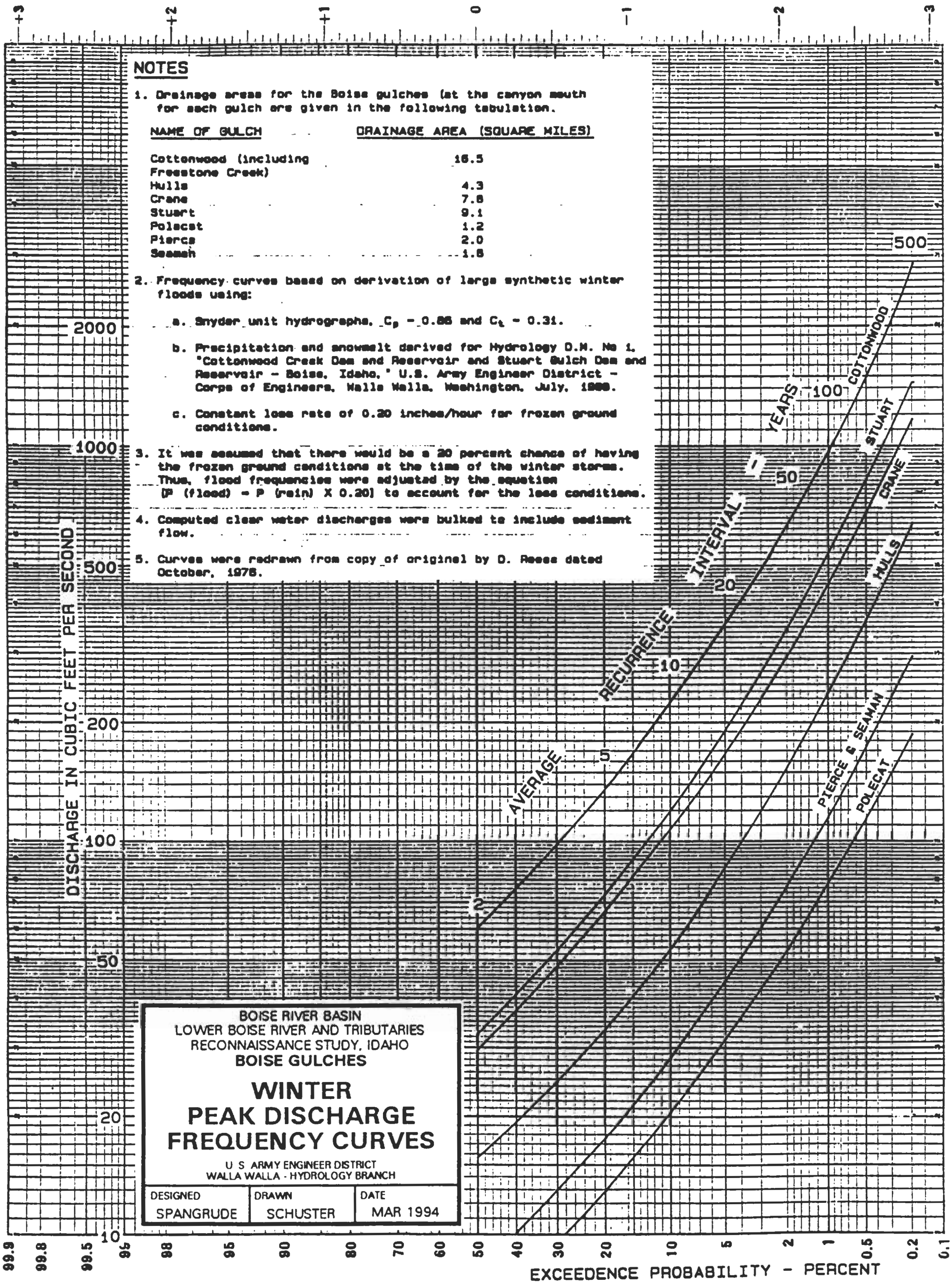
NOTES

1. Drainage areas for the Boise gulches (at the canyon mouth for each gulch are given in the following tabulation.

NAME OF GULCH	DRAINAGE AREA (SQUARE MILES)
Cottonwood (including Freestone Creek)	16.5
Hulls	4.3
Crane	7.8
Stuart	9.1
Polecat	1.2
Pierce	2.0
Seaman	1.8

2. Upper portion of frequency curves based on derivation of large synthetic specific frequency floods and lower portion of frequency curve based on limited historical data for Catttonwood and Stuart Gulches.
3. Synthetic specific frequency floods derived using:
   a. Snyder unit hydrographs, C_p - 0.86 and C_t - 0.31.
   b. NOAA Atlas 2, "Precipitation - Frequency Atlas of the Western United States, Volume V - Idaho.
   c. Constant loss rates of 0.84, 0.64, and 0.60 inches/hour for the 25-, 50-, and 100-year floods, respectively.
4. Peak discharges computed were bulked to include sediment flow.
5. Curves were redrawn from copy of original by D. Reese dated October, 1978.

APPENDIX B CHART 3



NOTES

1. Drainage areas for the Boise gulches (at the canyon mouth for each gulch are given in the following tabulation.

NAME OF GULCH	DRAINAGE AREA (SQUARE MILES)
Cottonwood (including Freestone Creek)	16.5
Hulls	4.3
Crane	7.8
Stuart	9.1
Polecat	1.2
Pierce	2.0
Seaman	1.8

2. Frequency curves based on derivation of large synthetic winter floods using:

   a. Snyder unit hydrographs, C_p = 0.88 and C_t = 0.31.

   b. Precipitation and snowmelt derived for Hydrology D.M. No 1, "Cottonwood Creek Dam and Reservoir and Stuart Gulch Dam and Reservoir - Boise, Idaho," U.S. Army Engineer District - Corps of Engineers, Walla Walla, Washington, July, 1988.

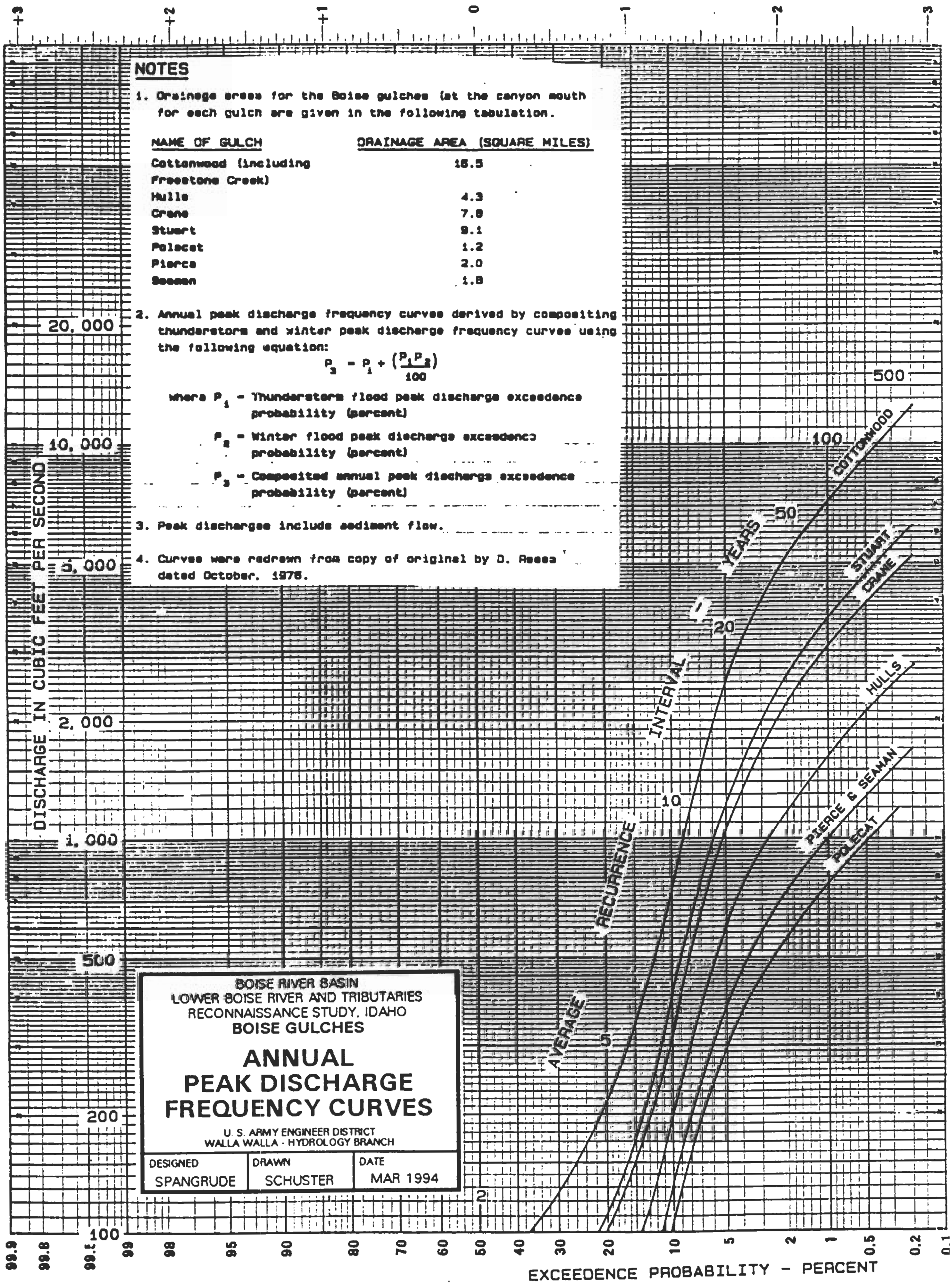
   c. Constant loss rate of 0.20 inches/hour for frozen ground conditions.

3. It was assumed that there would be a 20 percent chance of having the frozen ground conditions at the time of the winter storms. Thus, flood frequencies were adjusted by the equation [P (flood) = P (rain) X 0.20] to account for the loss conditions.

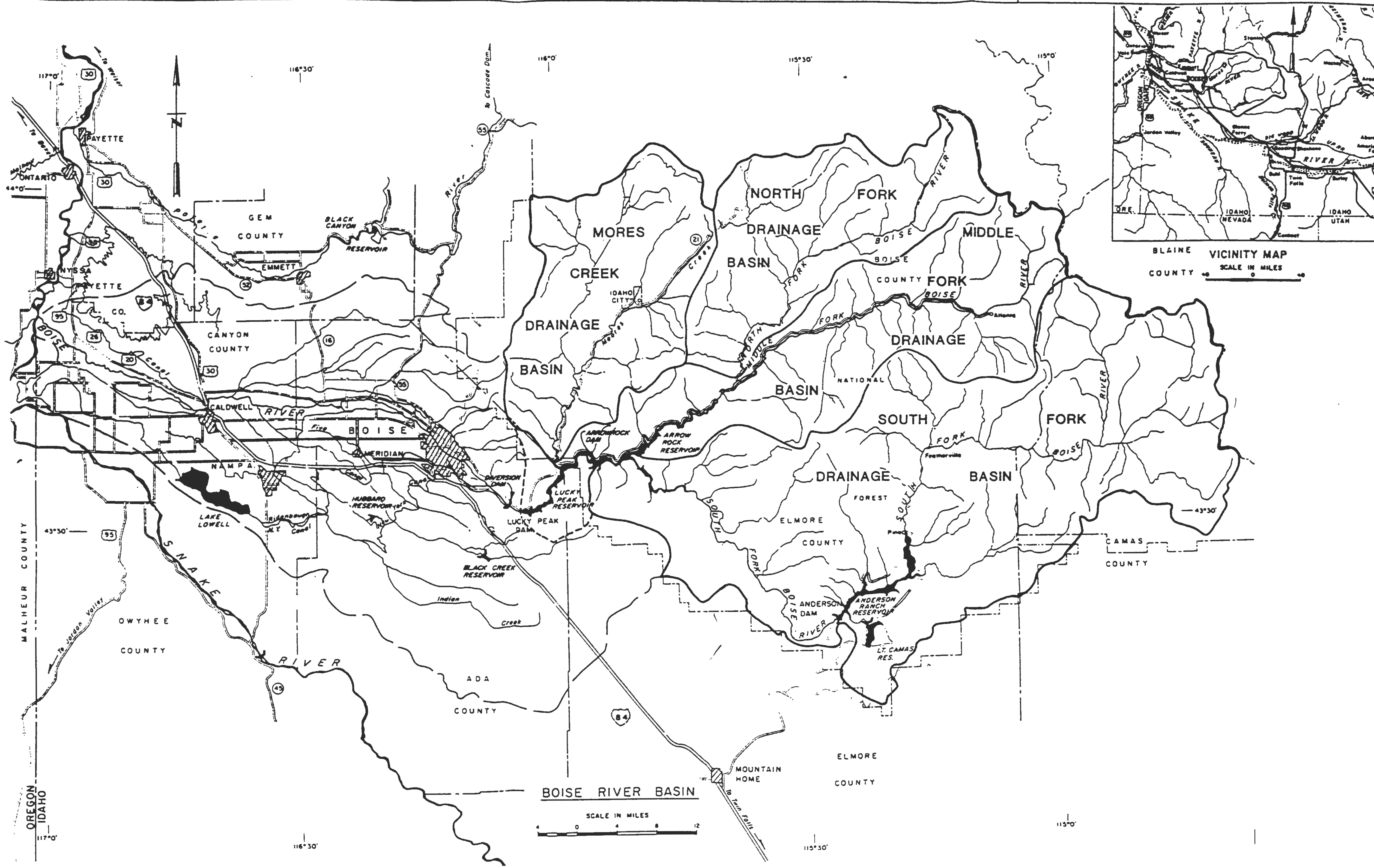
4. Computed clear water discharges were bulked to include sediment flow.

5. Curves were redrawn from copy of original by D. Reese dated October, 1978.

APPENDIX B CHART 4



APPENDIX B CHART 5

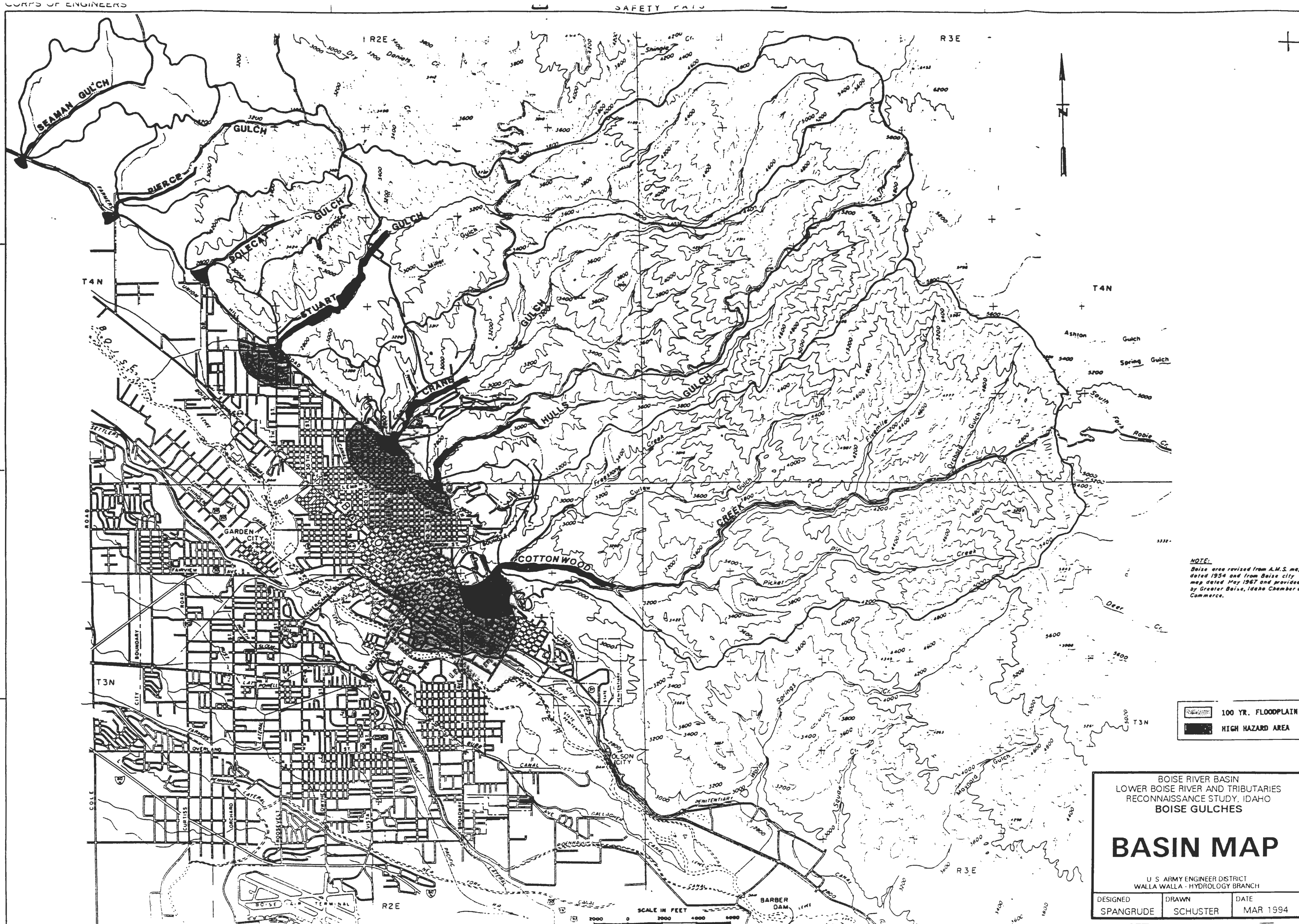


BOISE RIVER BASIN, IDAHO
LOWER BOISE RIVER AND TRIBUTARIES
RECONNAISSANCE STUDY, IDAHO

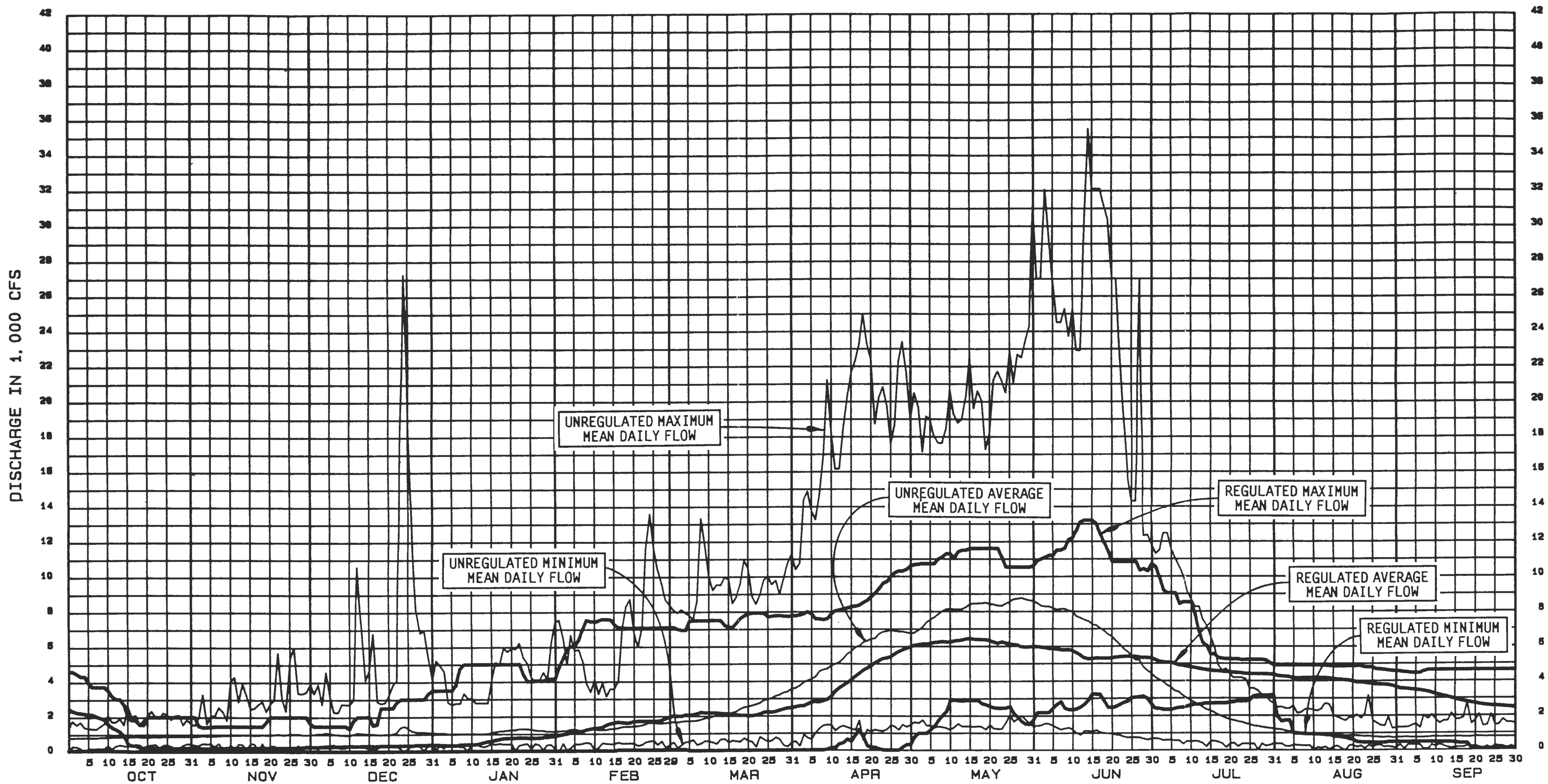
BASIN FEATURES

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA HYDROLOGY BRANCH

DESIGNED	DRAWN	DATE
SPANGRUDE	SCHUSTER	MAR 1994



APPENDIX B PLATE 2



NOTES:

1. REGULATED VALUES ARE DATA FOR USGS GAGE NO. 13202000, BOISE RIVER NEAR BOISE, IDAHO.
2. UNREGULATED VALUES WERE COMPUTED FROM DAILY CHANGES IN STORAGE AT ANDERSON RANCH, ARROWROCK, AND LUCKY PEAK RESERVOIRS AND WERE ADDED TO LUCKY PEAK'S OUTFLOW. TRAVEL TIMES AND OTHER ROUTING EFFECTS WERE NEGLECTED
3. THE PLOT REPRESENTS A COMPARISON OF REGULATED MAXIMUM, AVERAGE, AND MINIMUM MEAN DAILY FLOWS TO UNREGULATED MAXIMUM, AVERAGE, AND MINIMUM MEAN DAILY FLOWS.
4. PERIOD OF RECORD = 1955 THROUGH 1994.
5. DRAINAGE AREA = 2,680 SQUARE MILES.
6. UNREGULATED VALUES WERE COMPUTED BY THE BUREAU OF RECLAMATION IN BOISE, IDAHO.

BOISE RIVER, IDAHO
LUCKY PEAK DAM AND RESERVOIR
SUMMARY HYDROGRAPHS
U.S. ARMY ENGINEER DISTRICT
WALLA WALLA - HYDROLOGY BRANCH
SPANGRUDE/SCHUSTER MARCH, 1995

APPENDIX C

FLOOD DAMAGE REDUCTION BENEFIT ANALYSIS

LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
RECONNAISSANCE REPORT

APPENDIX C
FLOOD DAMAGE REDUCTION BENEFIT ANALYSIS

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APPENDIX C
FLOOD DAMAGE REDUCTION BENEFIT ANALYSIS

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TABLES

APPENDIX C
FLOOD DAMAGE REDUCTION BENEFIT ANALYSIS

TABLE OF CONTENTS (continued)

TABLES (continued)

LOWER BOISE RIVER AND TRIBUTARIES, IDAHO
RECONNAISSANCE REPORT

APPENDIX C
FLOOD DAMAGE REDUCTION BENEFIT ANALYSIS

1.01. PURPOSE OF ECONOMIC AND SOCIAL IMPACTS.

The purpose of this appendix is to measure the economic and social effects of the alternative proposed for the lower Boise River. Section 102 of the National Environmental Policy Act (NEPA) as well as guidelines from the Council on Environmental Quality (CEQ), which interprets NEPA, requires that economic and social impacts be identified. This information is useful to decision makers and others interested in the future of the lower Boise River study area.

Social analysis identifies impacts to individuals and groups. Such evaluation identifies the gains and losses of implementing a particular alternative to society, as a whole, as well as to specific elements within society. For this reconnaissance report, social impacts were not assessed. However, when this study process proceeds to the feasibility phase, social impacts will be assessed.

1.02. GENERAL CHARACTERISTICS OF THE FLOODPLAIN.

The study area encompasses the Boise Valley, from Lucky Peak Dam to the mouth of the Boise River. It also includes the Mores Creek sub-basin that flows into the Lucky Peak reservoir. It includes the Boise, Nampa, and Caldwell metropolitan areas; the cities of Parma, Notus, Caldwell, Middleton, Nampa, Star, Eagle, Meridian, Boise, Garden City, and Idaho City; and portions of Ada, Canyon, Payette, Gem, and Boise Counties. The study area, also known as the "lower Boise River Basin," consists of an area of approximately 1,500 square miles.

The lower Boise River, the only major river in the basin, flows approximately 64 miles from Lucky Peak Dam to the mouth of the Snake River, and drops approximately 450 feet during its journey.

a. Boise River Regulation.

The Boise River is a highly regulated stream. Natural flows are greatly modified by three storage projects on the upper river (Anderson Ranch, Arrowrock, and Lucky Peak); one offstream reservoir (Lake Lowell); and numerous diversion canals. These reservoirs are operated as a system to serve flood control, irrigation, and recreation. Flood control regulation releases often require early releases of higher-than-natural flows in order to evacuate the reservoirs so that high spring floodflows can be controlled. Irrigation flows, diverted into canals early in the year, often complement flood control operations by allowing higher flows to be released from Lucky Peak Dam. The most significant of these diversions is New York Canal which, by itself, can reduce downstream floodflows in the Boise River by nearly 3,000 cubic feet per second (cfs) during maximum irrigation demand periods.

A series of seven adjacent dry gulch tributaries in the Boise Front Range drain through narrow canyons onto alluvial fans and into the Boise River (within the city of Boise). These seven gulches are Cottonwood Creek, Hulls Gulch, Crane Creek, Stuart Gulch, Polecat Gulch, Pierce Gulch, and Seaman Gulch.

b. Climate and Precipitation.

The climate of the area is marked by hot, dry summers and cold winters. Average minimum daily temperatures for November through March are below freezing, with average minimum daily summer temperatures around 80 degrees Fahrenheit (°F). The frost-free growing season is about 6 months in length. Elevations in the study area range from about 6,000 feet to 2,200 feet above sea level. Normal precipitation in the study area varies from 30 inches in the hills north of Boise, to 10 inches at Boise, and 9 inches in the Caldwell/Nampa area.

c. Population and Growth.

Ada County comprises 1¼ percent of the land area in the State of Idaho, but contains 20 percent of Idaho's population. It is currently the center of rapid urban growth. From 1980 to 1990, the population of Ada County increased from 173,125 to 205,775, an increase of approximately 19 percent.

The city of Boise, with a population of 125,738 in 1990, is the capitol of the State of Idaho. It serves as an economic, cultural, and governmental center for the area. The population of Boise increased approximately 23 percent from 1980 to 1990. Several nationally-known firms have headquarters there, including Morrison-Knudson Company, Boise Cascade Corporation, J.R. Simplot Company, Ore-Ida Foods, and Albertson's, Inc. Boise is located near the head of the fertile Boise Valley, and the Boise River flows through the city. The central city area lies on the north side of the river, between the river and the foothills. Boise has expanded along the river and into the dry foothill gulches. Urban development south of the Boise River has spread due to a lack of natural boundaries (*e.g.,* the foothills on the north) and limited land-use controls.

The cities of Nampa and Caldwell, with 1990 populations of 28,365 and 18,400, respectively, are the largest cities in Canyon County. The total Canyon County population in 1990 was 90,076 (a 7½-percent increase from 1980).

1.03. HISTORIC AND POTENTIAL FLOOD DAMAGES.

a. Historic Flood Damages.

There has been no major flood damage along the lower Boise River since the completion of the Lucky Peak Project. Since Lucky Peak Dam began operating in 1955, the maximum target flow of 6,500 cfs (measured at Glenwood Bridge) has been equaled or exceeded 13 times. The most recent occurrence was in 1993, when flows reached about 6,500 cfs. The largest flow in the lower Boise river was witnessed in 1983, when flow at Glenwood Bridge was measured at 9,500 cfs. As the result of a major floodfighting effort by the U.S. Army Corps of Engineers (Corps) and the local community, actual flood damages were kept to a minimum. Because of limited damages, a post flood damage survey was not warranted or completed by the Corps. Based on information included in the book *When the River Rises, Flood Control on the Boise River 1943-1985* by Susan M. Stacy, the only damage survey estimate was made by the Ada County Civil Defense Coordinator. Damages were estimated to be $146,900 at the 1983 price level (or $193,000 at the 1994 price level). These damages included personal property damages, U.S. Government employee overtime, erosion repair, and other property protection work. The estimates did not include any repair expenditures made by farmers, homeowners, or public agencies in the months following the flood.

b. Damage Estimates.

(1) Stage/Damage Estimate.

As floodwaters exceed river banks and flow onto nearby developed properties, damages occur. Generally, the deeper the water and the longer it stands on structures, the greater the damage. Likewise, greater damage is caused by larger floods that inundate more structures. This stage/damage relationship is used to predict the amount of damage that could occur at various depths of flooding.

(2) The Discharge/Stage Relationship.

Discharge is the measure of water moving across a given point. Generally, discharge is expressed in cfs. For any given geographic area to be flooded to a certain depth, a sufficient quantity of water is required. This relationship between discharge and stage is called the rating curve. The rating curve is integrated with the stage/damage curve to yield the discharge/damage curve.

(3) The Discharge/Frequency Relationship.

The discharge/frequency relationship describes the probability of exceeding a given discharge in any year. The discharge/frequency curve is integrated with the discharge/damage curve to yield the frequency/damage curve.

c. Economic Impacts.

Economic impacts are expressed as average annual dollars. The expected annual flood damage (EAD) is the average flood damage expected over the long term. Expected annual values are stochastically determined from observations over many years. The EAD values are typically seen in flood control studies where the expected annual damage is the average damage that can be expected to result from many years of flow experience with conditions remaining unchanged. It is computed by weighing each damage value according to its probability of exceedance. Graphically, it represents the area under the damage/frequency curve. Computer programs are used to estimate expected annual damages.

(1) Damage Categories.

Estimates of flood damages were collected and analyzed for the following categories of damages:

(a) Residential.

Residential damages included inundation losses to residential structures and contents, appurtenant buildings, and grounds. Damage to structures and contents were estimated by combining water depths and depth/damage functions for various structure types. Average content value was estimated to be 40 percent of the structure's value. Flood losses included damage to floors, walls, heating equipment, furniture, appliances, and personal property; and damages to grounds (*i.e.*, yards and fences).

(b) Commercial.

Commercial damages included inundation losses to all properties used in commerce, business, wholesale and retail trade, services, and entertainment. Physical flood damages to commercial property and facilities included damages to land, buildings, equipment, supplies, inventory, and other items used to conduct business.

(c) Industrial.

Industrial damages represent inundation losses to properties and facilities used in manufacturing and food processing. They include physical damage to buildings, raw materials, equipment, finished products, and overhead expenses.

(d) Agricultural.

Agricultural damages included the loss and destruction of growing crops, land, barns, and other appurtenant buildings and their contents.

(e) Public.

Public damages included inundation losses to schools, parks, and other facilities. They included equipment and furnishings owned and/or operated by Federal, State, county, or local government units.

(f) Utilities.

Utility damages included losses to electric, water, telephone plants, transmission lines, and similar facilities.

(g) Transportation.

Transportation damages included inundation and destruction losses to roads, streets, pavement, sidewalks, bridges, and other highway structures, supplies, and equipment. Other transportation damages included losses to railroad property, vehicles, and mobile equipment. Railroad losses included damage to tracks, roadbed rights-of-way, supplies, and equipment directly attributable to flooding. Vehicle damage included buses, trucks, automobiles, and mobile equipment.

(h) Emergency Expenses.

Emergency aid expenses included expenditures deemed essential to the preservation of life and property (*i.e.,* clearance of debris and wreckage, emergency repair or temporary replacement of private and public facilities, evacuation assistance, Federal aid for flood fighting, flood emergency preparation, rescue operations, police protection, and repair and restoration of damaged flood control works).

(i) Clean-Up Expenses.

Clean-up expenses included Federal assistance to State and local governments to accomplish channel clearing, debris removal, and other emergency channel work on unimproved streams.

(j) Other Agriculture Losses.

Other agriculture losses included losses experienced from equipment losses, damage to the quality of the land, fencing, loss of fertilizer and chemicals, clean-up of fields, and labor for replanting crops. Siltation, loss of soil fertility, and the cost of debris removal and weed seed were not analyzed at this time.

(k) Business Losses.

Business losses included the loss of income by commercial, industrial, and other business firms. Loss of income because of idle labor is net income to labor employed in the clean-up and repair of damages.

(2) Methodology and Assumptions.

The study area consists of approximately 1,500 square miles, and includes both Ada and Canyon Counties. Since flow differential is minimal, and the type of development is similar throughout, the study area was considered as one reach for analysis purposes. Potential flood damages were estimated for both the 100- and 500-year flood events. Due to time and budget constraints, the August 1994 field inventory of structures within the 500-year floodplain was limited to the major damage center (those properties in and around the city of Boise). The period of analysis is 100 years. The Federal discount rate (as of October 1, 1994) is 7¾ percent.

Floodplains and water surface elevations (profiles) for the 100- and 500-year events identified by the Flood Insurance Association were furnished by the Corps, Walla Walla District, Hydrology Branch. Flow for both the 100- and 500-year floods was assumed to be 16,000 and 35,000 cfs, respectively, without the project; and 14,000 and 29,000 cfs, respectively, with the project. Flood frequency tables were also furnished by the Hydrology Branch.

To obtain an accurate assessment of property valuation and damage, each damage category was studied independently. The value and damage of each category was determined by the best method available (assessor's data, depreciated replacement value, or values assigned by category experts). A description of the survey method utilized to assess floodplain structures is contained in the following paragraphs.

Damages for all types of property are summarized in table C-1. Tables C-2 through C-4 are provided for general informational purposes regarding assumptions.

Table C-1.
Lower Boise Basin Without Project Conditions--Summary Table
(1994 Price Level)

Damage Category	Ada County ($)	Canyon County ($)	Total Reach ($)
Residential Structures			
(100-Year Flood) 16,500 cfs	6,967,000	609,000	7,576,000
(500-Year Flood) 35,000 cfs	43,775,000	7,238,000	51,013,000
Residential Contents			
(100-Year Flood) 16,500 cfs	1,181,000	238,000	1,419,000
(500-Year Flood) 35,000 cfs	16,105,000	3,244,000	19,349,000
Industrial, Commercial, and Public Structures			
(100-Year Flood) 16,500 cfs	12,177,000	884,000	13,061,000
(500-Year Flood) 35,000 cfs	61,969,000	5,358,000	67,327,000
Subtotal Structures and Contents			
(100-Year Flood) 16,500 cfs	20,325,000	1,731,000	22,056,000
(500-Year Flood) 35,000 cfs	121,849,000	15,840,000	137,689,000
Agricultural Crops			
(100-Year Flood) 16,500 cfs	8,000	248,000	256,000
(500-Year Flood) 35,000 cfs	65,000	2,116,000	2,181,000
Other Agriculture			
(100-Year Flood) 16,500 cfs	790,000	1,414,000	2,204,000
(500-Year Flood) 35,000 cfs	5,882,000	9,596,000	15,478,000
Utilities			
(100-Year Flood) 16,500 cfs	5,983,000	1,787,000	7,770,000
(500-Year Flood) 35,000 cfs	34,188,000	10,212,000	44,400,000
Transportation			
(100-Year Flood) 16,500 cfs	11,057,000	4,773,000	15,830,000
(500-Year Flood) 35,000 cfs	81,183,000	35,040,000	116,223,000
Emergency Expenses			
(100-Year Flood) 16,500 cfs	283,000	681,000	964,000
(500-Year Flood) 35,000 cfs	473,000	1,140,000	1,613,000
Clean-Up Expenses			
(100-Year Flood) 16,500 cfs	1,349,000	339,000	1,688,000
(500-Year Flood) 35,000 cfs	1,349,000	339,000	1,688,000
Business Losses			
(100-Year Flood) 16,500 cfs	330,000	88,000	418,000
(500-Year Flood) 35,000 cfs	7,707,000	2,050,000	9,757,000
Subtotal Other Damages			
(100-Year Flood) 16,500 cfs	19,792,000	9,328,000	29,120,000
(500-Year Flood) 35,000 cfs	130,847,000	60,493,000	191,340,000
Total Damages			
(100-Year Flood) 16,500 cfs	**40,117,000**	**11,059,000**	**51,176,000**
(500-Year Flood) 35,000 cfs	**252,696,000**	**76,333,000**	**329,029,000**

Table C-2. Lower Boise Basin Projected Growth Based on Historical Growth				
County	1970 Population	1980 Population	1994 Population	Average Annual Growth Rate (%)
Ada County	112,230		242,429	3.13
Canyon County		83,756	100,300	1.21
Total Reach			342,729	4.3

Lower Boise River Basin Population			
Ada County		Canyon County	
Year	Population	Year	Population
1970	112,230	1980	83,756
1971	117,800	1990	90,076
1972	123,100	1994	100,300
1973	129,700		
1974	135,500		
1975	141,100		
1976	147,300		
1977	154,500		
1978	162,300		
1979	168,800		
1980	173,036		
1981	174,150		
1982	176,818		
1983	179,081		
1984	182,260		
1985	185,567		
1986	186,647		
1987	188,358		
1988	190,740		
1989	194,898		
1990	205,775		
1994	242,429		
Average annual growth rate in Ada County from 1970 to 1994 was 3.13 percent.		Average annual growth rate in Canyon County from 1980 to 1994 was 1.21 percent.	

Table C-3. Lower Boise Basin, Ada and Canyon Counties, Idaho **Without** Project Condition for All Damage Categories (1994 Price Level)						
Discharge (cfs)	**Frequency**	**Damage ($)**	**Average Damage of Interval ($)**	**Frequency of Interval**	**Annual Damage ($)**	**Accumulated Damage ($)**
4,000	0.5700	0				0
5,000	0.4900	46,000	23,000	0.0800	1,840	1,840
6,500	0.3100	147,000	96,500	0.1800	17,370	19,210
7,000	0.2200	349,000	248,000	0.0900	22,320	41,530
7,200	0.0360	434,000	391,500	0.1840	72,036	113,566
8,000	0.0320	759,000	596,500	0.0040	2,386	115,952
10,000	0.0240	3,283,000	2,021,000	0.0080	16,168	132,120
12,000	0.0180	12,696,000	7,989,500	0.0060	47,937	180,057
15,000	0.0120	32,560,000	22,628,000	0.0060	135,768	315,825
20,000	0.0070	86,000,000	59,280,000	0.0050	296,400	612,225
25,000	0.0045	141,000,000	113,500,000	0.0025	283,750	895,975
30,000	0.0030	216,000,000	178,500,000	0.0015	267,750	1,163,725
35,000	0.0020	329,030,000	272,515,000	0.0010	272,515	1,436,240

Table C-4. Lower Boise Basin, Ada and Canyon Counties, Idaho With Project Condition (Fargo Wasteway Project) for All Damage Categories (1994 Price Level)						
Discharge (cfs)	**Frequency**	**Damage ($)**	**Average Damage of Interval ($)**	**Frequency of Interval**	**Annual Damage ($)**	**Accumulated Damage ($)**
4,000	0.5700					
5,000	0.4900	46,000	23,000	0.0800	1,840	1,840
6,500	0.3100	147,000	96,500	0.1800	17,370	19,210
6,500	0.0330	147,000	147,000	0.2770	40,719	59,929
7,000	0.0300	349,000	248,000	0.0030	744	60,673
8,000	0.0260	759,000	554,000	0.0040	2,216	62,889
10,000	0.0180	3,283,000	2,021,000	0.0080	16,168	79,057
12,000	0.0135	12,696,000	7,989,500	0.0045	35,953	115,010
15,000	0.0090	32,560,000	22,628,000	0.0045	101,826	216,836
20,000	0.0050	86,000,000	59,280,000	0.0040	237,120	453,956
25,000	0.0030	141,000,000	113,500,000	0.0020	227,000	680,956
30,000	0.0019	216,000,000	178,500,000	0.0011	196,350	877,306
Present average annual flood damage = $1,436,240. Remaining flood damages with project = $877,306. Average annual flood control benefit = $558,934; say $559,000.						

(3) Residential, Commercial, Industrial, and Public.

Flood damages for existing conditions were estimated in a two-phase process. The 1974 inventory of structures in the 500-year floodplain (conducted for the report, *Boise Valley Regional Water Management Study*, U.S. Army Corps of Engineers, 1977) was updated to 1994 price levels to adjust for inflation and development. Secondly, a field inventory was conducted in August 1994 to identify all structures within the 500-year floodplain in Ada County that were built subsequent to the 1974 field survey. The data base included residential, commercial, industrial, and public structures built after 1980.

Information was not available for structures in Ada County constructed from 1975 to 1979. For Ada County, the Engineering New Record Construction Index (ENR-C) was used to update the existing 1974 property values to the 1994 price level. However, no adjustment was made for construction during this period, because construction activity was considered relatively minor. (For Canyon County, the level of growth since the 1974 field inventory did not warrant another field survey in 1994. Therefore, a population growth factor was applied to the 1974 inventory of Canyon County structures to update the property values to the 1994 price level.)

For the period from 1980 to the present, a field survey of the 100- and 500-year floodplain was conducted in August 1994, based upon data obtained from the Ada County assessor. Due to the size of the floodplain, as well as time and budget constraints, a 10-percent sample of residential structures was completed. However, a 100-percent field inventory of commercial, industrial, and public structures was conducted. An inventory of structures (residential, public, and commercial) for the 25-year floodplain was not completed due to time and budget restraints. Damage levels between zero and the 100-year floodplain (16,500 cfs) were interpolated and adjusted to the 1994 price level from the previous structure inventory taken in 1974 (*Boise Valley Regional Water Management Study*).

Detailed information was obtained in the field on the sample group of structures (including structure type, square footage, condition, age, and elevation of the first floor to the ground). Ground elevations, used to establish water depths, were derived from the Department of the Interior, U.S. Geological Survey, quadrangle maps and cross sections from the Federal Emergency Management Agency's (FEMA) flood insurance maps. The replacement value of each structure was estimated. The total value of the sampled structures was then multiplied by a factor of ten to arrive at the estimated total value of all new structures constructed between 1980 and the present. This data was combined with water depths and depth/damage functions for various structures to estimate damages to structures and contents. See tables C-1, C-5, C-6, and C-7 for more detailed information.

(4) Remaining Damage Categories.

The remaining damage categories (including agricultural crop losses; other agricultural losses; damages to utilities; damages to roads, bridges, and railroads; emergency expenses; clean-up expenses; and business losses) were updated based on interviews with representatives from the counties and utilities, updating of previous figures to the 1994 price level, and using statistical indices and adjustments for development. Damages for Canyon County were considered relatively minor, and were updated by factors for inflation and population, except where otherwise noted.

Table C-5. Residential Inventory of Lower Boise River Basin (1994 Price Level)

	Canyon County ($)	Ada County ($)	Total Reach ($)
100-Year Floodplain			
1974 Inventory	175,000	1,196,000	1,371,000
1974 Inventory in 1994 Dollars[1]	473,000	3,224,000	3,697,000
1994 Dollar Adjusted Growth[2]	609,000		609,000
Field Inventory 1994		3,744,000	3,744,000
Totals	**609,000**	**6,968,000**	**7,577,000**
500-Year Floodplain			
1974 Inventory	2,086,400	14,214,000	16,300,400
1974 Inventory in 1994 Dollars[3]	5,623,000	38,306,000	43,929,000
1994 Dollar Adjusted Growth[4]	7,238,000		7,238,000
Field Inventory 1994		5,469,000	5,469,000
Totals	**7,238,000**	**43,775,000**	**51,013,000**

[1]ENR construction adjustment 2.695 (September 1974 to January 1995).
[2]Development adjustment based on average annual population growth (October 1974 to January 1995) at 1.21 percent per year to account for area development in addition to adjustment for price levels.
[3]ENR construction adjustment 2.695 (September 1974 to January 1995).
[4]Development adjustment based on average annual population growth (October 1974 to January 1995) at 1.21 percent per year to account for area development in addition to adjustment for price levels.

Table C-6. Residential Contents of Lower Boise River Basin (1994 Price Level)			
	Canyon County ($)	Ada County ($)	Total Reach ($)
100-Year Floodplain			
1974 Inventory	69,000	342,000	411,000
1974 Inventory in 1994 Dollars[1]	185,000	922,000	1,107,000
1994 Dollar Adjusted Growth[2]	238,000		238,000
Field Inventory 1994		259,000	259,000
Totals	**238,000**	**1,181,000**	**1,419,000**
500-Year Floodplain			
1974 Inventory	935,000	4,665,000	5,600,000
1974 Inventory in 1994 Dollars[3]	2,520,000	12,572,000	15,092,000
1994 Dollar Adjusted Growth[4]	3,245,000		3,245,000
Field Inventory 1994		3,533,000	3,533,000
Totals	**3,245,000**	**16,105,000**	**19,350,000**

[1]ENR construction adjustment 2.695 (September 1974 to January 1995).
[2]Development adjustment based on average annual population growth (October 1974 to January 1995) at 1.21 percent per year to account for area development in addition to adjustment for price levels.
[3]ENR construction adjustment 2.695 (September 1974 to January 1995).
[4]Development adjustment based on average annual population growth (October 1974 to January 1995) at 1.21 percent per year to account for area development in addition to adjustment for price levels.

Table C-7. Commercial, Industrial, and Public Inventory of Lower Boise River Basin (1994 Price Level)			
	Canyon County ($)	Ada County ($)	Total Reach ($)
100-Year Floodplain			
1974 Inventory	255,000	991,000	1,246,000
1974 Inventory in 1994 Dollars[1]	687,000	2,670,000	3,357,000
1994 Dollar Adjusted Growth[2]	884,000		884,000
Field Inventory 1994		9,506,000	9,506,000
Totals	**884,000**	**12,176,000**	**13,060,000**
500-Year Floodplain			
1974 Inventory	1,545,000	10,906,000	12,451,000
1974 Inventory in 1994 Dollars[3]	4,162,000	29,390,000	33,552,000
1994 Dollar Adjusted Growth[4]	5,358,000		5,358,000
Field Inventory 1994		32,579,000	32,579,000
Totals	**5,358,000**	**61,969,000**	**67,327,000**

[1]ENR construction adjustment 2.695 (September 1974 to January 1995).
[2]Development adjustment based on average annual population growth (October 1974 to January 1995) at 1.21 percent per year to account for area development in addition to adjustment for price levels.
[3]ENR construction adjustment 2.695 (September 1974 to January 1995).
[4]Development adjustment based on average annual population growth (October 1974 to January 1995) at 1.21 percent per year to account for area development in addition to adjustment for price levels.

d. Agriculture.

Sources contacted in the estimation of flood damages on agricultural crops include the U.S. Department of Agriculture (USDA), the Agriculture Stabilization and Conservation Service (ASCS), and the Canyon County Agriculture Extension Service.

The Canyon County Agriculture Extension Service furnished a 1994 estimate of average profit per acre for 19 major crops grown in Canyon County and 7 major crops grown in Ada County. The ASCS furnished 1994 acres of major crops in Canyon and Ada Counties. The total number of acres in production in Ada County is 3,050, at an average profit per acre of $21.27. The total number of acres in production in Canyon County is 56,000, at an average profit per acre of $37.78. The total net profit for production in both counties in the 500-year floodplain was $2,181,000. To calculate agricultural crop losses, this total net profit was apportioned between the 100-year and the 500-year floodplains in the same proportion used in the *Boise Valley Regional Water Management Study*, dated 1977 (12 percent of the agriculture crop losses were allocated to the 100-year floodplain, and 88 percent were allocated to the 500-year floodplain). See table C-8 for further details.

Table C-8. Lower Boise River Basin Estimated Crop Production Values[1] (1994 Price Level)			
Crops[2]	Number of Acres	Average Net Profit Per Acre ($)	Average Total Profit ($)
Pasture	2,193	12.50	27,413
Alfalfa Hay	342	37.50	12,825
Alfalfa Seed	39	75.00	2,925
Small Grains	198	-	-
Field Corn	144	12.50	1,800
Sugar Beets	7	125.00	875
Peppermint and Spearmint	127	150.00	19,050
Total	**3,050**		**64,888**
500-Year Floodplain Acreage			
	Crops Acres	**Weighted Average per Acre ($)**	**Total Profit ($)**
Ada County	3,050	21.27	64,874
Canyon County	56,000	37.78	2,115,813
Total	**59,050**		**2,180,687[3]**

[1]Ada and Canyon Counties
[2]Irrigated
[3]Use *Boise Valley Regional Water Management Study*, 1977 report to establish proportion of 100-year flood damage to the 500-year damage (100 year = .1174 of 500-year damage).

e. Utilities.

Values for five categories of utilities were obtained from local utility managers representing Idaho Power, Intermountain Gas, U.S. West, and Cable Television Station. The five categories were telephone installations, gas installations, television stations, electrical/power facilities, and water supply facilities. All damage estimates were assigned only to aboveground facilities, since the area has no record of major flooding on which to base underground damage. Since the damage estimates given by local experts were for the total lower Boise River Basin 500-year floodplain, which contains 59,050 acres (see tables C-5 and C-9); the *Boise Valley Regional Water Management Study*, dated 1977, was used to assign the proportion of total damages per county and the proportion of damages for both the 100- and 500-year floodplains.

Table C-9. Lower Boise River Basin Utilities Damages (1994 Price Level)	
Telephone Stations	$3,500,000
Gas Facilities	$9,400,000
Television Stations	$3,500,000
Electrical/Power Companies	$7,000,000
Water Companies	$21,000,000
TOTAL	**$44,400,000**[1,2,3]

[1]Total damage within the 500-year floodplain.
[2]Of this total, 100-year floodplain damages ($7,770,000) are apportioned based on the ratio of damages in *Boise Valley Regional Water Management Study*, dated 1977.
[3]Damages by county are: Ada County, 77 percent ($34,188,000); and Canyon County, 23 percent ($10,212,000).

f. Transportation.

An interview with local transportation managers was conducted to obtain the best estimate of flood damages associated with transportation facilities. Local transportation managers (Ada and Canyon County Highway Departments and the Union Pacific Railroad) were asked to estimate flood damages for roads, bridges, and railroads in the 100- and 500-year floodplains in Ada and Canyon Counties. Since estimates given included the whole 500-year floodplain area, damage estimates were apportioned to the 100-year floodplain in the same proportion used in the *Boise Valley Regional Water Management Study*, dated 1977. This report apportioned 100-year damages as 13.62 percent of the 500-year damages (see tables C-10 and C-11 for more detailed information).

Table C-10. Summary of Lower Boise River Basin Transportation Damages (1994 Price Level)		
	100-Year Damage	500-Year Damage
Ada County Roads	$8,854,000	$65,006,000
Canyon County Roads: Parma District (73,392 feet @ $125/foot = $9,174,000 Caldwell District (137,280 feet @ $3.50 = $12,492,000 Total Canyon Roads = $21,666,000	$2,951,000	$21,666,000
TOTAL ROADS	**$11,805,000**	**$86,672,000**
Ada County Bridges	$1,114,000	$8,177,000
Canyon County Bridges: Parma District = $9,174,000 Caldwell District = $4,200,000 Total Canyon County Bridges = $13,374,000	$1,822,000	$13,374,000
TOTAL BRIDGES	**$2,936,000**	**$21,551,000**
Ada County Railroads	$1,090,000	$8,000,000
Canyon County Railroads	$0	$0
TOTAL RAILROADS	**$1,090,000**	**$8,000,000**
TOTAL TRANSPORTATION DAMAGES	**$15,831,000**	**$116,223,000**

Table C-11
Assumptions Used for Calculations of Lower Boise River Basin Roads, Bridges, and Railroads Damages[1, 2] (1994 Price Level)

Road Types	Linear Feet	Cost per Linear Foot ($)	Total Cost ($)
Collector	92,871	142	13,149,605
Local		-	-
Local/Replacement at 80 Percent	398,330	56	22,414,029
Local/Repair at 20 Percent	99,582	7	737,903
Minor Arterial	62,037	174	10,805,605
Principal Arterial	92,462	194	17,898,794
Total (Linear Feet)	**745,282**	**87**	**65,005,935**
Total (Miles)	**141**	**460,539**	**65,005,935**

[1]Damages for 500-year floodplain.
[2]Of this total, 100-year floodplain damages (*i.e.*, 0.1362 of 500-year floodplain damages) are apportioned based on the *Boise Valley Regional Water Management Study*, dated 1977.

(1) Roads.

Linear feet of roads by category were estimated by the Ada and Canyon County Highway Departments, along with current local labor costs to repair each category. Costs assumed major repair, but not complete replacement.

The sum of linear feet for Ada County was 745,282. At an average cost of repair per linear foot of $87, the total repair cost was estimated at $65,006,000.

The sum of linear feet for the Canyon County/Parma District was 73,392. At an average cost of repair per linear foot of $125, the total cost was estimated at $9,174,000.

The sum of linear feet for the Canyon County/Caldwell District was 137,280. At an average cost of repair per linear foot of $91, the total cost was estimated at $12,492,000.

(2) Bridges.

When this study proceeds into the feasibility phase, the repair costs presented below must be reassessed to determine if the bridges will indeed suffer the major damages assumed in this reconnaissance-level report.

The Ada County Highway Department estimated bridges in the 500-year floodplain at 148,680 square feet, with an average repair cost of $55 per square foot, thus yielding a total cost of $8,177,000. These figures are for major repairs only.

The Canyon County Highway Department estimated bridge damage at $13,374,000. No square footage or cost to repair per square foot was given. This cost assumed major repairs, and these figures are for major repairs only.

(3) Railroads.

The Union Pacific Railroad estimated 8 miles of railroad within the 500-year floodplain, at an average repair cost of $1,000,000 per mile, for a total cost of $8,000,000. This cost assumed major repairs. When this study proceeds into the feasibility phase, these repair costs must be reassessed to determine if the railroad will indeed suffer major damage (see tables C-10 and C-11).

g. Emergency Expenses.

To calculate emergency expenses, the number of structures with water surface elevations above the first floor (from the 1994 field inventory) were multiplied by the number of days that inhabitants would have to relocate to a motel, and then multiplied by $76 per day. It was assumed that residents would require relocation for 7 days for the 100-year event, and 10 days for the 500-year event. The number of structures subjected to water levels above the first floor were 181 in the 100-year floodplain, and 212 in the 500-year floodplain (see table C-12 for more detailed information).

Table C-12. Lower Boise River Basin Emergency Expenses[1] (1994 Price Level)

	Number of Structures	Number of Days Inundated	Number of Structure Days[2]	Sustenance Cost Per Day ($)	Emergency Sustenance Cost[3] ($)
100-Year Flood					
Ada County	128	7	896	76	681,000
Canyon County[4]	53	7	372	76	283,000
Total	181	7	1,268		964,000
500-Year Flood					
Ada County	150	10	1,500	76	1,140,000
Canyon County[4]	62	10	620	76	473,000
Total	212	10	2,120		1,613,000

[1]There were no emergency expenses reported in the *Boise Valley Regional Water Management Study*, dated 1977. These figures represent expenses related to residential structures constructed after 1980.
[2]Number of structure days is the total number of days that all of the structures in the county would be inundated during a flood event.
[3]Includes adjustment for a 10-percent sample of structures [*e.g.*, total structures in the 500-year floodplain is 212. 212 x 10 days of inundation = 2,122 structure days. 2,122 structure days x 10 = 21,220. 21,220 structure days x $76 (overnight sustenance expense) = $1,613,000 emergency sustenance cost).
[4]Proportion for Canyon County compared to the total (41.5 percent) represents the proportion of Canyon County population compared to the Ada County population.

h. Clean-Up Expenses.

Clean-up expenses are costs necessary to clean up the sedimentation left after a flood subsides. This expense is calculated by multiplying the depth and surface area of residue remaining on roads and parking lots. It was assumed that 0.2 feet of sediment would remain, and would require removal. It was assumed that it would cost $7.70 per hour to remove 1 cubic yard of sediment (see table C-13 for detailed information by county).

Table C-13. Lower Boise River Basin Clean-Up Expenses (1994 Price Level)	
Roads and Parking Lots	
Canyon County	District #4 26 miles @ 5,280 feet per mile = (26)(5,280) = 137,280 feet Assuming 24 feet wide (137,280)(24) = 3,294,720 square feet District #2 73,392 feet at 36 feet wide (73,392)(36) = 2,642,112 square feet Subtotal for Canyon County = 5,936,832 square feet
Ada County	Collector Roads - 92,871 feet at 36 feet wide = (92,871)(36) = 3,343,356 square feet Local Roads - 497,912 feet at 24 feet wide = (497,912)(24) = 11,949,888 square feet Minor Arterials - 62,037 feet at 41 feet wide = (62,037)(41) = 2,543,517 square feet Primary Arterials - 92,462 feet at 52 feet wide = (92,462)(52) = 4,808,024 square feet Subtotal for Ada County = 22,644,785 square feet
Assuming .2 foot of mud/soil to be removed. Canyon County Roads - (5,936,832 square feet)(.2) = 1,187,366 cubic feet = 43,976.5 cubic yards. Ada County Roads - (22,644,785 square feet)(.2) = 4,528,957 cubic feet = 167,739 cubic yards. Ada County Parking Lots - (1,008,113 square feet)(.2) = 201,623 cubic feet = 7,467.5 cubic yards.	
Cost (using $7.70 per cubic yard)	
Canyon County Ada County	(43,976.5)(7.70) = $338,623 (167,739)(7.70) = $1,291,590
Note: Ada County also has parking lots that would be covered with soil. Total square feet of parking lots is 1,008,113. Total cubic feet of soil is 201,623 or 7,467.5 cubic yards at $7.70 per cubic yard. Total cost is $57,500 **Total Clean-Up Expenses are $1,687,713 ($338,623 + $1,291,590 + $57,500).**	

i. Other Agriculture Losses.

Other agriculture losses included losses experienced from equipment losses, damage to the quality of the land, fencing, loss of fertilizer and chemicals, clean-up of fields, and labor for replanting crops.

The values used in *Boise Valley Regional Water Management Study*, dated 1977, were updated to 1994 price levels using an agriculture index combination of USDA "prices paid" by farmers (80 percent) and "prices received" by farmers (20 percent). No adjustment was made for development, since the local Agriculture Extension Agent from the University of Idaho indicated that less than 1 percent of the two-county area was diverted from agriculture to non-agricultural land between 1974 and 1994. The proportion of losses between the 100-year and 500-year floodplains were assigned using the same proportion as the above subject report (see table C-14 for detailed information by county).

Table C-14. Lower Boise River Basin "Other Agriculture Damages"

	Ada County		Canyon County		Total Reach
	1974 Price Level[1]	1994 Price Level[2]	1974 Price Level[1]	1994 Price Level[2]	
100-Year Damages	$362,000	$790,000	$648,000	$1,414,000	$2,204,000
500-Year Damages	$2,698,000	$5,882,000	$4,402,000	$9,596,000	$15,478,000
Percent of Total	38 percent		62 percent		100 percent

[1]Based on *Boise Valley Regional Water Management Study*, dated 1977.
[2]Updated to a 1994 price level using an agriculture index combination of USDA "prices paid" by farmers (80 percent) and "prices received" by farmers (20 percent).

j. Business Losses.

Business losses cited in *Boise Valley Regional Water Management Study*, dated 1977, were updated 1994 price levels using the Consumer Price Index (CPI) to account for growth and inflation. The subject report was used as a standard to apportion damages between the 100- and 500-year floodplains, as well as between Ada and Canyon Counties. The unit number of businesses used for the total 500-year floodplain was 600 (see table C-15 for more details).

Table C-15. Lower Boise River Basin Business Losses

	Ada County		Canyon County		Total Reach
	1974 Price Level[1]	1994 Price Level[2]	1974 Price Level[1]	1994 Price Level[2]	
100-Year Damages	$117,000	$330,000	$31,000	$88,000	$418,000
500-Year Damages	$2,733,000	$7,707,000	$727,000	$2,050,000	$9,757,000
Percent of Total	79 percent		21 percent		100 percent

[1]Based on *Boise Valley Regional Water Management Study*, dated 1977.
[2]Updated to a 1994 price level using the CPI for January 1995.

k. Flood Damages Synopsis.

Flood damages occur as floodwaters exceed river banks and flood onto nearby developed properties. Damages generally increase with the depth of the water, the length of time water stands on structures, and the number of structures inundated.

A discharge/damage table was developed as a result of updating the 1974 field inventory, conducting another inventory in August 1994, and combining the inventory data with ground elevations and water surface profiles obtained from FEMA and the Corps, Walla Walla District. The point at which flood damages begin was based on discussion with the Corps, Walla Walla District, Hydrology Branch. Table C-16 shows the relationship between potential flood damages that would occur under existing conditions for a given flow rate, as measured at Glenwood Bridge.

Table C-16
Flow Versus Flood Damages
Existing Conditions (Without Project)
500-Year Floodplain
(1994 Price Level)

Flow (cfs)	Damages ($)
4,000	0
5,000	46,000
6,500	147,000
7,000	349,000
7,200	434,000
8,000	759,000
10,000	3,300,000
12,000	12,700,000
15,000	33,000,000
16,600	51,176,000
20,000	86,000,000
25,000	141,000,000
30,000	216,000,000
35,000	329,000,000

l. Economic Impacts.

Economic impacts are expressed as average annual dollars. Based on the information presented above, average annual damages were computed for the basin using a program developed by the Corps, Walla Walla District. The average annual damages under existing conditions were estimated to be $1,436,000. Table C-17 shows the breakdown of average annual damages by category or damage type.

Table C-17. Existing Conditions 1994 500-Year Floodplain (1994 Price Level)				
Damage Category	**Number**	**Percent of Total Damages**	**Total Damages ($1,000)**	**Average Annual Damages ($1,000)**
Residential Structures	8,000	15.4%	51,000	221.1
Residential Content	8,000	5.9%	19,300	84.7
Commercial Structures	600	20.5%	67,300	294.4
Agriculture (crop acres)	59,000	0.7%	2,200	10.0
Other Agriculture	*	4.7%	15,500	67.5
Utilities (miles of line)	N/A	13.5%	44,400	194.0
Transportation (miles)	177	35.3%	116,200	507.0
Emergency Expenses (days)	2,321	0.5%	1,600	7.2
Clean-Up Expenses (cubic yards of sediment)	219,183	0.5%	1,700	7.2
Business Losses (number of businesses)	600	3.0%	9,800	43.0
Total		100%	$329,000	$1,436
*Included in the 59,000 crop acres.				

1.04. BENEFITS (ALTERNATIVE 2).

Congress, in the Flood Control Act of 1936, established a nationwide policy that flood control (*i.e.,* flood damage reduction) on navigable waters, or their tributaries, is in the interest of the general public welfare and is, therefore, a proper activity of the Federal Government in cooperation with state and local entities. It is provided that the Federal Government may improve streams or participate in improvements "for flood control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected."

Flood damage reduction benefits for Alternative 2 were calculated as the difference between the damages under existing conditions and damages projected with Alternative 2 in place. Average annual benefits for Alternative 2 were estimated to be $559,000, as shown in table C-18.

Table C-18 Average Annual Benefits for Alternative 2	
Average Annual Damages, Existing Conditions	$1,436,000
Average Annual Damages with Alternative 2	($877,000)
Average Annual Benefits, Alternative 2	**$559,000**

Table C-19 shows the breakdown of average annual benefits by category or damage type.

Table C-19. Average Annual Benefits for Alternative 2 (1994 Price Level)

Benefit Category	Percent of Total Benefits	Average Annual Benefits ($)
Residential Structures	15.4%	86,000
Residential Content	5.9%	33,000
Commercial, Public, and Industrial	20.5%	115,000
Agricultural Crop Losses	0.7%	4,000
Other Agricultural Losses	4.7%	26,000
Utilities	13.5%	75,000
Transportation	35.3%	197,000
Emergency Expenses	0.5%	3,000
Clean-Up Expenses	0.5%	3,000
Business Losses	3.0%	17,000
TOTAL	**100%**	**559,000**

1.05. RISK AND UNCERTAINTY.

Risk and uncertainty affect many of the elements that go into the estimation of flood damages. The variability of these effects is magnified in a reconnaissance study where the scope does not permit in-depth analysis. The following is a list of factors subject to risk and uncertainty. This list is not all inclusive. Many elements are built on sub-elements that are not listed. It is beyond the scope of this study to define the bounds and probability distributions for the items affected by risk and uncertainty.

- Flooded area
- Flood depths
- Topography

- Floodflow velocity
- Flood frequency (probability of occurrence)
- Structure value estimates (as a proxy for replacement cost less depreciation)
- Number of structures
- Physical characteristics of structures
- First floor elevations
- Structure depth/damage functions
- Contents value
- Contents depth/damage functions
- Units and unit damages for non-structural property
- Levee restoration time and cost

APPENDIX D

LUCKY PEAK DAM AND LAKE STORAGE REALLOCATION APPRAISAL REPORT

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EXHIBITS

GLOSSARY OF TERMS, ABBREVIATIONS, AND ACRONYMS

TERMS

Natural Flow Right:	Right to the use of water that would normally be in the stream without storage in the stream (these are typically all senior to storage rights).
Storage Right:	Right to the use of water release from storage.
Consumptive Use/Component:	Evapotranspiration, sometimes called total evaporation, describes the total water removed from an area by transpiration and by evaporation.
Water Storage Contract (Part 1):	The user contracts with the Government for the use of storage for municipal and industrial water supply, and for payment of the cost of that storage space.
Surplus Water Contract (Part 2):	The user contracts with the Government for the privilege of withdrawing surplus water from the project.

ACRONYMS

AF	Acre-Foot
ASA	Assistant Secretary of the Army
BLM	U.S. Bureau of Land Management
BPA	Bonneville Power Administration
BWC	Boise Water Corporation
cfs	Cubic Feet per Second
Corps	U.S. Army Corps of Engineers
DOI	U.S. Department of the Interior
EIS	Environmental Impact Statement
GWMA	Groundwater Management Areas
HQUSACE	Headquarters, U.S. Army Corps of Engineers
IDFG	Idaho Department of Fish and Game
IDWR	Idaho Department of Water Resources
mgd	Million Gallons per Day
M&I	Municipal and Industrial
NEPA	National Environmental Policy Act
OMRR&R	Operation, Maintenance, Repair, Replacement, and Rehabilitation
SBMIC	South Boise Mutual Irrigation Company
USBR	U.S. Bureau of Reclamation
UWI	United Water Idaho, Inc. (formerly Boise Water Corporation)

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SECTION 1 - INTRODUCTION

1.01. AUTHORITY.

Section 301(a) of the Water Supply Act of 1958, as amended by 43 United States Code 390b, established a policy of cooperation in the development of water supplies for domestic, municipal, industrial, and other purposes. Section 301(b) is the authority for the U.S. Army Corps of Engineers (Corps) to include municipal and industrial (M&I) water storage in reservoir projects.

Because this is the first reallocation of storage space to M&I water supply purposes at Lucky Peak, approval by the Assistant Secretary of the Army (ASA) is required. For subsequent reallocations up to 499 acre-feet (AF), the Commander, Headquarters, U.S. Army Corps of Engineers (HQUSACE), has delegated approval authority to the Commander, North Pacific Division.

1.02. PURPOSE AND SCOPE.

The purpose of this report is to investigate the reallocation of storage space in the Lucky Peak reservoir from an irrigation to an M&I water supply. The scope of this report is an appraisal to determine Federal interest. Issues surrounding contractual storage agreements with the U.S. Bureau of Reclamation (USBR), the Corps, and state water rights will be addressed.

This investigation is in response to a request by United Water Idaho, Inc. (UWI) formerly Boise Water Corporation (BWC), of Boise, Idaho, for M&I storage space in the Lucky Peak reservoir (see exhibit D-1). The volume they request is 280 AF (see exhibit D-2).

A preliminary estimate of the non-Federal sponsor's appropriate share of the specific and joint-use operation, maintenance, replacement, and major rehabilitation (OMRR&R) cost is presented.

This report is prepared according to Engineer Regulation (ER) 1105-2-100, *Policy and Planning, Planning Guidance*, section VII, "Water Supply."

1.03. PRIOR STUDIES AND REPORTS.

No formal cost allocation has been prepared for Lucky Peak Dam and Lake. No prior reports have been prepared addressing M&I water supply storage in the Lucky Peak reservoir.

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SECTION 2 - BACKGROUND

2.01. BOISE RIVER RESERVOIR SYSTEM.

a. Dams and Reservoirs.

Within the Boise River Basin, four separate Federal reservoir projects are operated as one system, referred to as the "Boise River Reservoir System." This system includes Anderson Ranch, Arrowrock, Lucky Peak, and an offstream storage reservoir (Lake Lowell). Lucky Peak Dam is located at River Mile 63.8 on the Boise River, and Arrowrock Dam is immediately upstream from Lucky Peak Reservoir at River Mile 75.4. Anderson Ranch Dam is located further upstream, at River Mile 43.5 on the South Fork Boise River. The New York Canal diversion facilities and Lake Lowell are downstream of Lucky Peak.

The joint-use capacity at each project is operated as a system for flood control and irrigation water supply by a Memorandum of Understanding executed on November 20, 1953. The 5,000 AF exclusive power capacity at Anderson Ranch is not included in the flood control capacity. A Water Control Manual implements this agreement, and is updated periodically.

b. Project Owners and Operators.

The USBR, Pacific Northwest Regional Office and Central Snake Projects Office, owns and operates the New York Canal and Lake Lowell projects, but the Boise Project Board of Control operates them under an operation and maintenance contract with USBR. The Corps, Walla Walla District, owns and operates Lucky Peak Project and its facilities. The Lucky Peak Power Plant Project is owned and operated under agreements between the irrigation districts that make up the Boise Project Board of Control and Seattle City Light, under Federal Energy Regulatory Commission license number 2832.

The Boise Project Board of Control is authorized to represent the New York Irrigation District in Boise, Idaho; the Nampa and Meridian Irrigation District in Nampa, Idaho; the Boise-Kuna Irrigation District in Kuna, Idaho; the Wilder Irrigation District in Caldwell, Idaho; and the Big Bend Irrigation District in Nyssa, Oregon.

c. Regulating Agencies.

Regulation of the Anderson, Arrowrock, and Lucky Peak Projects is a joint effort between USBR, the Corps, and the Boise River Watermaster (Idaho Water District #63). The Boise Project Board of Control regulates the New York Canal and Lake Lowell.

2.02. BOISE RIVER SYSTEM OPERATION.

The amount of water stored in the system, and precisely when it is stored, is dependent on water rights, the amount of water available as runoff, the timing of the runoff, and the required flood control regulation. Flood control regulation, during the period of 1 November through the spring high water period, endeavors to maintain adequate flood control spaces within the reservoirs and still refill the reservoirs without exceeding a target flow of 6,500 cubic feet per second (cfs), as measured at the Glenwood Bridge gaging station. In low runoff years, flood control regulation during the spring snowmelt period is normally limited or not necessary, and water conservation and reservoir refill are the primary objectives. Near normal runoff years require delicate balances between flood control and refill regulation, with runoff timing and volume forecasts as key factors for these balances.

After the annual spring flood season (1 January to 15 July) is over, and until the end of the irrigation season, the reservoirs are drafted to maintain irrigation flows. Arrowrock Reservoir is drafted first to maintain the power head at Anderson Ranch Reservoir, as well as a desirable recreation level at the Lucky Peak reservoir. If the storage in Arrowrock has been used before the end of August, both the Anderson Ranch and Lucky Peak reservoirs are drafted without exceeding powerplant capacity at Anderson Ranch. After the end of August, irrigation demands are met primarily from storage in the Lucky Peak reservoir.

The Lucky Peak Power Plant does not change operational modes for flood control and irrigation. No releases, whether they are extremely high or extremely low, are altered by the presence of the generation facilities.

2.03. LUCKY PEAK DAM AND LAKE.

Construction of Lucky Peak Dam and Lake was authorized by Public Law 526, 79th Congress, 2d Session, and was approved on 24 July 1946. Construction began in October 1949, and the project was completed in December 1957. Storage began on 16 October 1954.

Lucky Peak Dam is located at River Mile 63.8 on the Boise River, a tributary of the Snake River. The dam is about 9 statute miles southeast of Boise, Idaho. The project purpose is flood control. It is also used to regulate releases from Arrowrock Dam, store irrigation water, provide recreation, store fish and wildlife water, and generate hydropower from the regulated releases for irrigation, streamflow maintenance, and flood control.

The USBR retains the storage license for the Lucky Peak reservoir. This license is issued by the Idaho Department of Water Resources (IDWR) for a total gross storage of 307,043 AF. Tables D-1 and D-2 describe reservoir data and storage water allocations. Surcharge capacity is reservoir storage between normal full pool and the spillway crest. This space is used only during major flood events.

Table D-1. Lucky Peak Reservoir Storage		
Surcharge Capacity	3,055 to 3,060 feet mean sea level	13,905 AF
Joint-Use Capacity	2,905 to 3,055 feet mean sea level	264,371 AF
Inactive Capacity	2,824 to 2,905 feet mean sea level	28,767 AF
	Total Gross Storage:	**307,043 AF**

Table D-2. Lucky Peak Storage Water Allocations
(Water Control Manual for Boise River Reservoirs, Table 7-7, revised July 1988)

Name	AF of Storage Water	Percent of Space
Ballentyne	1,300	0.492
Boise City	1,000	0.378
Boise Valley	2,500	0.946
Bubb Canal (South Boise Mutual)[1]	500	0.189
Canyon County	6,000	2.271
Capital View Irrigation District	300	0.114
Davis Ditch (Village of Garden City)	1,500	0.568
Eagle Island Water Company	7,650	2.895
Eureka Water Company #1	2,800	1.060
Farmers Union	10,000	3.784
Little Pioneer	500	0.189
Middleton Irrigation Association	6,380	2.414
Middleton Mill	4,620	1.748
New Dry Creek	3,000	1.135
New Union	1,400	0.530
Phyllis (Pioneer Irrigation District)	16,000	6.055
Ridenbaugh	35,000	13.245
Rossi Mill (South Boise Water)	700	0.264
Settelers	10,000	3.784
Thurman Mill	800	0.303
Idaho Fish and Game	50,000	18.921
Streamflow Maintenance	102,300	38.713
TOTAL	**264,250**	**100 percent**

[1]United Water Idaho, Inc., owns a share of South Boise Mutual, Boise City Canal, and Thurman Mill.

All water releases from the Lucky Peak reservoir are determined, controlled, and directed by the Corps. The Corps transmits water release schedules at the dam to the Boise Project Board of Control. The Boise Project Board of Control is then responsible for implementing these release schedules. Flows pass through the powerplant and/or the auxiliary outlet and/or the original project outlet works. Table D-3 shows the average monthly regulated discharges from Lucky Peak, and the equivalent volume. Average flows are based on the period of record from 1955 to 1994.

Table D-3. Lucky Peak Dam Average Monthly Total Project Releases

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
(cfs)											
916	205	318	575	1405	2128	4157	6199	5495	4618	3989	2915
or (thousand AF)											
56.3	12.2	19.5	35.3	78.0	130.8	247.4	381.2	327.0	283.9	245.3	173.4

2.04. UNITED WATER IDAHO, INC.

The UWI operates as a regulated public utility pursuant to a certificate of public convenience and necessity issued by the Idaho Public Utilities Commission, and a franchise from the city of Boise. Under Idaho statute, UWI has some of the characteristics of a public entity, including condemnation powers. The corporation currently serves 53,600 residential, commercial, and industrial customers. The 92-square-mile area that UWI serves has a population of approximately 150,000. Peak water use occurs in the summer.

Much of UWI's water supply comes from groundwater wells located throughout the service area. A significant portion, particularly during the irrigation season, is pumped from three Ranney collectors located directly next to the Boise River. These collectors allow the diversion of high-quality groundwater from the alluvium adjacent to and below the Boise River. The quality of water minimizes treatment costs and, ultimately, the cost to water consumers. However, because of their proximity to the river, a portion of UWI's diversions from the Ranney collectors can affect surface flows in the Boise River.

The UWI's collector diversions are junior to earlier surface water rights, and because they can affect more senior rights, UWI operates its collectors under an augmentation plan approved by IDWR. The plan involves the use of senior Boise River natural flow and storage rights in Anderson Ranch to "make up" approximately 1000 AF per year of depletion in river flows IDWR believes may be attributed to pumping from the Ranney collectors (see exhibit D-1). The UWI has acquired some senior natural flow rights over the last few years from canal companies and shareholders in areas that are being taken out of agricultural production due to expanding suburbs and commercial developments in the Boise area.

The UWI presently holds a permit with a priority date of September 8, 1993, authorizing it to divert 24.8 cfs from the Boise River, and has a water service contract with USBR for 1,000 AF of M&I storage space in Anderson Ranch.

The UWI uses the 1,000 AF of M&I storage space in Anderson Ranch as the primary source of mitigation water to offset depletions to the Boise River caused by pumping of its Ranney collectors under a 1952 groundwater license issued by IDWR. The South Boise Mutual Irrigation Company rights, together with rights obtained from the Boise City Canal Company and Thurman Mill, are used primarily for direct diversion into UWI's system for M&I use. As such, the storage water sought as a result of UWI's acquisition of South Boise Mutual Irrigation Company (SBMIC) shares would be diverted from the Boise River through a river intake structure at UWI's Warm Springs Water Treatment Facility. This river intake is located in close proximity to the Ranney collectors, which also divert into the Warm Springs facility.

The UWI's request to reallocate 280 AF of Lucky Peak storage is UWI's share of SBMIC's contracted irrigation storage (500 AF) in the Lucky Peak reservoir.

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SECTION 3 - WITHOUT PROJECT CONDITION

3.01. GENERAL.

The without project condition is defined as currently existing conditions that will probably exist in the future within the period of analysis. Population projects are to the year 2015, defining the period of analysis as 20 years. It is assumed that UWI will expand facilities and acquire future water supplies to meet rising demands.

3.02. WATER CONSUMPTION AND NEEDS.

The national average water consumption is 123 gallons per capita per day. In arid regions, such as Boise and its vicinity, the average consumption would be considerably higher. Consumption needs approaching three times the national average in arid regions are common.

The portion of Ada County representing UWI's current service area, as well as areas where UWI may expand in the future, had a population of 164,780 in 1990. This area has a projected population of 253,483 in the year 2015 (see exhibit D-3). Table D-4 shows that the expansion capability of UWI's existing facilities to 80 cfs is less than the projected peak demand (116 cfs) in the year 2015.

Table D-4. Estimated Water Demands

Past Usage and Future Service Estimates		
Year	**Population**	**Water Needs**
1990	164,780	20 to 50 million gallons per day (mgd) (31 to 77 cfs)
2015	253,483	30 to 75 mgd (46 to 116 cfs)
Current UWI Capacity and Expansion Capability		
Year		**Capacity/Capability**
1994		44 to 52 mgd (68 to 80 cfs)

3.03. CONSTRAINTS AND LIMITATIONS.

On May 3, 1995, IDWR rescinded that portion of its moratorium affecting new water right applications for the portion of the Snake River Basin within the Boise River Drainage Area (Basin 63).

Several areas within Basin 63 are designated as Groundwater Management Areas (GWMA). These include the Boise Front Low Temperature Geothermal Area and the Southeast Boise Groundwater Management Area. The UWI does not rely on geothermal resources and, therefore, is not directly affected by the Boise Front Geothermal GWMA. However, conditions of water supply in the Southeast Boise GWMA do limit UWI's water supply options in that area. Despite the lifting of the moratorium for Basin 63, these GWMA's remain subject to the limitations on water rights development and administration imposed pursuant to Idaho Code §42-233b.

From UWI's perspective, the lifting of the moratorium in Basin 63 does not appreciably alter the situation with respect to UWI's desire to obtain dependable surface water supplies to complement its groundwater rights. The IDWR's Amended Moratorium Order indicates that applications to appropriate water in Basin 63 will receive closer scrutiny in the future, may require mitigation of potential impacts to prior water rights, and may be subject to more stringent conditions on use than those imposed previously.

3.04. PROJECTIONS.

The city of Boise and its vicinity have experienced a rapid and vibrant population growth. Urban development will continue to supplant irrigated agricultural lands. This trend is expected to continue for the next 20 years.

Because UWI understands that irrigation storage dedicated to lands that have been converted from agricultural use is subject to forfeiture under state law if it is not changed to a new use, conversion of the storage rights associated with UWI's shares in Boise Valley canal companies must remain a priority.

SECTION 4 - LUCKY PEAK STORAGE REALLOCATION

4.01. GENERAL.

a. Use Conflicts.

Because Boise River reservoirs are managed as a multiple-purpose system, it is not possible to optimize regulation for each of the separate uses. The optimum flood control protection possible with the system would require that the reservoirs be kept empty and available to control floodwaters. Optimum irrigation and recreation use would require the reservoirs to be kept as full as possible to provide carry-over storage water for drought years.

Flood control is the primary project purpose for the Lucky Peak reservoir, which conflicts with all of the other system uses to some degree. Reallocation of storage space in Lucky Peak for M&I purposes requires compromises between the various uses. Three options for reallocating storage for dedicated M&I purposes include: 1) continue the existing joint use of flood control space; 2) reallocating flood control space; and 3) reallocating conservation space.

b. Change in Average Monthly Project Releases.

In general, dedicated storage for M&I purposes allows users to request water from storage at any time. Table D-5 presents two possible release options to illustrate the withdrawal of 280 AF, at a constant rate, from storage over the following periods:

(1) May through October 180 days = 0.5 mgd or 0.8 cfs

(2) June through July 60 days = 1.5 mgd or 2.3 cfs

Assuming each release for M&I water supply is a simple plus and minus to the average monthly flow, table D-5 illustrates the very small change in monthly project releases.

An investigation of the change in historic flows is necessary to evaluate and quantify impacts. Although the change in flow is very small, a shift in flow from the fall time period to the June through July freshet would affect the Lucky Peak Power Plant, because power is of less value during the freshet. Environmental effects due to the small change in flow would also be minimal and difficult to quantify.

Table D-5. Lucky Peak Dam Estimated Change in Average Monthly Total Project Releases (cfs)											
Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
916	205	318	575	1405	2128	4157	6199	5495	4618	3989	2915
280 AF Released at a Constant Flow from Storage During June through July											
916	205	318	575	1405	2128	4157	6199	+2.3 5497	+2.3 4620	-2.3 3986	-2.3 2913
or **280 AF Released at a Constant Flow from Storage During May through October**											
+1 917	205	318	575	1405	2128	4157	+1 6200	+1 5496	+1 4619	-2 3987	-2 2913

4.02. <u>OPTION 1--CONTINUE THE EXISTING JOINT USE OF FLOOD CONTROL SPACE</u>.

Joint use of flood control space is shared space. This option would require no change from the existing operation of Lucky Peak Project. All water releases for flood control would be determined, controlled, and directed by the Corps. Releases for M&I purposes would be secondary to flood control.

One illustration of M&I purposes being secondary to flood control occurs when extreme spring evacuation requirements are implemented (1 January through 31 March). Evacuation is necessary to provide adequate flood spaces within the reservoir projects to control forecasted flood flows resulting from melting snowpacks within the upper Boise River Basin. During this condition, any water in storage for purposes other than flood control would be released to provide flood control space. Years with small runoff volume forecasts may require no evacuation, while years with large runoff volume forecasts may require large releases for evacuation.

With this option for reallocation, flood control benefits would not be affected, and there would be no foreseeable impact to any project purpose.

4.03. <u>OPTION 2--REALLOCATE FLOOD CONTROL SPACE</u>.

A general example for considering the reallocation of flood control space occurs when the reallocation of flood control storage volume is small and would have little or no affect on flood protection. A small change (even 2 inches) in pool elevation may be larger than the volume reallocated for M&I. Another example for considering the reallocation of flood control space occurs when the downstream floodplain has changed or supplemental protection has been provided. When these conditions exist, the reallocation of flood control space may be a possibility.

The following is presented to illustrate the small increments and elevation changes associated with 280 AF. The 280 AF is 0.03 percent of the total 974,000 AF of storage space for flood control at Anderson Ranch, Arrowrock, and Lucky Peak. At Lucky Peak, 280 AF is about 0.1 percent of the active storage (joint-use space). Near minimum pool elevations, the 280 AF represents a 0.3-foot change in water surface elevation. At full pool, this volume represents a 0.1-foot change in water surface elevation.

The combined use of all three reservoirs does not provide sufficient flood control along the lower Boise River, because this amount of space is not large enough to control the runoff from large floods (50- to 100-year events). Any reduction in active storage at Lucky Peak would impact flood control. A quantitative analysis of the impacts from a reduction of 0.03 percent in storage space to flood control is beyond the scope of this appraisal.

4.04. <u>OPTION 3--REALLOCATE CONSERVATION SPACE</u>.

The reallocation of reservoir conservation space is a possibility when the originally-authorized project purposes are no longer required to meet present needs, or when the conservation space is available for a new or higher purpose. The opportunity then exists to modify or update the authorized project purposes, in this case the conservation space, through reallocation.

Conservation space in the Lucky Peak reservoir is designated for fish and wildlife, and for sediment build-up. The conservation storage is 28,767 AF at a pool elevation of 2905 feet mean sea level. At this point, a 1-foot differential in water surface elevation is equal to about 800 AF.

APPENDIX D
LUCKY PEAK DAM AND LAKE STORAGE REALLOCATION
APPRAISAL REPORT

SECTION 5 - ALTERNATIVES TO STORAGE REALLOCATION

5.01. ALTERNATIVE WATER SUPPLY SOURCES.

As a test of financial feasibility, the annual cost of reallocated storage should be compared to the annual cost of the most likely, least costly alternative that would provide an equivalent quality and quantity of water that the non-Federal interest would undertake in the absence of utilizing the Federal project. Additional groundwater wells, or the construction of an additional storage reservoir in the Boise River drainage, are considered the most likely alternatives.

5.02. ADDITIONAL WELLS.

Generally, additional wells for M&I water supply would be the likely alternative to reallocating reservoir storage. However, constraints and limitations in the Boise area may prohibit additional wells.

The Southeast Boise GWMA represents an important source of groundwater. Although UWI has wells in this area, this is not the major groundwater source in the Boise area and it is also not UWI's primary groundwater source.

The UWI has many other wells located throughout its service area that draw from the Boise aquifer system. However, significant urban development is ongoing and expected in southeast Boise which, because of the designation of the Southeast Boise GWMA and local hydrogeologic conditions, has a more limited groundwater supply. In large part because of the Southeast Boise GWMA designation, surface water supplies represent the most viable source of water to serve this area of Boise.

5.03. NEW DAM AND STORAGE RESERVOIR.

Constructing a new dam and reservoir is not considered a viable alternative because of the inherent high costs for small volumes. Previous cost analyses for small reservoir projects having storage capacities of 6,000 AF and 8,800 AF show average annual costs to be about $460 to $580 per AF, at 1991 price levels (*Reconnaissance Report, Walla Walla River Basin, Oregon and Washington*, U.S. Army Corps of Engineers, April 1992).

5.04. <u>SURFACE WATER</u>.

The UWI also has the option of purchasing senior natural flow water rights on a willing buyer/willing seller basis, and transferring them to its intake at the Warm Springs Facility. However, for various reasons, such opportunities have been limited to date. Also, this option still does not address the issue of what will happen if irrigation storage associated with canal company shares is no longer used for irrigation.

APPENDIX D
LUCKY PEAK DAM AND LAKE STORAGE REALLOCATION
APPRAISAL REPORT

SECTION 6 - ECONOMIC CONSIDERATIONS

6.01. GENERAL.

This appraisal analysis assumes that the effects of reallocating 280 AF of reservoir space at Lucky Peak for M&I purposes are minimal. Analyses at a greater level of detail are needed to quantify those effects.

6.02. COST OF STORAGE ANALYSIS.

The non-Federal sponsor's appropriate share of costs is based on the storage to be reallocated in proportion to the total storage water allocated in Lucky Peak (280 AF ÷ 264,250 AF = 0.106 percent of Total Allocated Storage).

The cost that would be allocated to UWI normally is established as the highest of the benefits or revenue foregone, the replacement cost, or the updated cost of storage in Lucky Peak. The analysis of each is discussed in the following paragraphs.

a. Benefits Foregone.

This reallocation in usage is not expected to change the present operation at Lucky Peak or significantly affect downstream flows.

The consumptive component for M&I use is generally considered less than the consumptive component for irrigation use, because of the large volumes of water taken up by plants, as well as the water lost through evapotranspiration. Therefore, it is expected that downstream flows in the Boise River may be greater than historical flows when water was used only for irrigation.

The benefit foregone is based on using this water for the irrigation of new croplands. Benefits foregone, based on a study of other comparable areas, are estimated to be between $30.00 and $40.00 per AF.

b. Revenues Foregone.

Revenue foregone from project purposes is the reduction in revenues accruing at the U.S. Treasury, based on any existing repayment agreements. Including the appropriate operation and maintenance component, revenues foregone are estimated to be $3.26 per AF.

c. Replacement Costs.

Assuming the effect of reallocating 280 AF is negligible, the analysis of replacement cost would not be appropriate for this reallocation. This reallocation is within the Chief of Engineers' discretionary authority which, by definition, does not have severe impacts on authorized purposes.

d. Updated Cost of Storage.

The updated cost of storage is based on feature costs updated to 1992 price levels using the *Engineering News Record* and the *Civil Works Construction Cost Index System* indices. Including updated real estate costs, amortized at 7-3/4 percent interest for 30 years, the updated average annual cost of storage is estimated to be $56.00 per AF at October 1994 price levels.

e. Annual Costs.

The greatest cost of the four criteria listed above is the updated annual cost of storage. In addition, UWI would be responsible for an appropriate share of the specific and joint-use OMRR&R costs at Lucky Peak. The 5-year average (1987 to 1991) for appropriate OMRR&R costs is $430,529. Annual OMRR&R costs are estimated at $430,529 ÷ 264,250 AF = $1.63 per AF. The combined total annual cost is estimated as $56.00 + $1.63 = $57.63 per AF.

6.03. PRELIMINARY FINANCIAL ANALYSIS.

The UWI is aware of the cost-sharing responsibilities for implementation of this reallocation. Their interest is high, and they fully support potential solutions to implement the reallocation of space to M&I purposes.

United Water may be willing to share in the cost of further studies and perfecting the reallocation of storage space to M&I. However, a primary factor affecting UWI's willingness or ability to proceed and participate in such reallocation is the overall cost to UWI for each AF of water that can actually be delivered to the desired point of diversion. This overall cost includes costs to United Water for participation in necessary feasibility studies, National Environmental Policy Act (NEPA) compliance, annual rental and operation and maintenance costs, and the costs associated with obtaining approval by IDWR of the proposed change in use. This overall cost almost certainly will exceed $57.63 per AF. Therefore, UWI's willingness or ability to pay for reallocated storage will, in large part, depend upon the additional transaction costs that can be expected over and above the $57.63. Assuming that these other costs can be minimized or paid for by funds from sources other than UWI, a further review of storage reallocation is warranted.

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LUCKY PEAK DAM AND LAKE STORAGE REALLOCATION
APPRAISAL REPORT

SECTION 7 - ENVIRONMENTAL CONSIDERATIONS

Water pumped from the Ranney collectors directly adjacent to the Boise River can affect surface flows in the Boise River. The current operating method allowing flows to remain in the Boise River under the established augmentation plan approved by IDWR is mitigating the effects attributed to the Ranney collectors. This operation is expected to continue.

The change in use would not require any physical modification of Corps facilities, nor would it significantly change the operation of the Lucky Peak reservoir to store or deliver water. The Lucky Peak reservoir is drafted annually for flood control and irrigation, sometimes up to 150 feet. Environmental effects within the reservoir are assumed to be negligible, because any seasonal change in water surface elevation (0.1 foot or less) is well within the existing 150-foot operating range.

SECTION 8 - FUTURE STUDY REQUIREMENTS

Future study requirements are dependent upon UWI's desire to acquire dedicated storage in the Lucky Peak reservoir for M&I purposes. Joint use of flood control space requires the least amount of studies. The reallocation of flood control space, or conservation space, for M&I purposes are the most complex. These options will include the following study requirements:

- Hydrologic analyses to quantify potential changes in flow regimes ($10,000 - October 1995 price level).

- Analysis of the environmental effects, both at the reservoir and on the Boise River ($10,000).

- National Environmental Policy Act documentation ($10,000).

- Storage reallocation report, coordination, and management ($50,000).

- Cost analysis and economics ($20,000).

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SECTION 9 - COORDINATION

Preliminary coordination with USBR began in 1992 at the time of UWI's initial request for reallocation. Initial contacts and meetings involving the State of Idaho have been informal and introductory in nature. The level of coordination to date is commensurate with the level of detail for this appraisal stage.

Unique to Lucky Peak is the Memorandum of Understanding governing the operation of the three storage projects, and the State storage license for Lucky Peak Lake issued to USBR. More intense coordination will be necessary to deal with policy and contractual agreements between the Corps and USBR. Assuming that overall costs of reallocation on a per-AF basis can be kept at an economical level when compared with the cost per AF for water from other available sources. The UWI would be willing to participate, in coordination with USBR and IDWR, to accomplish this reallocation.

The sponsor is responsible for coordinating and securing, or transferring, necessary water rights for M&I purposes.

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LUCKY PEAK DAM AND LAKE STORAGE REALLOCATION
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SECTION 10 - CONCLUSIONS AND RECOMMENDATIONS

10.01. CONCLUSIONS.

a. Authorization.

Contained in House Record 6597, 79th Congress, 2d Session, is the report from the Board of Engineers for Rivers and Harbors, dated April 30, 1946. Portions of the authorizing document state:

> "The plan of the district engineer contemplates joint use of the storage in Lucky Peak, Arrowrock, and Anderson Ranch Reservoirs and his recommendation makes initiation of construction of Lucky Peak Reservoir contingent upon securing certain prior agreements from local interests. In the opinion of the Board, the plan should be flexible in regard to combined operation of the reservoir sin order that the use of storage may at all times conform to changing conditions and best serve the varying needs of the locality."

The report continues:

> "The Board is of the opinion that the reservoir should be authorized for construction at this time and for operation initially for flood control with the understanding that changes in the method of operation will be made in the future when the Secretary of War, upon the advice of the Chief of Engineers, finds that such changes are in the best interest of flood control, irrigation and power development, and that they are agreeable to the Secretary of the Interior and to local interests concerned with flood control and the use of irrigation water."

Although Lucky Peak was authorized initially for flood control and potential future changes for flood control, irrigation, and power; the local need for an M&I water supply is a beneficial change in the use of water consistent with the intent of the Board for Lucky Peak to serve, at all times, the varying needs of the locality. Based on this document, satisfying those needs is in the Federal interest.

b. Implementation.

Alternatives to reallocating Lucky Peak storage are too costly, or are not implementable. To meet the M&I needs of the locality, reallocation is the only viable solution. Other alternatives for obtaining water may exist, but they do not address the fact that, as a shareholder in SBMIC, UWI has an interest through SBMIC's storage contracts in the 280 AF that can be realized only through its reallocation to M&I. They also may not be feasible for meeting the water needs in east and southeast Boise.

The method of reallocation chosen will depend on UWI's need for dedicated storage, or joint use of storage and future coordination with all regulating agencies. Dedicated storage from flood control; space, or from the conservation pool space, are options.

The change in use would not require any physical modification of Corps facilities. Implementation could, however, be fraught with administrative and coordination problems.

c. Cost.

The cost allocated to the non-Federal sponsor for dedicated storage is normally established as the highest of the benefits or revenues foregone, the replacement cost, or the updated cost of storage in the Federal project. The UWI's estimated appropriate share of the cost of storage at Lucky Peak is the combination of the updated annual cost of storage ($56.00 per AF) and the appropriate OMRR&R costs ($1.63 per AF), for a total estimated annual cost of $57.63 per AF at October 1994 price levels.

d. Impacts.

The incremental change in project releases from 280 AF of dedicated storage is small (0.1 percent of total Lucky Peak storage). Changes in reservoir water surface elevations would also be very small, and well within the 150-foot normal operating range.

Dedicated storage for M&I purposes would impact flood control or conservation pool purposes, as well as hydropower production at Lucky Peak. Environmental impacts, both at the reservoir and downstream in and along the Boise River, would also be minimal. However, further investigations are necessary to clearly identify and quantify those impacts.

10.02. <u>RECOMMENDATION</u>.

It is recommended that reconnaissance studies continue to evaluate implementation and quantify the impacts of reallocating storage for M&I purposes.

The recommendations contained herein reflect the information available at this time and current departmental policies governing the formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the sponsor, the states, interested Federal agencies, and other parties will be advised of any modifications; and will be afforded an opportunity for further comment.

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July 20, 1992

LTC Robert D. Volz
Commander
Department of the Army
U.S. Army Corps of Engineers
Walla Walla District
Walla Walla, WA 99362-9265

Re: Boise Water Corporation's Request For M&I Storage Space in Lucky Peak Reservoir, Boise, Idaho.

Dear Colonel Volz:

This letter is to notify you that Boise Water Corporation ("BWC") wishes to begin discussions with the Corps regarding BWC's use for municipal purposes of the approximately 94 acre-feet of water that is BWC's share of South Boise Mutual Irrigation Company's ("SBMIC's") contracted irrigation storage in Lucky Peak Reservoir.

BWC is an investor owned utility which operates under franchise from the City of Boise. BWC is regulated by the Idaho Public Utilities Commission and currently serves 48,812 residential, commercial and industrial customers within the City of Boise and the surrounding area. The 78 square mile area that BWC serves has a population of approximately 135,000 people and it is growing rapidly. BWC's peak use occurs in the summer.

Much of BWC's water supply comes from groundwater wells located throughout its service area. A significant portion, particularly during the irrigation season, also is pumped from three Ranney collectors that BWC has installed directly adjacent to the Boise River. (See attached map.) These collectors allow the diversion of high-quality groundwater from the alluvium adjacent to and below the bed of the

Boise River. The quality of this groundwater minimizes BWC's treatment costs, and ultimately, the cost to the water consumers. However, because of their proximity to the river, at least a portion of BWC's diversions from the Ranney collectors can affect surface flows in the Boise River.

Practically speaking, nearly all the Boise River's summer surface flows were appropriated for irrigation by the early 1900's. Because its diversions from the Ranney collectors are junior to these early surface water rights, and because they can affect the more senior rights, BWC operates its collectors under an augmentation plan approved by the Idaho Department of Water Resources ("Department"). BWC's augmentation plan involves the use of senior Boise River natural flow rights and storage rights to "make up" approximately 1000 acre-feet per year of depletions in river flows that the Department believes is attributable to pumping from the Ranney collectors. In other words, the augmentation plan allows BWC to divert water essentially out of priority while protecting vested rights from injury. Augmentation plans are commonly used in Colorado and some other western states, and have been used successfully in Idaho by BWC for several years.

BWC has acquired these senior natural flow rights over the last few years from canal companies, including SBMIC, and their shareholders in areas that are being taken out of agricultural production due to expanding suburbs and commercial developments in the Boise Area.

SBMIC's decreed period of use for its water rights is May 1 through October 31 of each year. During the irrigation season, the Boise River Watermaster delivers water to SBMIC's headgate. (See attached map.) Under BWC's augmentation plan, its share of the SBMIC natural flow right is allowed to pass the SBMIC headgate and flow downstream to make up any stream depletion caused by BWC's pumping from the collectors. Thus, other than the fact the a portion of SBMIC's natural flow rights are now used as BWC's augmentation water, the water is called for and delivered as if it had remained dedicated to irrigation.

Because of the priority date of SBMIC's water right, and because of the natural annual decline of Boise River surface flows through the summer months, SBMIC typically must call on contract storage rights that it holds in Anderson Ranch and Lucky Peak Reservoirs to supplement its natural flow rights. SBMIC historically has gone on storage around July 15 of each year. Under its current contract with the United States, SBMIC has contracted to pay for 0.17973% or 500 acre-feet of the active space in Lucky Peak Reservoir. BWC's share of that amount is approximately

94 acre-feet or 0.03378% of the active capacity of the reservoir. BWC's share of SBMIC's contract storage rights in Anderson Ranch is approximately 100 acre-feet. BWC has asked the Bureau to reallocate BWC's share of the SBMIC storage in Anderson Ranch to M&I purposes for BWC's use, with the current intention of using this storage water under its augmentation plan. The Bureau has responded by stating that it can approve such a change. The Bureau anticipates that the cost per acre-foot of water would be somewhere between $18 and $20 per year. This is in the neighborhood of the amount the Bureau charges BWC for 1000 acre-feet of M&I storage in Anderson Ranch under a 1986 contract. BWC is now working out the details of a change in nature of use with the Bureau and expects to participate fully in the necessary state water right transfer procedures and other review of the change of this Bureau water.

As with the change of nature of use of the Anderson Ranch storage, BWC's proposed use of its share of SBMIC's storage rights in Lucky Peak Reservoir should not have any effect on the Corps' current reservoir operations or contract obligations. BWC expects that if the 94 acre-feet of storage were reallocated to M&I purposes, it would be called for by SBMIC and delivered to the Boise River between May 1 and October 31 each year in much the same way that it has been historically.[1] BWC's portion of the storage would pass SBMIC's headgate and move downstream to augment flows below the Ranney collectors.

The change would not require any modification of the Corps' facilities at Lucky Peak to store or deliver the water. In addition, because the reallocation of storage to another beneficial use would involve a portion that is already allocated to, and used for irrigation, it should have no effect on available flood control storage, hydropower generation, recreation, fish and wildlife, navigation or public safety. In fact, BWC believes that from an administrative standpoint, the storage or withdrawal of the 94 acre-feet would have imperceptible impacts on reservoir storage and management. The management of the right basically would involve a paper accounting on the books of the Bureau, Corps and the watermaster. Under these

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[1]The actual timing and rate of release during the irrigation season would be defined when an application for change in use is approved by the Department. For example, the Department's approval might call for the water to be released at a constant rate from May 1 to October 31, or only during the period when SBMIC's natural flow rights are curtailed. It also is possible that the Department would condition its approval of the change to limit the amount of storage water available, or the timing of its delivery to reflect the actual historical use of the right. In any event, BWC would expect to use the 94 acre-feet to the fullest extent possible each year.

facts, it does not appear that any significant amount of time or money should be required for reconnaissance studies of the proposed reallocation. As with BWC's past dealings with the Bureau, BWC would be willing to play a significant role in obtaining approval of the water right transfer from the Department.

From the standpoint of downstream impacts of the change, an approved augmentation plan would prevent injury to senior water rights. The reach of river between the SBMIC headgate and some point (not easily determinable) below BWC's Ranney collectors would experience slightly increased streamflow conditions during the irrigation season. This slight increase in flow during the summer months would have positive benefits for aquatic life and for recreation, although admittedly these benefits probably would be small.

Another benefit of BWC's proposal is that it ensures the continued beneficial use and validity of the storage right. Particularly in the Boise River Valley, where urban development in some areas is rapidly supplanting irrigated agriculture as the dominant land use, questions arise as to the continued viability under state law of natural flow and storage appropriations for irrigation if the water is not put to that beneficial use for five years. See Idaho Code §42-222(2). In other words, other than the change in use from irrigation to municipal purposes, BWC's proposal essentially would maintain the status quo on the Boise River with respect to maintenance and use of existing Federal water rights. Moreover, the economic growth that has spurred the conversion of farmland to other uses is reflected by the population growth in the Boise Valley. BWC has an obligation to meet the water demands of this growing population, and through the use of storage water in upstream reservoirs, it also has the opportunity to do so.

When Jeff Fereday spoke with you over the phone, you suggested that BWC might expect to pay the Corps in excess of $1,500 per acre-foot per year for the use of BWC's share of the SBMIC water for M&I purposes. This amount is far above the amounts that BWC has paid for storage water in Anderson Ranch, or any amount that we are aware is being paid on an acre-foot basis for the outright purchase of natural flow rights in the Boise River. In fact, a price in that range is so high - even on a westwide basis - that BWC probably could not even enter negotiations if that were a starting point.

We would appreciate it if you could tell us which formula the Corps would use in this situation to develop the cost per acre-foot of water. We also would like to know the Corps' position as to whether reallocated storage water would be supplied under a repayment contract or a water service contract, and whether this would involve an amendment to the United States' existing contract with SBMIC or a new contract. Also, since the Bureau is the actual holder of the water right permit for irrigation storage in Lucky Peak Reservoir (see attached Department report), we would like to know whether the Corps believes that the Bureau would be a necessary party to such a contract. We also would like to know how much time and effort the Corps anticipates that the proposed reallocation would require. In particular, we are interested in the Corps' view on what will be required in the way of reconnaissance studies or NEPA documentation, if any, and what the procedures, timelines and respective obligations of the Corps and BWC will be in completing them. BWC would like this information as soon as it is available.

I hope that this letter has provided you with the information you and your staff will need to properly evaluate BWC's proposal, and to provide BWC with guidance on how the Corps expects its review to proceed. Please call Jeff Fereday or me if you need additional information. I look forward to hearing from you soon.

Sincerely,

Michael C. Creamer

Michael C. Creamer

Enclosures

cc: Mr. Benjamin Hepler, Boise Water Corporation
~~Dick Harland, SBMIC~~
Willis E. Sullivan, III, Esq.

United States Department of the Interior

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PN-440

NOV 20 1992

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Subject: Shares Purchased in South Boise Mutual Irrigation Company (SBMIC) by Boise Water Corporation (BWC), Derivation of Acre-feet of Storage in Anderson Ranch and Lucky Peak Reservoirs (Water Transfer)

Dear Messrs. Creamer and Sullivan:

So that everyone is dealing with the same information, this office has put together the following tabulation as to the amount of storage in Anderson Ranch and Lucky Peak Reservoirs represented by the shares purchased in SBMIC by BWC. Based on information furnished by Mr. Creamer, plus provisions in existing contracts between the United States and SBMIC, the following amounts of storage were computed for Anderson Ranch and Lucky Peak Reservoirs.

<u>Anderson Ranch (Contract No. Ilr-1476, dated February 26, 1945)</u>:

The contract entitles SBMIC to .13 percent of the storage capacity available for irrigation in Anderson Ranch which is considered to be equivalent to 543 acre-feet. Accordingly the shares purchased by BWC represent the following amounts of storage:

Shares purchased = 139

$$\frac{139 \text{ shares}}{316 \text{ total shares}} = .43987, \text{ So, } .43987 \times 543 = 238.85 \text{ or } 239 \text{ acre-feet}$$

Share purchase pending = 38

$$\frac{38 \text{ shares}}{316 \text{ total shares}} = .12025, \text{ So, } .12025 \times 543 = 65.29 \text{ or } 65 \text{ acre-feet}$$

Total Anderson Ranch Storage Space 304 acre-feet

Lucky Peak (Contract No. 14-06-100-5590, dated July 26, 1966):

The contract entitles SBMIC to .17973 percent of the active capacity of the reservoir, which is considered equivalent to 500 acre-feet. Accordingly, the shares purchased by BWC represent the following amounts of storage:

Shares purchased = 139

$$\frac{139 \text{ shares}}{316 \text{ total shares}} = .43987, \text{ So, } .43987 \times 500 = 219.93 \text{ or } 220 \text{ acre-feet}$$

Share purchase pending = 38

$$\frac{38 \text{ shares}}{316 \text{ total shares}} = .12025, \text{ So, } .12025 \times 500 = 60.12 \text{ or } 60 \text{ acre-feet}$$

Total Lucky Peak Storage space 280 acre-feet

The above storage space data along with other pertinent information is being presented to the Commissioner of Reclamation in order to obtain formal approval of the terms of the transfer.

Mr. Sullivan has indicated that SBMIC would prefer to effect the transfer by having SBMIC bill the BWC for both the annual water service installment due the United States and the proportionate share of the annual operation and maintenance (O&M) charge for Anderson Ranch. Such amounts would then be returned to the United States by SBMIC. Once the terms of the transfer are formally approved by the Commissioner of Reclamation, this office suggests that both parties get together with Al Reiners or Rich Rigby in the Repayment and Acreage Limitation Branch to discuss the best way to make the transfer legally sufficient.

As you are aware, Reclamation is referring the request for the transfer of storage in Lucky Peak Reservoir to the Corps of Engineers (Corps) in Walla Walla, Washington, as Reclamation only has authority to market Corps storage water for irrigation.

We trust this information clarifies questions as to the amount of storage represented by the shares purchased in SBMIC by BWC. If you wish to discuss this further, please call Al Reiners at (208) 334-1547.

Sincerely,

Jim Budolfson

Regional Supervisor of
Water, Power, and Lands

cc: Corps of Engineers, Attention: Mr. Gareth Clausen, Walla Walla WA 99362-9265

South Boise Mutual Irrigation Company, Attention: Mr. Dale Milton,
1120 Chamberlin St., Boise ID 83706

BOISE WATER CORPORATION

January 23, 1995

Lt. Colonel James Weller
District Engineer
Walla Walla District
U.S. Army Corps of Engineers
City-County Airport
Walla Walla, WA 99362

Re: Boise Water Corporation - Request for Reallocation of Storage for Municipal and Industrial Purposes

Dear Lt. Colonel Weller:

This letter follows up on a meeting held in Boise, Idaho on January 12, 1995 between Boise Water Corporation ("BWC"), our legal counsel, and members of your staff. The purpose of that meeting was to discuss BWC's pending request for reallocation of 280 acre-feet of storage in Lucky Peak Reservoir from irrigation to municipal and industrial ("M&I") uses, and to discuss options for longer-range needs for storage water by BWC. The purpose of this letter is to provide you with some additional background about BWC and current and future water supply issues it faces.

BWC operates as a regulated public utility pursuant to a certificate of public convenience and necessity issued by the Idaho Public Utilities Commission, and a franchise from the City of Boise. Under Idaho statute, BWC has some of the characteristics of a public entity, including condemnation powers.

BWC is the primary water provider to a growing Boise metropolitan area, which is located in Ada County. As Idaho's largest single provider of water for domestic, commercial, municipal and industrial users, BWC serves an estimated population of 140,000 in the Boise Valley. The projected average annual growth rate for Ada County through the year 2015 is 3 percent, which is a percentage point higher than the growth experienced between 1980 and 1990. The Ada Planning Association predicts that Ada County's non-rural population, which stood at 192,200 in 1990, will reach approximately 322,000 by 2015. That portion of Ada County which generally represents BWC's current service area, and areas to which it may expand in the future, had a population of 164,780 in 1990, and has a projected 2015 population of 253,483.[1] BWC is not

[1]Please see the attached tables which are taken from Ada Planning Association, APA Report No. 16-93: 1993 Provisional Demographic Report for Northern Ada County, Idaho (August 1993). BWC understands that the figures in the Provisional

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aware of reliable population projections that go beyond 2015. However, it probably is not unreasonable to predict that the current trends may continue thereafter.

BWC's primary water supply is groundwater, which is drawn from 60 wells in the Boise Valley at a rate of over 13 billion gallons per year. In addition, BWC has a limited number of rights to natural flow from the Boise River, and 1000 acre-feet of storage in Anderson Ranch Reservoir pursuant to a Water Supply Contract with the Bureau of Reclamation. BWC's diversions from the Boise River are pumped to its recently completed water treatment facility. That facility is sized to treat approximately 8 million gallons of water per day, and has been designed to facilitate expansion to 16 mgd in the future.

Because of local variations in hydrogeology, the rate and direction of growth in the Boise Valley, and restrictions on groundwater development imposed by the Idaho Department of Water Resources ("IDWR"), groundwater development is not always a feasible option for BWC.[2] BWC is increasingly interested in obtaining additional, firm supplies of surface water, particularly to serve areas in the upper Boise Valley where high-quality ground water in dependable supplies is less available.

Urban development in the Boise Valley has in many instances occurred on farm land that historically has been irrigated with natural flow rights and storage rights from the Boise River. Mutual ditch companies, canal companies and irrigation districts throughout the valley all have natural flow rights in the Boise River with varying priorities, and almost uniformly, also have contracted for federal storage water as a supplemental supply. Most of these irrigation entities have contract storage in Anderson Ranch, Arrowrock, and Lucky Peak. As urban development occurs, the water rights appurtenant to these lands must be transferred to beneficial use on new lands, or be subject to forfeiture after five years of non-use.

BWC has, on a willing-buyer/willing-seller basis when farmland is converted to other uses, purchased shares in several canal companies in the Boise Valley that entitle BWC to a proportionate share of the water delivered by such companies. BWC's share of the water is then

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Report represent the best official information currently available from a public agency on demographics and population forecasts for Ada County.

[2]For example, in Southeast Boise the population has been projected to more than double, between 1990 and 2015, with an increase of over 24,000 people. A major groundwater source in that area, the Boise-Fan Aquifer, has been designated as a Groundwater Management Area by the IDWR. This designation limits new development and will impose stricter management criteria on existing diversions. In addition, the entire Boise River Basin currently is under a moratorium that, with limited exceptions, prevents the consideration of new applications to appropriate groundwater.

"transferred" through state statutory proceedings conducted by the IDWR, to a new point of diversion, place of use and season of use for M&I purposes.

For example, BWC has purchased shares, and is a major shareholder in, South Boise Mutual Irrigation Company ("SBMIC"). SBMIC has natural flow rights and storage rights in Anderson Ranch and Lucky Peak. SBMIC has agreed that, as a shareholder, BWC is entitled to receive its proportionate share of storage water and natural flow. BWC's proportionate share of the storage water in Lucky Peak currently amounts to 280 acre-feet. This is the amount of water that BWC has requested be reallocated by the Corps to M&I purposes for BWC's use. BWC recognizes that the IDWR will have to approve the transfer to this new use. BWC would carry the responsibility for accomplishing this, and the conditions of transfer would ensure that there would be no adverse impact to other water rights, or to systems operations in the Boise River reservoirs. BWC would like to see the reallocation of the 280 acre-feet proceed directly.

BWC recognizes that the Corps also must go through various steps before any reallocation can be approved, and that the assessments for M&I water would be somewhat higher than they are for SBMIC's use of storage for irrigation.

While reallocation of the above-referenced 280 acre-feet of Lucky Peak storage remains an important issue for BWC, it should be apparent from the above discussion that from a long-term planning perspective, population growth and a shift in land use from agricultural to urban point to the need to look beyond the reallocation of 280 acre-feet. As we expressed to Mr. Mann, Mr. Roediger and Mr. Reese at our meeting, BWC expects to have future need and opportunities to acquire shares in canal companies, and will be making similar requests for reallocation of reservoir storage. BWC therefore wishes that any options the Corps considers regarding reallocation of Lucky Peak storage to M&I purposes would allow for routine adjustments in BWC's storage account as new shares are acquired, and/or for contract adjustments to be made as additional need for M&I water are realized. Whether this can be accomplished by merely establishing a standardized procedure for incremental reallocation, or by reallocating a significant portion of space for present and future M&I needs, is a question that BWC believes should be addressed as soon as possible.

BWC of course recognizes the need for feasibility and environmental analysis as part of responsible action by the Corps and BWC. However, it also has a duty to its shareholders and rate-paying customers to use its time and dollars efficiently. For example, unless there would be some kind of categorical exclusion for reallocations below a certain volume, incremental reallocation may not be the most cost-effective approach for BWC or the Corps. BWC would be reluctant to run successive reallocation requests through reconnaissance and feasibility level analysis, NEPA review or Section 7 consultation, particularly where such requests may involve relatively small amounts of water that are acquired on an "as available" basis. This suggests that the scope of an initial reallocation review probably should be broad enough to address long-range needs and impacts together, up front.

BWC also understands that federal funds for carrying out the various levels of analysis are limited, and may become more so. However, BWC hopes that the Corps' planned evaluation of the Boise River Basin can be scoped and financed to address the Boise Valley's long-range M&I needs and reallocation options. If so, BWC may be able to contribute funding, technical services, or both to such evaluations.

After meeting with your staff, I am confident that they are aware of BWC's needs, and that there are feasible options for dealing with the 280 acre-feet of storage, and developing a long-range M&I storage strategy. I hope this letter has been helpful in setting out the issues as BWC sees them.

I look forward to working with you and your staff, and to the opportunity to respond to any questions you might have.

Sincerely,

BOISE WATER CORPORATION

Benjamin M Hepler

Benjamin Hepler
Vice President, Technical Services

Enclosure

cc: Michael C. Creamer

POPULATION FORECASTS

Planning area summaries for the 1990 census data and the 1995-2015 projections are shown below.

CHART 1: Ada County Population Projections by Planning Area

Planning Area	1990 (US Census)	1995	2000	2005	2010	2015
Airport	749	758	765	730	678	606
Central Bench	35,738	38,433	39,557	40,395	40,667	41,361
Eagle	5,970	7,828	10,785	11,560	12,105	13,331
Garden City	6,620	8,242	9,265	9,666	10,079	10,651
Kuna	2,418	2,725	3,062	3,239	3,472	3,917
Meridian	12,412	18,790	27,588	31,275	35,515	40,551
North River						
- Downtown	3,022	3,279	3,657	3,817	3,975	4,003
- East End	5,925	6,407	6,723	6,930	7,147	7,414
- Foothills	7,679	8,717	9,756	10,491	11,279	12,116
- North End	15,645	16,253	16,796	17,142	17,493	17,937
- Northwest	9,886	15,115	15,847	16,323	16,635	17,107
Southeast	21,742	28,323	32,967	36,835	40,854	45,958
Southwest	20,090	22,387	25,702	28,033	29,689	32,693
West Bench	44,304	53,058	60,080	65,939	69,905	74,288
Rural County	13,575	15,683	19,449	24,626	32,508	41,067
TOTAL	205,775	246,000	282,000	307,000	332,000	363,000

Future population increase for Ada County was forecast at an average annual rate of about three percent. That rate is considerably greater than the nearly two percent average annual rate seen between 1980 and 1990.

These projections show that the West Bench will experience the largest increase in population. It will gain over 31,000 persons, from 43,000 in 1990 to 74,000 in 2015. Other areas expected to experience significant growth are Meridian with an increase of 29,000, Rural with some 26,000 and the Southeast with over 24,000 persons.

In 1990, the Central Bench area contained the second largest concentration of population with nearly 36,000 persons. That area is not projected to increase a great deal, since most of the land suitable for residential use has been developed.

CHART I:Population For(ɔasting for Ada County

Comparing Current Estimates and Forecasts

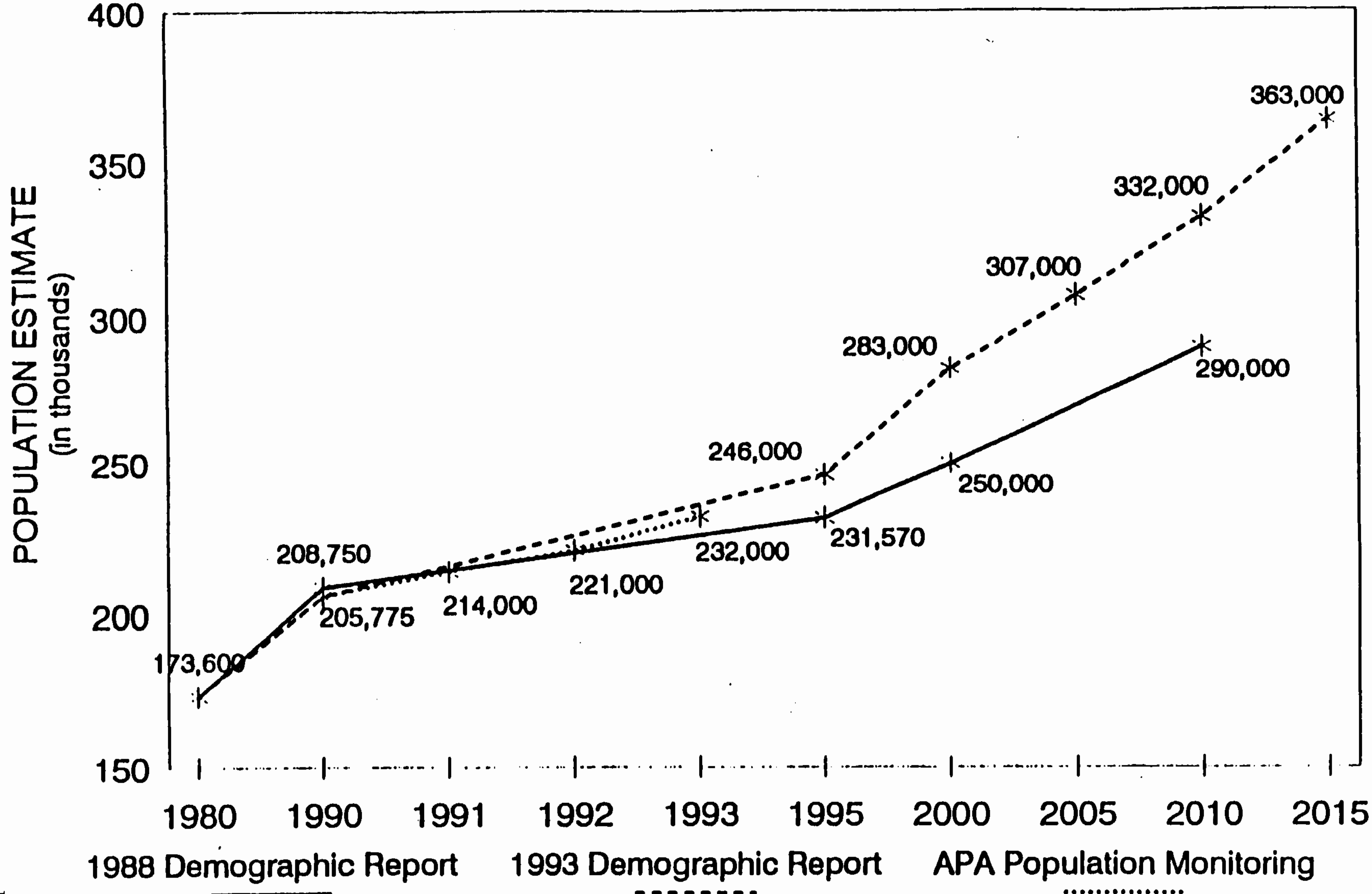

Exhibit D-3