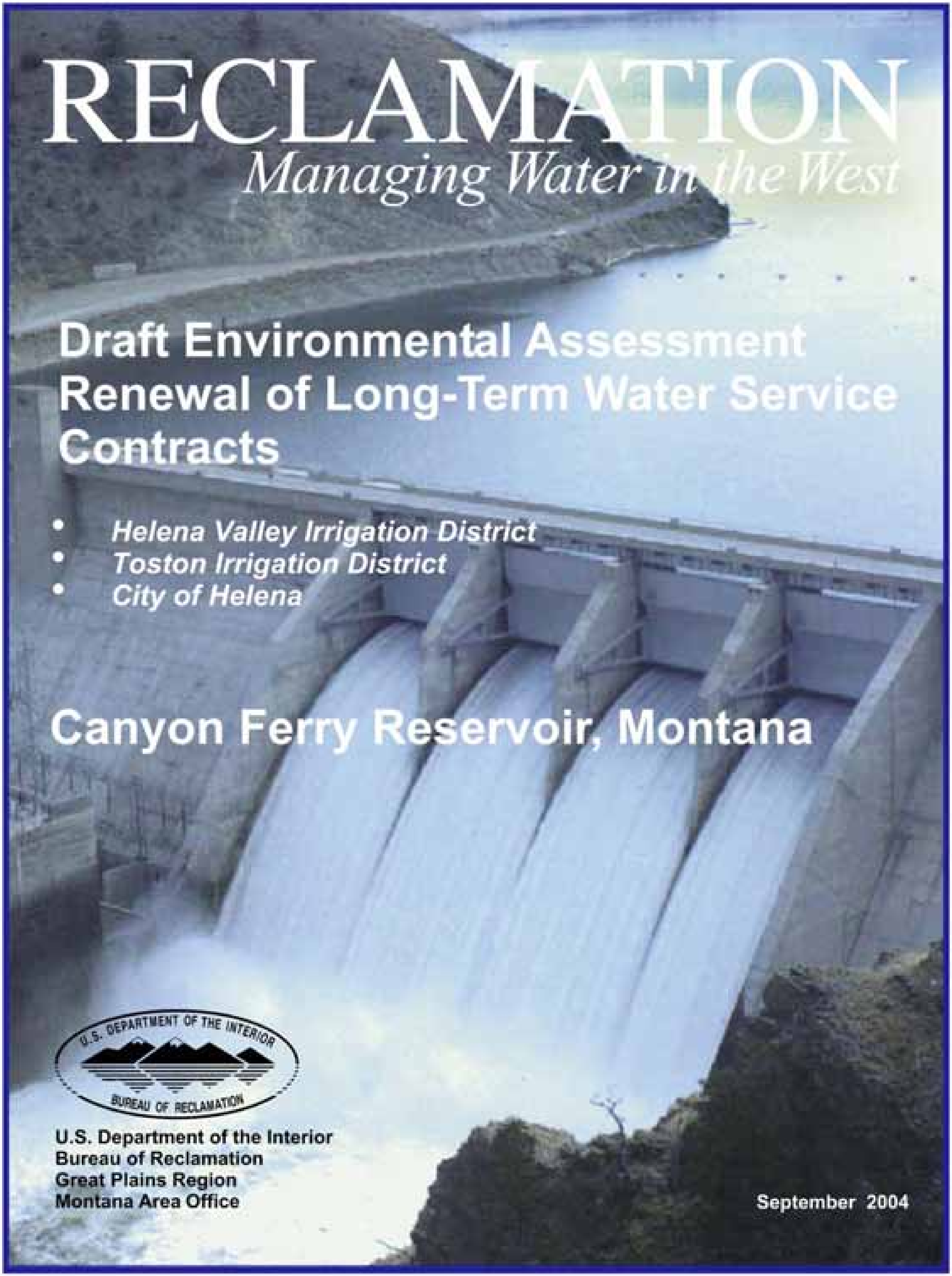

RECLAMATION

Managing Water in the West

Draft Environmental Assessment Renewal of Long-Term Water Service Contracts

- *Helena Valley Irrigation District*
- *Toston Irrigation District*
- *City of Helena*

Canyon Ferry Reservoir, Montana

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

U.S. Department of the Interior
Bureau of Reclamation
Great Plains Region
Montana Area Office

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Contents

Executive Summary

The Bureau of Reclamation proposes to renew long-term water service contracts with the Helena Valley (HVID) and Toston (TID) irrigation districts and City of Helena (Helena). Water would be pumped from Canyon Ferry Reservoir and Crow Creek Pumping Plant. Canyon Ferry Reservoir is a unit of the Pick-Sloan Missouri Basin Program (P-SMBP) and provides water for power, flood control, irrigation, municipal and industrial supplies, fish and wildlife, recreation, and other purposes in the upper Missouri River basin.

This draft environmental assessment (EA) was prepared in accordance with National Environmental Policy Act and analyzes and discloses impacts of renewing the contracts with HVID, TID, and Helena. The EA would lead to a Finding Of No Significant Impact if impacts to the human environment are found to be insignificant or to an environmental impact statement if impacts to the human environment are significant.

Purpose and Need

The purpose of the proposed action is to provide for continued beneficial use of federally-developed water supplies from Canyon Ferry Reservoir. The federal action is needed to renew the long-term water service contracts before they expire; to continue to supply water to HVID, TID, and Helena for authorized purposes for which Canyon Ferry Dam and Reservoir were constructed; and to permit repayment of allocated costs associated with construction of Canyon Ferry Dam and Reservoir and associated water conveyance and distribution facilities.

Alternatives

Two alternatives—the Proposed Action Alternative and the No Action Alternative—were examined in detail in this draft EA. Other alternatives were considered but were eliminated from further consideration.

Proposed Action Alternative

The new long-term water service contracts would consolidate district lands now irrigated under other contracts. The new contract for HVID would add 1,324 acres that have been irrigated under temporary contracts, 899 acres irrigated under Reclamation long-term contracts with other entities, and 412 acres currently not being irrigated for a total of up to 18,243 acres. The new contract for TID would add 810 acres that have been irrigated under temporary contracts for a total of up to 6,490 acres.

The long-term water service contracts with HVID and TID have been in effect for 40 years. Shortly following execution of these long-term water service contracts, Reclamation began issuing temporary contracts for lands adjacent to and/or near the districts.

Helena would be entitled to 11,300 AF/year under the Proposed Action Alternative. Helena wants to increase the volume of water they take from Canyon Ferry Reservoir to offset some of the water that is now being diverting from the Tenmile Creek drainage or that would be pumped from groundwater wells in the future.

No Action Alternative

The No Action Alternative assumes lands now irrigated under long-term contracts, temporary contracts, and other Reclamation long-term contracts would continue to receive water. Up to 17,831 acres would be irrigated in the HVID and up to 6,490 acres would be irrigated in TID.

The No Action Alternative assumes Helena would receive 5,680 AF/year. The rest of Helena's demands would be met with water from Tenmile Creek and from groundwater wells yet to be developed.

Environmental Impacts

Reclamation considered impacts of the alternatives on hydrology, water quality, threatened or endangered species, fisheries, wildlife, wetlands, recreation, cultural resources, socioeconomics, water conservation, prime and unique agricultural lands, noxious weeds, and environmental justice. The results of these analyses are summarized at the conclusion of Chapter 2 and are discussed in detail in Chapter 4.

Chapter 1
INTRODUCTION

Proposed Action

The Bureau of Reclamation (Reclamation) proposes to renew long-term water service contracts with the Helena Valley Irrigation District (HVID), Toston Irrigation District (TID), and the City of Helena, Montana (Helena). Water would be pumped from Canyon Ferry Reservoir through the Helena Valley Pumping Plant (HVPP) for the HVID and Helena and through the Crow Creek Pumping Plant near the Broadwater-Missouri Diversion Dam for TID (see the Location Map).

Canyon Ferry Reservoir is a unit of the Pick-Sloan Missouri Basin Program (P-SMBP) and supplies water for power generation, flood control, irrigation, municipal and industrial (M&I), recreation, and other purposes in the upper Missouri River basin. Canyon Ferry Reservoir is located about 17 miles east of Helena.

The Proposed Action would include minor changes from the current contracts. Both HVID and TID have requested boundary changes as both districts currently provide irrigation water to lands outside their boundaries under temporary water service contracts. HVID also supplies water to other Federal supplemental contracts (Montana Tunnels and North Helena Water Association). Helena is requesting to increase the volume of water they are able to take from Canyon Ferry Reservoir to reduce their dependence on the Tenmile Creek watershed and groundwater sources.

In the chapters that follow, alternatives are described in Chapter 2, the affected environment is described in Chapter 3, the effects of the alternatives are described in Chapter 4, and coordination and consultation conducted during the study is located in Chapter 5.

Purpose and Need

The purpose of this federal action is to provide for continued beneficial use of federally-developed water supplies from Canyon Ferry Reservoir. Federal law requires Reclamation to provide irrigation districts and municipalities a first right to renew water service contracts for a stated share of the available water supply under mutually-agreeable terms and conditions while complying with applicable laws and policies.

The proposed action is needed:

- To renew the long-term water service contracts before they expire December 31, 2004;

- To continue to supply water to HVID, TID, and Helena for authorized purposes for which Canyon Ferry Dam and Reservoir were constructed; and

- To permit repayment of allocated costs associated with construction of Canyon Ferry Dam and Reservoir and associated water conveyance and distribution facilities.

Background

Dam and Reservoir

Canyon Ferry Dam (cover) is a concrete gravity dam about 1,000 feet long at its crest with a structural height of 225 feet. The central part of the dam contains the spillway with a capacity of 150,000 cubic-feet/second (cfs). Four river outlets are embedded in the spillway including a penstock pipe near the left abutment for the HVPP and three penstock pipes near the right abutment for power generation. A power plant at the dam houses three 16.7 megawatt (mW) generating units.

Total capacity of the reservoir is 1,891,888 acre-feet (AF) at elevation 3,797. The reservoir covers about 33,500 surface acres at that elevation extending about 19 miles upstream from the dam.

Canyon Ferry Reservoir is a multipurpose facility designed and constructed to provide benefits for several purposes. Water is stored to supply the needs of irrigation, M&I, fish and wildlife, power, and recreation. Some of the stored space in the reservoir water is used to provide replacement water that is released downstream to meet the needs of PP&L Montana for hydropower generation at their facilities. Some storage space in the reservoir is reserved for flood control that is coordinated with the U.S. Army Corps of Engineers. The current allocation of storage space in the Canyon Ferry Reservoir is illustrated in Figure 1.1.

A contract for coordination of power generation on the upper Missouri River between the United States and Montana Power Company (now PP&L Montana) was signed in March 1972. The contract provides for coordination of hydroelectric operation of Reclamation and PP&L Montana reservoirs and electric generating plants on the Missouri River above the Fort Peck Reservoir. The intent of the agreement is to make available to each party its optimum usable energy production at all times and to assure the availability and release of water on a pre-planned basis, exclusive of certain non-power uses.

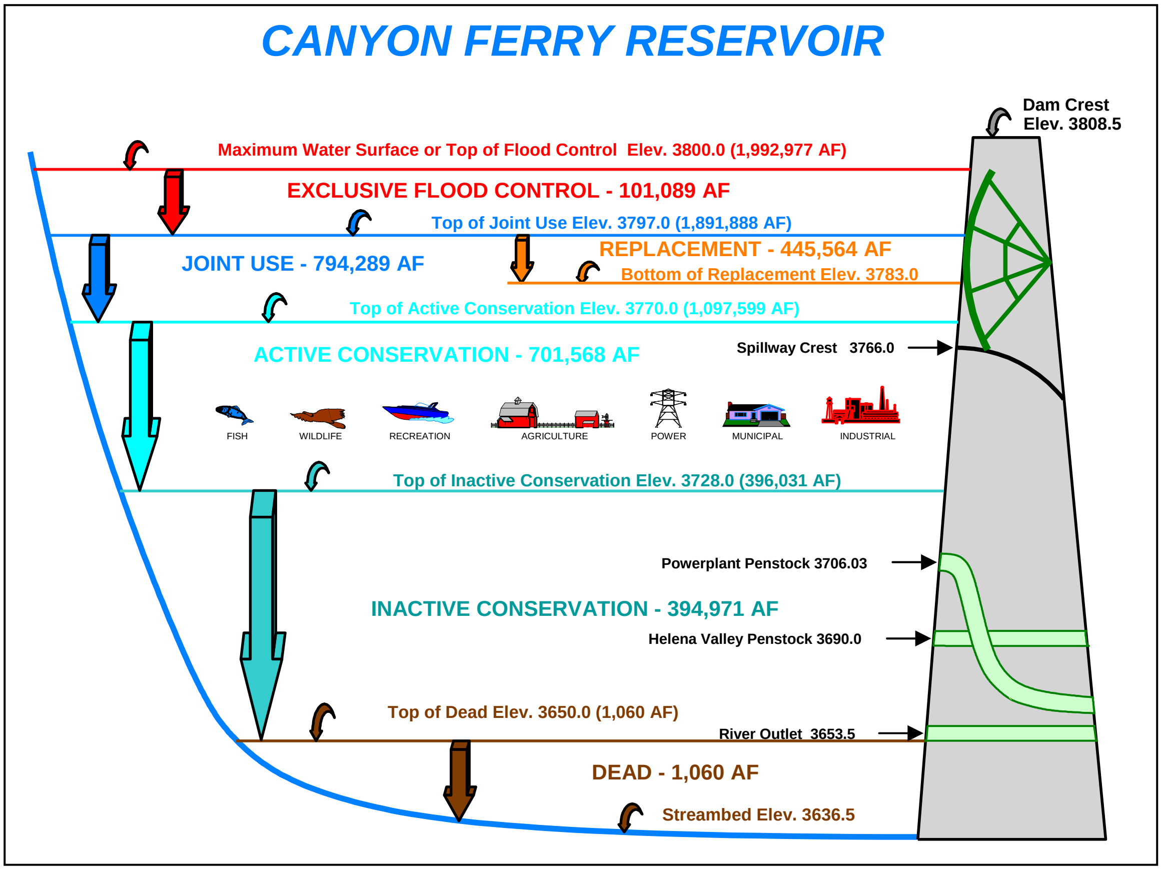


Figure 1.1: Canyon Ferry Reservoir allocations

Helena Valley Irrigation District

HVID irrigates up to 15,608 acres in the Helena Valley Unit of the P-SMBP under the terms of the current long-term water service contract (Drawing 596-600-64 at the end of this EA). Another 1,324 acres are irrigated through temporary contracts. Water to satisfy other long-term water service contracts, e.g. Montana Tunnels and North Helena Water Supply Association, is provided through Helena Valley Regulating Reservoir (HVRR).

The long-term water service contracts with HVID and TID have been in effect for 40 years. Shortly following execution of these long-term water service contracts, Reclamation began issuing temporary contracts for lands adjacent to and/or near the districts.

Water is conveyed from Canyon Ferry Reservoir to the HVPP through a penstock pipe from the dam's left abutment. Pumps lift water from the HVPP out of the canyon where it enters the Helena Valley Tunnel. Water from the tunnel enters the Helena Valley Canal that conveys it to the HVRR. Laterals from the canal both upstream and downstream of the HVRR supply water throughout HVID.

The HVRR is an off-stream storage and reregulation facility that is impounded by the 91-foot high earth-filled Helena Valley Dam that has a crest length of 2,650 feet (Figure 1.2). The reservoir has a total capacity of 10,500 AF at elevation 3820.1 with an active conservation space of 5,900 AF for irrigation and M&I use.

Water is pumped from Canyon Ferry Reservoir beginning in late March and continues through mid-October. Based on demand, the beginning of the irrigation season and shut down of the canal varies from year-to-year. During winter months, Helena can request and divert water from HVRR to meet demand.

Figure 1.2: Helena Valley Regulating Reservoir

The HVRR fluctuates between an average minimum elevation of 3805.5 in March to an average maximum elevation of 3814.1 in July. Generally, HVID attempts to maintain a full pool throughout the irrigation season to ensure it has an adequate water supply.

A U.S. Geological Survey study (1992) estimated seepage losses from HVID canals and laterals to be about 7,000 AF/year. This represents about 9.5% of the average annual diversion to HVID of 73,7000 AF.

Over the past several years, irrigation in HVID has increasingly changed from flood irrigation to sprinkler. About 65% of HVID lands are now irrigated by sprinkler with the remaining 35% flood irrigated. Farmers have been encouraged by HVID to modernize their on-farm irrigation practices to improve operational efficiency of HVRR and to reduce their need to purchase excess water. In the *2000 Crop Census Report* (reference), HVID reported a crop mix of about 74% alfalfa, 20% irrigated pasture, and 6% wheat, barley, and other small grains.

The HVID currently charges members $16.51/acre for operation and maintenance (O&M) in addition to $1.45/acre for repayment of construction. The total annual amount water users pay HVID is $17.96/acre.

A manager directs day-to-day operations while Reclamation conducts routine O&M of the reserved works. The HVID is responsible for O&M for HVPP, HVRR, canals, laterals, and drains. Reclamation retains oversight of HVID facilities and reviews O&M functions according to Reclamation policy.

Toston Irrigation District

The Crow Creek Pump Unit of the P-SMBP supplies water for TID and is located about 16 miles south of Canyon Ferry Reservoir and six miles upstream of the Community of Toston (Drawing 606-600-16 at the end of the EA). Water is elevated and briefly impounded by the state-owned Broadwater-Missouri Diversion Dam. The dam is 56-feet high and 3,000-feet long. Water is supplied by three 33.3-cfs pumps driven by a 900-horsepower (hp) synchronous motor at the pumping plant.

Water is delivered through the Toston Tunnel into the Toston Canal. Toston Canal has a flow capacity of 100 cfs. The three-mile long Lombard Canal conveys water from the Toston Canal to TID lands in the northern part of the unit. Canals and laterals irrigate about 6,500 acres mainly by sprinkler.

The TID has modernized their distribution system replacing laterals with buried pipe. Only the main canal is an earth-lined ditch subject to seepage losses. The majority of water users have converted from flood to sprinkler irrigation over the past several years. Most irrigators use low-head pivot systems. The TID reports the average crop mix for the past five years has been 57% wheat, barley, and other small grains; 25% alfalfa; 15% seed potatoes; and 3% other crops.

A manager directs day-to-day operations for TID. The TID conducts routine O&M through a contract with Reclamation. Reclamation oversees TID facilities and reviews O&M functions according to Reclamation policy.

City of Helena

Canyon Ferry Reservoir provides Helena with one of its sources of M&I water through the HVRR (Carollo Engineers 1997). An outlet from HVRR leads to a pipeline that connects to Helena's Missouri River Water Treatment Plant. This plant provided 15% of Helena's M&I water supply from 1991-2003 (Rundquist #1 2004). The process at the plant complies with EPA's Safe Drinking Water Act standards for arsenic. Under the current contract, Helena committed to purchase at least 600 AF/year from Canyon Ferry Reservoir at a fixed price with the option of buying up to 5,680 AF/year. Helena has used an average of about 2,700 AF/year from Canyon Ferry Reservoir.

Helena reported average annual per-capita water use of 173 gallons/capita/day (gpcd) from 1995-2003 with its greatest use being 192 gpcd and its lowest use being 157 gpcd (Rundquist #1, 2004). The average water use in Lewis and Clark County, where Helena is located, was 198 gpcd. Montana counties having large population centers and climate similar to Lewis and Clark County, such as Yellowstone and Cascade counties, reported average water use of 206 gpcd and 184 gpcd, respectively. All service connections to the Helena water system are metered.

Helena has a low base monthly water charge ($2.10) when compared to other Montana cities. Higher volumes are charged a rate of $2.14/half cubic-foot. No credit is provided to high volume users. These rates are about 124% of the national average (Rundquist #2, 2004).

Helena's Utilities Maintenance Division budgets for annual leak detection and water pipes are inspected every five to ten years for leaks. Helena budgets additional funds annually for main replacement with attention directed to leaking or high maintenance water mains.

Helena has entered into discussions with the Environmental Protection Agency (EPA) concerning EPA's Upper Tenmile Creek Mining Area Superfund Record of Decision (ROD). The ROD outlines augmentation of stream flow in Tenmile Creek during low-flow periods by constructing improvements to Chessman Reservoir and Red Mountain flume in the upper Tenmile Creek watershed to provide additional water storage in the reservoir and/or implementing other water management actions. The additional stored water would be available to Helena to offset water that would bypass their Tenmile Creek intake structures. The bypassed flows would augment flows through and below the Community of Rimini during late summer and early fall low-flow periods. Flow augmentation would complement EPA's cleanup activities and improve Tenmile Creek water quality (Figure 1.3).

Helena has proposed to the EPA to forgo proposed improvements to Chessman Reservoir and Red Mountain flume and instead invest these funds in the planned upgrade of the Missouri River Treatment Plant. The Missouri River Treatment Plant would operate as a year round facility and provide Helena with their primary source of M&I water. This would allow Helena to operate the Tenmile Treatment Plant primarily to meet peak demand in the summer. Helena would continue to store runoff in their reservoirs in the upper Tenmile Creek watershed and release that storage to meet peak demand. This would allow Helena to bypass natural flows.

The natural flow of Tenmile Creek would likely stay in the channel until the stream left Helena National Forest where it could be utilized by other water right holders in accordance with Montana state law. Such use is likely to occur primarily during the irrigation season. Helena is working with Montana Fish, Wildlife and Parks (MFWP) to identify mechanisms to protect the bypassed flows.

Relationship of the Proposed Action to Other Activities

Several relevant reports have been completed regarding Canyon Ferry Reservoir and the immediate area. Reclamation completed an environmental assessment (EA) and Finding of No Significant Impact (FONSI) in 2001 to evaluate selling 265 lots around the reservoir as directed by the *Canyon Ferry Reservoir Act* (P.L. 105-277, Title X, as amended). Information collected for that EA was used for this document.

Figure 1.3: Tenmile Creek

Reclamation completed a water quality study for Canyon Ferry Reservoir in 1998 (Horn 1998).

Reclamation also prepared the *Canyon Ferry Reservoir Resource Management Plan/Environmental Assessment* to guide use of reservoir resources for the next ten years. This report evaluated alternative ways of managing recreation, wildlife, and other resources at the reservoir. A FONSI was signed in February 2003.

This draft EA was prepared in accordance with the *National Environmental Policy Act (*NEPA) and analyzes and discloses impacts of renewing existing long-term water service contracts with HVID, TID, and Helena. The EA would lead to a FONSI if impacts to the human environment are found to be insignificant or to an environmental impact statement if impacts are found to be significant.

Decisions to be Made

Reclamation will use this EA and other relevant information to make the following decisions regarding renewal of long-term water service contracts: (1) should Reclamation renew the long-term water service contracts; (2) what terms and conditions regarding environmental quality should be included in those contracts; and (3) does the proposed action constitute a major federal action significantly affecting the quality of the human environment therefore requiring preparation of an environmental impact statement?

Issues

The following resource issues were identified through internal and public scoping activities with some considered to be potentially significant. These issues are relevant to the federal action proposed by Reclamation and were used to guide analysis of environmental impacts.

Significant Issues

Posed as questions, significant issues include:

- How would contract renewal affect volumes, flows, releases, seepage, and return flows to water bodies and aquifers in the area (Hydrology)?
- How would contract renewal affect water quality of water bodies and aquifers of the area?
- How would contract renewal affect fish and other aquatic species?
- How would contract renewal affect wildlife?
- How would contract renewal affect wetlands?

- How would contract renewal affect federally-listed threatened and endangered species?

- How would contract renewal affect recreation at Canyon Ferry Reservoir and HVRR?

Other Resource Issues

Other resource issues were raised during internal and public scoping that Reclamation determined were not significant to the action proposed. These issues include social and economic conditions, power generation at Canyon Ferry Dam, water conservation, prime and unique agricultural lands, noxious weeds, cultural resources, and environmental justice.

Concerns were also identified related to irrigation contracts in Prickly Pear Creek and trails and fencing in HVID. Reclamation and HVID attempted to contract with irrigators taking water from Prickly Pear Creek but were unsuccessful. Reclamation determined that establishing trails along canals and fencing canals and siphons were beyond the scope of this federal action.

Chapter 2
ALTERNATIVES

Reclamation examined two alternatives in detail in this EA: the Proposed Action and No Action alternatives. The components that represent both alternatives are described in this chapter. Other alternatives were considered during development of the EA, and they are briefly discussed at the end of this chapter along with the rationale for eliminating them from further consideration.

Table 2.1 shows irrigated acreage and M&I needs and the Canyon Ferry Reservoir diversions necessary to meet these demands. Both alternatives and current conditions are presented.

Table 2.1: Alternatives Considered in Detail

	Current Condition		Proposed Action		No Action	
	Acres	**AF**	**Acres**	**AF**	**Acres**	**AF**
HVID Total	**Up to 17,831**		**Up to 18,243**		**Up to 17,831**	
Long-term Temporary Supplemental Un-irrigated	15,608 1,324 899 0	As much water as the district can beneficially apply to the acreage	15,608 1,324 899 412	As much water as the district can beneficially apply to the acreage	15,608 1,324 899 0	As much water as the district can beneficially apply to the acreage
TID Total	**Up to 6,490**		**Up to 6,490**		**Up to 6,490**	
Long-term Temporary Supplemental Un-irrigated	5,680 810 0 0	As much water as the district can beneficially apply to the acreage	5,680 810 0 0	As much water as the district can beneficially apply to the acreage	5,680 810 0 0	As much water as the district can beneficially apply to the acreage
Helena	--	2,700	--	Up to 11,300	--	Up to 5,680

Alternatives Considered In Detail

Proposed Action Alternative – Reclamation's Preferred Alternative

The Proposed Action Alternative represents Reclamation's preferred alternative. Long-term water service contracts would be renewed with the HVID, TID, and Helena under this alternative. Administrative and operational changes would be included.

Irrigation

Contracts with HVID and TID were entered into under sections 9(e) and 9(d) of the Reclamation Project Act of 1939 (53 Stat 1196; 43 U.S.C. § 485h) (1939 Act). The contracts consist of two parts. Part A is entered into pursuant to section 9(e) of the 1939

Act and consists of a 40-year water service contract for water delivery. Part A covers the districts' share of the costs of the water supply works, e.g., Canyon Ferry Dam. Part B is entered into pursuant to section 9(d) of the 1939 Act and consists of a repayment contract for the districts' share of construction costs for the distribution works, e.g. laterals. Part A requires water users pay a negotiated amount to the U.S. Treasury for 40 years. Under Part B, water users agree to pay an amount established through Reclamation law and policy in 40 equal annual installments. Part B of the contracts has no term and is not subject to renewal.

The 1939 Act was amended in 1956 by the Administration of Contracts Under Section 9, Reclamation Project Act of 1939 (70 Stat 483) (1956 Act). The 1956 Act provides water users with a first right to renew long-term water service contracts to a stated share of the available water supply under mutually agreeable terms and conditions at the expiration of Part A and with the opportunity to convert Part A to a repayment contract. To qualify for conversion to a repayment contract, the districts must be able to repay their outstanding negotiated obligation under Part A within 40 years. Should a district's payment capacity be insufficient to repay their negotiated obligation within 40 years, "aid to irrigation" (P-SMBP power revenues) would pay the balance. A repayment contract has no term and is not subject to renewal.

The contracts with the HVID and TID would include minor changes from the current contract:

- Boundary changes have been requested because both HVID and TID currently irrigate lands outside their boundaries under temporary water service contracts (see Drawing 596-600-64 at the end of this report for proposed boundary changes to HVID and Drawing 606-600-16 for proposed changes to the TID). Boundary changes would add 1,324 acres to HVID and 810 acres to TID (Table 2.1)

- 899 acres now irrigated through HVID facilities under Reclamation long-term water service contracts with other entities would be added to HVID in the new contract (Table 2.1)

- 412 acres not presently being irrigated would be added to the HVID (Table 2.1)

- O&M agreements would be entered into with HVID and TID.

In this alternative, up to 18,243 acres would be irrigated in the HVID with the inclusion of lands in the new contract that are currently served through temporary contracts, lands irrigated through other contracts, and lands not currently irrigated. Up to 6,490 acres would be irrigated in TID with the inclusion of lands now irrigated under temporary contracts.

Municipal and Industrial Water

In the Proposed Action, Reclamation would renew the long-term water service contract with Helena. The new contract would have a term of up to 40 years and would reflect Helena's desire to increase the volume of water they take from Canyon Ferry Reservoir to meet anticipated future demand.

The new contract would allow Helena to increase their supply as needed up to 11,300 AF/year subject to water availability and supply-work capability (Table 2.1). Helena has requested this increase to offset most of the water currently diverted from the Tenmile Creek drainage. Helena would continue to use about 3,000 AF/year from Tenmile Creek during peak demand and to keep the Tenmile Treatment Plant operational.

The HVPP would pump more water during the April-October irrigation season to fill and refill HVRR from which Helena would acquire most of its supply. The initial increase is anticipated to occur in 2010 when Helena completes the upgrade of their Missouri River Treatment Plant to enable them to use Canyon Ferry Reservoir as their primary source of M&I water.

Environmental Commitments

The intent of the following environmental commitments is to avoid and/or minimize adverse impacts that may result from implementing the proposed action. They are incorporated into the proposed action and are not intended to be implemented as separate, unrelated actions. The analysis of impacts in Chapter 4 assumed these measures had been implemented.

1. Water Quality Reclamation will continue to collect water quality data and information, including data and information relevant to productivity in HVRR. Such information would facilitate future monitoring of HVRR conditions resulting from implementation of Reclamation's preferred alternative and the need for any corrective actions that may be identified in the future. Reclamation will coordinate its water quality data collection activities with the Fish and Wildlife Service (Service) and MFWP to ensure appropriate data collection activities are undertaken.

2. Riparian Habitat Reclamation will develop and implement a program, in coordination with MFWP to monitor riparian habitat adjacent to HVRR. The program would involve establishment of three permanent plots to monitor changes in willows, cottonwoods and other vegetation. Plots would be established in 2005 and monitored annually to observe the effects of implementing Reclamation's preferred alternative.

3. Grebe Nesting The HVID, Service, and Reclamation will communicate during the spring nesting season to attempt to minimize operational effects on nesting western and red-necked grebes at HVRR. HVID will attempt to fill the reservoir to elevation 3,820 by April 1 before grebes typically establish nests and then maintain, as much as possible, stable water levels until chicks have fledged in mid-July. This would avoid inundation of nests. Lowering HVRR elevations may be unavoidable when peak irrigation demand begins in May due to inflow limitations, but reservoir levels will be held as steady as possible during the April 1 to July 15 period.

Reclamation will monitor western and red-necked grebe nesting in the HVRR riparian area during 2006 and 2007 to evaluate effects of implementing Reclamation's preferred alternative and the reservoir elevation operational commitment. Monitoring results will be provided to HVID and the Service to assist them in adaptively-managing HVRR elevations to avoid and/or minimize adverse effects to over-water nesting birds.

4. Fish Protection Helena will monitor and report current and future fish losses into the Missouri River Treatment Plant until 2015 to establish a baseline against which to measure any changes in the amount of fish loss as a result of implementing Reclamation's preferred alternative. Monitoring and reporting will begin upon renewal of the long-term water service contract. Helena will report the information to Reclamation's Montana Area Office on a semi-annual basis. If the operational changes implemented with Reclamation's proposed action (such as increased water deliveries or addition of pumps at the intake) result in increased fish loss, then Helena will screen their intakes in HVRR, in coordination with Reclamation and MFWP to avoid and/or minimize fish loss.

5. Warm Springs Creek Fishery Reclamation and TID, in coordination with MFWP will continue to investigate measures to avoid and/or minimize return flow issues currently limiting the fishery potential of the Warm Springs Creek fishery.

6. Water Quality/Arsenic Best Management Practices Reclamation will encourage HVID and TID water users to incorporate the following best management practices into current and future agricultural practices.

Increase irrigation efficiency This practice results in less arsenic leaching through soil profiles and into return flows or groundwater.

Cover cropping between growing seasons with winter wheat and/or winter legumes This introduces organic matter while preventing wind erosion.

Annual plowing This practice aerates soils and can increase volatilization of arsenic from near-surface soils.

Minimize the use of phosphate-based fertilizers and soil amendments This practice prevents excessive arsenic from being released into ground or surface waters.

Consistently monitor soil and water in the area coupled with management practices to maintain soil physical properties such as pH, oxidation-reduction potential, and organic matter This practice should identify any concerns associated with arsenic-laden irrigation water.

No Action Alternative

This alternative assumes that water uses pursuant to the current long-term water service contracts with HVID, TID, and Helena would continue and that water uses pursuant to current temporary contracts also continue. Under this alternative, in the future Reclamation likely would not issue temporary contracts over an extended period of time. However, Reclamation believes current conditions would continue to the future: that the lands that are currently being irrigated through temporary contracts would continue to be served.

Irrigation

HVID and TID would continue to irrigate lands within the districts and lands outside the districts that are being irrigated through temporary contracts (Table 2.1). Up to 17,831 acres would be irrigated by the HVID and up to 6,490 acres would be irrigated by TID.

The long-term water service contracts with HVID and TID have been in effect for 40 years. Shortly following execution of these long-term water service contracts, Reclamation began issuing temporary contracts for lands adjacent to and/or near the districts.

Municipal and Industrial Water

Reclamation assumed growth and demand in Helena would require the use of their full entitlement of 5,680 AF/year from HVRR by 2044. The remainder of Helena's demand would be satisfied with water from Tenmile Creek and from ground water wells yet to be developed. Helena has been granted a groundwater reservation for 7,071 AF/year. Helena has not developed this groundwater source because of concerns about reliable capacity and long-term yields (Carollo, 1997). Development of the ground water reservation is also likely to be controversial because of potential effects on shallow domestic wells in the area (Rundquist #3, 2004).

Alternatives Considered But Eliminated from Detailed Study

Contract Renewal with Inclusions Alternative

This alternative was developed early in the environmental compliance process and became the Proposed Action Alternative.

Contract Renewal without Inclusions Alternative

This alternative was also developed early and was eliminated from further consideration because it duplicated the No Action Alternative.

No Contracts Alternative

This alternative was eliminated from further consideration because it did not fully meet the identified need for the federal action and was not considered to be reasonable.

Summary Table

Table 2.2 summarizes impacts of the alternatives.

Table 2.1: Summary of the Effects of the Alternatives

	Current Condition	No Action Alternative	Proposed Action Alternative
Irrigated Acreage and M&I Water Use	Up to 17,831 acres irrigated in HVID, up to 6,490 acres in TID; up to 3,000 AF/year M&I water provided from Canyon Ferry Reservoir.	Up to 17,831 acres irrigated in HVID, up to 6,490 acres in TID; up to 5,680 AF/year M&I water provided from Canyon Ferry Reservoir.	Up to 18,243 acres irrigated in HVID, up to 6,490 acres in TID; up to 11,300 AF/year M&I water provided from Canyon Ferry Reservoir.
Hydrology	Average of 73,700 AF/year diverted to HVID, 7,496 AF/year to TID, 3,000 AF/year to Helena from Canyon Ferry Reservoir.	Up to 76,300 AF/year diverted to HVID, 7,496 AF/year to TID, up to 5.680 AF/year to Helena from Canyon Ferry Reservoir.	Up to 83,156 AF/year diverted to HVID, 7,496 AF/year to TID, up to 11,300 AF/year to Helena from Canyon Ferry Reservoir.
Water Quality	Arsenic would continue to average 22-34 ppb in Canyon Ferry, <21to <27ppb in HVRR, 5-17 ppb in Lake Helena, 2-25 ppb in Helena Valley soils, <1-22 ppb in groundwater, and 10-50 ppb in TID; low DO in Missouri downstream of Canyon Ferry Dam.	Same as Current Condition.	Same as No Action Alternative.
Fisheries	Brown and rainbow trout, perch, burbot, perch, walleye, and kokanee salmon found in area, as well as number of non-game native species.	Fisheries in Canyon Ferry Reservoir and other Missouri River reservoirs would not be affected as water levels changed slightly; Tenmile and Prickly Pear creeks would continue to be dewatered for M&I and irrigation supplies; fisheries in HVRR and in river upstream of Canyon Ferry and in Warm Springs Creek would continue at current conditions.	Fisheries in Canyon Ferry Reservoir and other Missouri River reservoirs would not be affected as water levels changed slightly; fisheries in Tenmile Creek would improve as Helena took more M&I water from Canyon Ferry; Prickly Pear Creek would continue to be dewatered from non-federal irrigation; fisheries in HVRR would be similar to the No Action Alternative; fisheries in the river upstream from Canyon Ferry and in Warm Springs Creek would not change or would improve slightly.
Wildlife	Helena Valley provides habitat for upland bird species and raptors; HVRR for migrating water birds and shorebirds; TID for big game, predators, small mammals, and Lake Helena and Canyon Ferry	More water provided to HVRR and operational agreement would stabilize water levels for nesting water birds; may slightly reduce habitat for migrating shorebirds. Short-term loss of wetland	Same as No Action Alternative.

	WMAs for waterfowl.	and riparian habitat at HVRR.	Same as No Action Alternative.
Wetlands	Wetlands are found along the Missouri River, Canyon Ferry Reservoir, HVRR, and district canals, laterals, and drains.	Wetlands would benefit from greater water deliveries to, releases from, and operation of HVRR; increased seepage from canals would benefit wetlands. Possible short-term loss at HVRR.	Same as No Action Alternative.
Threatened and Endangered Species	Action area contains habitat for six federally-listed and one candidate species.	Bald eagle, black-footed ferret, gray wolf, Ute's ladies tresses, and fluvial arctic grayling would not be affected; compared to current conditions, pallid sturgeon not likely to adversely affected.	Same as No Action Alternative.
Recreation	About 259,000 people visit marinas, campgrounds, and day-use areas at Canyon Ferry Reservoir annually; about 55,000 visit day-use area at HVRR annually.	No changes in activities; levels of use would increase.	Same as No Action Alternative.
Other Resource Issues	Population doubled in last 50 years; per capita income in two counties averages $24,445.	Population would continue to increase; added irrigated acres would add $8,446 to economy.	
	HVID and TID both contain prime, unique, or farmlands of local or state importance.	Prime farmland would increase if added irrigated lands meet designation.	
	HVID and TID both control noxious weeds.	Noxious weed programs in neither district would be affected.	
	HVID and TID have current water conservation plans, while Helena has developed measures to reduce per-capita use.	Both HVID and TID would continue to improve system efficiency, affecting canal seepage, and Helena would probably institute further measures to reduce per-capita use.	
	Reclamation would consult SHPO, tribes, and interested parties if any cultural resources were to be affected in HVID and TID; no Indian sacred sites or Indian trust assets reported in the area.	Cultural resources would be same as current conditions; no Indian sacred sites or Indian trust assets affected.	
	Minority and low-income populations exist in the area.	No effects to minority or low-income populations.	

Chapter 3
AFFECTED ENVIRONMENT

Chapter 3 describes environmental resources of the Canyon Ferry Reservoir area that would be affected by the No Action and Proposed Action alternatives including hydrology, water quality, fisheries, wildlife, wetlands, threatened and endangered species, social and economic conditions, power generation, water conservation, recreation, noxious weeds, cultural resources, and environmental justice. The chapter is organized around specific concerns raised by the public, Reclamation's study team, or other organizations or agencies.

Hydrology

Water available for future uses was a recurring issue. The analyses of other environmental resources depend on the results of the hydrology analysis. Specific issues identified during scoping include:

- How would contract renewal affect volumes, surface elevations, and other releases from Canyon Ferry Reservoir? From HVRR?
- How would contract renewal affect flows in the Missouri River? In Prickly Pear, Silver, Tenmile, and Warm Spring creeks?
- What would happen to Tenmile Creek flows if restored flows were protected? If left unprotected?
- How would contract renewal affect irrigation return flows? Seepage in the canals and laterals? Groundwater wells?
- How would contract renewal affect the ability of the Canyon Ferry Reservoir cabin owners to access water in the future for domestic purposes?

Indicators chosen for the hydrology analysis to measure effects include end-of-month (EOM) reservoir contents for Canyon Ferry Reservoir and HVRR, EOM reservoir elevations, reservoir releases to the Missouri River, return flows (water returning to a water body after irrigation), and accreted flows (water entering a water body during the non-irrigation season normally through groundwater discharge).

Missouri River above Canyon Ferry Reservoir

Flows in the Missouri River above Canyon Ferry Reservoir are representative of snowmelt hydrology. Flows typically peak in June at an average monthly discharge of 956,100 AF. Minimum flows occur in August at an average monthly discharge of 150,900 AF. Above Canyon Ferry Reservoir, the Missouri River has an average annual discharge of 3,990,800 AF/year.

Canyon Ferry Reservoir

Canyon Ferry Reservoir is a multi-purpose water resource facility owned and operated by Reclamation. It functions as a base load power generating facility in addition to providing irrigation water to the HVID, M&I water to Helena, and maintenance flows in the Missouri River. Releases from Canyon Ferry Reservoir are coordinated with MFWP for instream flows and with PPL-Montana on operations for power demands at Hauser and Holter dams.

Hydrologic information on Canyon Ferry Reservoir was taken from the Hydromet database. It was necessary to adjust historic inflows to Canyon Ferry Reservoir to reflect present-level flow conditions in the basin. Development of present-level flows is necessary to reflect the effects present-day development, e.g., increases in irrigated acres, municipal growth, etc, would have on the historical flow record. Historical and present level depletions were updated to the year 2003 using irrigation and climate data for each node basin upstream of Canyon Ferry Reservoir. The period of record analyzed was 1929-2003.

In addition, inflows to Clark Canyon Reservoir on the Beaverhead River were adjusted for upstream depletions. A reservoir operation model for Clark Canyon Reservoir was run to determine effects of depletions of this reservoir under present conditions. These present-level depletions for the node basin at Clark Canyon Reservoir were included in depletions for the node basins above Canyon Ferry Reservoir.

Canyon Ferry Reservoir was modeled using the Reservoir Operations Model (ROM). Reclamation uses this monthly time-step computer model for monthly forecasting and operations of the reservoir.

Figure 3.1 illustrates the average EOM elevations for Canyon Ferry Reservoir. Figure 3.2 illustrates average monthly releases for Canyon Ferry Reservoir.

Helena Valley Regulating Reservoir

HVRR receives its water supply from Canyon Ferry Reservoir and supplies HVID with a firm annual supply for the 15,608 acres in the district. Also, Helena has a contract to receive up to 5,680 AF/year from Canyon Ferry Reservoir through HVRR. HVRR has a total capacity of 10,500 AF at elevation 3820.1 with active conservation space of 5,900 AF for irrigation and M&I use.

Figure 3.1

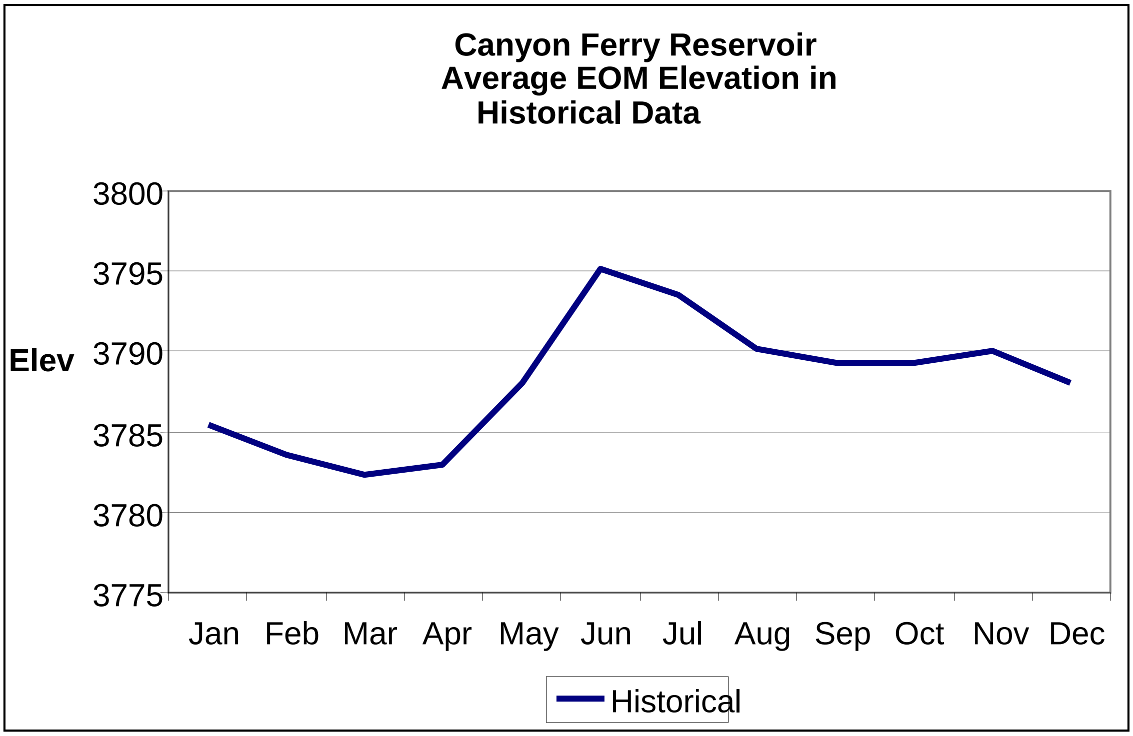
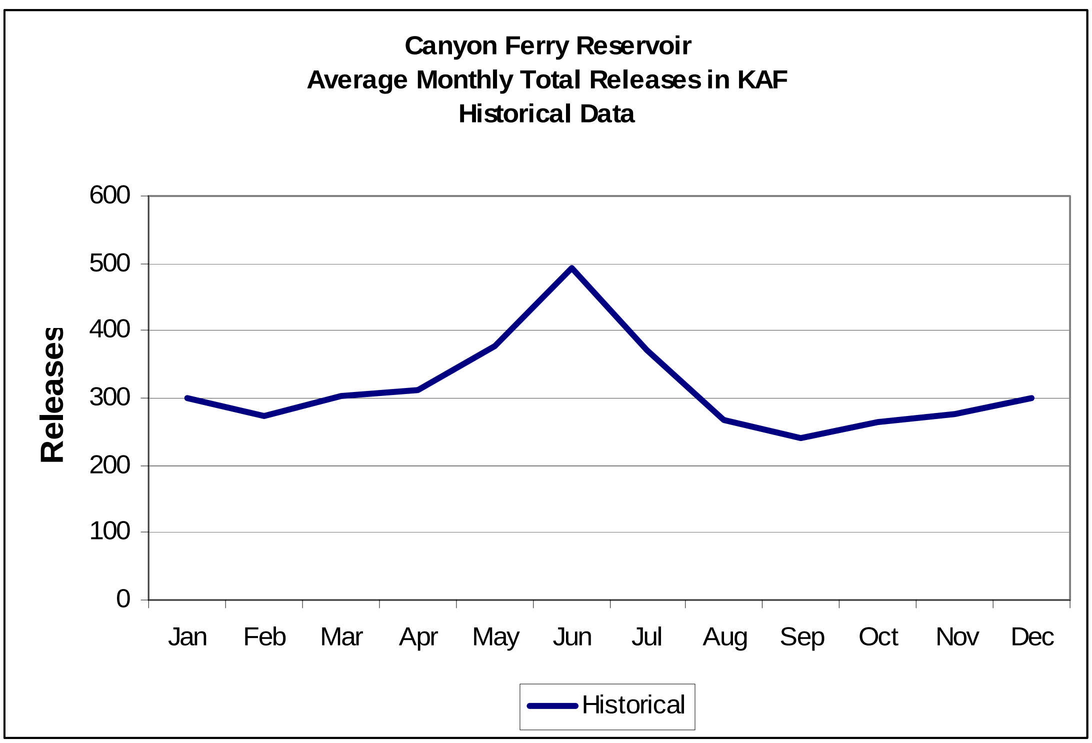


Figure 3.2



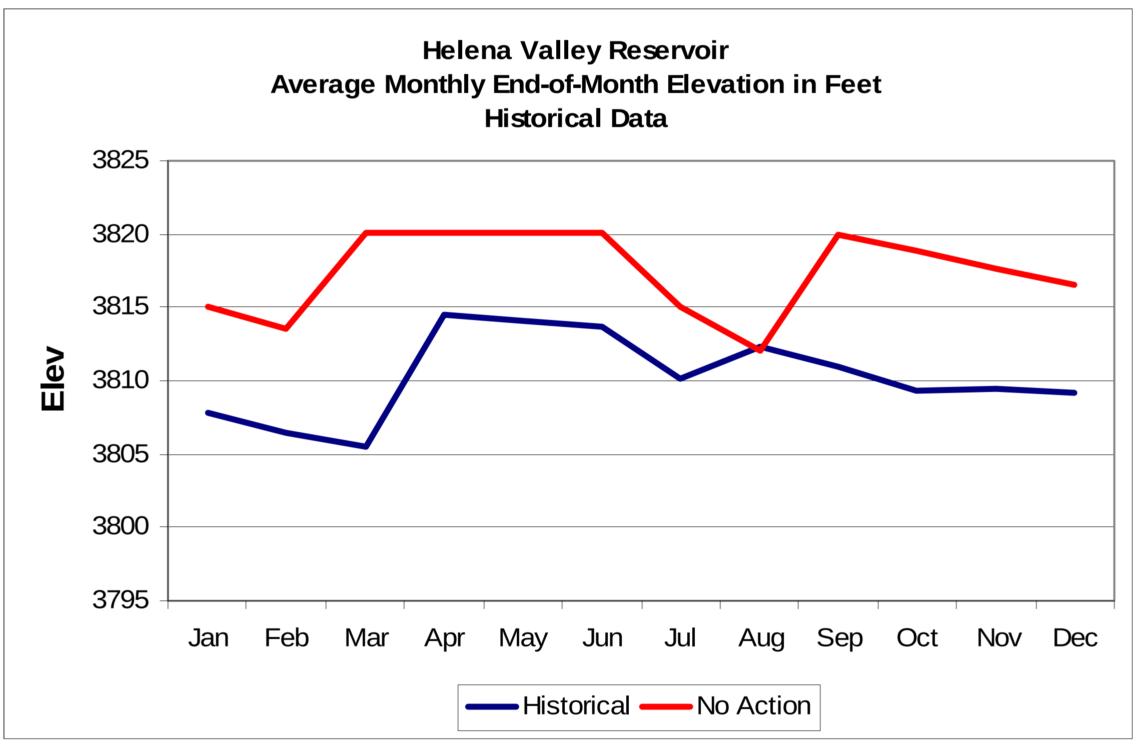
Water from Canyon Ferry Reservoir is pumped beginning in late March and continues through mid-October. Based upon the demands of HVID, the beginning of the irrigation season and canal shut down varies from year to year. During the winter months, Helena can request and divert water from HVRR to meet demand.

HVRR fluctuates between an average minimum elevation of 3805.5 feet in March to an average maximum elevation of 3814.1 feet in July. Generally, the HVID attempts to maintain a full pool elevation throughout the irrigation season to ensure an adequate water supply for their irrigators.

Reclamation has issued long-term water service contracts with other entities and individuals for water from Canyon Ferry Reservoir that is provided through HVRR and the HVID water conveyance system. Entities and individuals under Reclamation contract coordinate the delivery of water with the HVID.

Information on HVRR was taken from the Hydromet database. Figure 3.3 displays the average EOM elevations for HVRR.

Figure 3.3



Crow Creek Pumping Plant

The Crow Creek Pump Unit is a part of the Three Forks Division of the P-SMBP. Water is pumped from the west bank of the Missouri River by the Crow Creek Pumping Plant. It provides water through Toston Canal to TID lands. The plant consists of three units, and each pump has a capacity of 33 cfs driven by a 900-hp pump.

Small Streams

Parts of three small streams flow through HVID. Silver Creek flows directly into Lake Helena from the southwest. Prickly Pear Creek drains much of the area upstream of East Helena and flows into Tenmile Creek near Lake Helena. The upper Tenmile Creek watershed provides M&I water for Helena.

Streamflow records are unavailable for Silver Creek. Only the *Prickly Pear Creek at Clancy, MT* gage (USGS 06061500) has a long-term record; however, it is located midway in the drainage basin and upstream of HVID. Based upon a ratio of the drainage areas between the Clancy gage and the calculated drainage at the mouth of the creek, average annual flows for Prickly Pear Creek at its mouth are estimated to be 53,300 AF/year.

The *Tenmile Creek near Helena* gage (USGS 06063000) has 49 years of record. Average annual flows are 19,550 AF. *Tenmile Creek above Prickly Pear Creek near Helena* gage (USGS 06064150) has only two years of partial records. However, based on a ratio of the drainage areas, estimated flows at this gage are 38,300 AF/year.

The only potentially-affected stream in TID is Warm Springs Creek, a small tributary that flows into the Missouri River just downstream of Community of Toston. No flow records are available for Warm Springs Creek. Operational waste and return flows have increased flows in Warm Springs Creek and contribute to channel degradation.

Water Quality

The presence of naturally-occurring arsenic in the Missouri River and other water quality effects were identified as issues related to contract renewal. Specific concerns identified during scoping were:

- How would contract renewal affect water quality in Canyon Ferry Reservoir? HVRR? Lake Helena? Missouri River? Prickly Pear, Silver, Tenmile, and Warm Spring creeks? Return flows? Groundwater?

- How would contract renewal affect TMDL's (*total maximum daily loads)* in Canyon Ferry Reservoir? HVRR? Lake Helena? Missouri River? Prickly Pear, Silver, Tenmile, and Warm Spring creeks?

- How would contract renewal affect arsenic levels in soils and groundwater in or near the irrigation districts?

Indicators for water quality include trace element, nutrient, and organic chemical concentrations.

Various reconnaissance and field screening investigations have been conducted in the upper Missouri River basin and the Helena Valley and Spokane Bench sub-basins during the past ten years. Data and findings from these previous investigations were used to describe potential effects of the proposed action and alternatives.

The major source of the arsenic in the Missouri River is geothermal water from Yellowstone National Park. Arsenic levels at the headwaters of the Missouri River (median arsenic concentration, 74 ppb) generally exceed EPA's maximum contaminant level (MCL) (the level allowable for human health or aquatic life) of 10 parts-per-billion (ppb) for treated drinking water. Public water systems must meet this standard by January 2006.

Canyon Ferry Reservoir/Missouri River Above Canyon Ferry Reservoir

Horn (1998) describes Canyon Ferry Reservoir as an extremely productive reservoir and, for most parameters, it can be considered hypereutrophic (meaning that there are high degrees of physical, chemical, and biological changes associated with nutrient, organic matter, and silt enrichment and sedimentation). Data do not indicate substantial changes to the productivity of the reservoir since impoundment. Zooplankton and algal densities are similar to or fall within the range of values observed in previous studies. Primary and secondary productivity are variable from year to year and is dependent on climate and volume of water flowing into the reservoir. Nutrient inputs—particularly phosphorus—correlate with the volume of water flowing into the reservoir. High levels of phosphorus result in low nitrogen-to-phosphorus ratios that set the stage for blue-green algae blooms that occur almost yearly.

Water released from deep within the reservoir through the power penstocks limit the degree of nutrient buildup in the reservoir and productivity. The nutrient budget in Canyon Ferry Reservoir for phosphorus is nearly balanced on a seasonal basis. In reservoirs with surface withdrawals and in lakes where outlets are surface streams, nutrients build up and tend to result in eutrophication. Any increase in productivity in Canyon Ferry Reservoir would likely result from shifts in agricultural practices or urban growth.

Deep withdrawals, however, do create seasonal problems with low dissolved oxygen concentrations in outflows. This problem is not new nor does it appear to have increased in severity over time. The severity of the problem varies from year to year depending on climatic conditions. With high productivity, there is a considerable amount of organic debris settling out of surface water that decomposes and depletes oxygen. Historical data from the reservoir indicate low dissolved oxygen releases are the norm.

Arsenic levels in the reservoir are elevated but are not substantially different from values expected for the area. Mercury levels in water and sediments are not elevated indicating no current sources of major contamination. Pesticide analysis indicated no identifiable contamination. Oil and gas contamination from marinas was also found to be non-detectable. Bacterial problems are minimal.

Detectable levels of fecal coliforms were found. The presence of fecal coliforms could be an indicator of cattle, waterfowl, and/or human waste in the area.

Helena Valley

As part of the Department of the Interior, National Irrigation Water Quality Program, a study was conducted of water, bottom sediment, and biota associated with irrigation drainage in the

Helena Valley (Kendy et al. 1998). Data for this study were collected in 1993 and 1995 from areas that could be affected by canal seepage and irrigation return flows from HVID.

HVID receives about 73,300 AF of Missouri River water annually through Canyon Ferry Reservoir. At the point of diversion (Helena Valley Pumping Plant), the concentration of naturally-occurring arsenic ranges from 22-34 ppb.

Except for arsenic and zinc, trace-element concentrations in surface water in the Helena Valley are generally low. Arsenic concentrations in irrigation drains, natural stream, and lake sites ranged from 2-25 ppb with median concentrations of 15 ppb during the irrigation season and 5.5 ppb at other times. The highest concentrations were found in a drain receiving flows from irrigation laterals. Most surface water samples within the HVID had higher arsenic concentrations during the irrigation season when compared to a reference site unaffected by irrigation drainage. At the reference site, arsenic concentrations decreased slightly during the irrigation season. It is likely moderately-elevated zinc concentrations in Prickly Pear Creek result from historical mining and industrial activities.

Some irrigation delivery and return flow water returns to Lake Helena causing concerns about the biological risk of possibly high levels of arsenic. Toxicity levels have not been established for bottom sediment constituents. Lake Helena bottom sediment had arsenic and trace-metal concentrations comparable to those in bottom sediment from wetlands impaired by mining. Maximum concentrations were 46 parts-per-million (ppm) for arsenic, 47 ppm for chromium, 82 ppm for copper, 170 ppm for lead, and 600 ppm for zinc. Other possible sources of trace metals in the bottom sediment could include irrigation drainage mobilizing smelter fallout on irrigated lands and stream transport from upstream mining areas.

Helena Valley Groundwater

Groundwater was sampled in the Helena Valley in 1995 (Kendy et al. 1998). Most wells sampled were near the Helena Valley Canal or a lateral. Wells were sampled near lined and unlined sections. Previously unpublished analysis of 1993 groundwater samples by the U.S. Geological Survey from wells and boreholes in irrigated fields were also consulted.

Most of the wells sampled in both 1993 and 1995 were drilled to depths several feet below the top of the water table. Test wells were installed in clusters in a sprinkler-irrigated field and a flood-irrigated field. Groundwater samples were collected during the irrigation season in domestic, community, stock, irrigation, and test wells. Water collected from most wells was analyzed for major ions, nutrients, and selected trace elements including arsenic.

Trace-element concentrations in groundwater, with some exceptions, generally were low. Arsenic concentrations ranged from <1-22 ppb with a median value of 2 ppb.

In the western part of the Helena Valley, drinking water typically is obtained from alluvial aquifers. The median arsenic concentration more than three feet below the top of the water table in alluvium was 1.2 ppb. Arsenic concentrations generally were higher in irrigation water that in soil moisture and higher in soil moisture than in the shallow groundwater under irrigated areas. This suggests arsenic is sorbed (taken up and held) by soil particles as irrigation water percolates through the profile and is diluted by groundwater as it reaches the underlying aquifer. Deeper in the aquifer, arsenic may continue to sorb and be further diluted, or hydraulic gradients may prevent infiltrated irrigation water from moving further down resulting in relatively low arsenic concentrations at depth.

The highest arsenic concentrations in groundwater (17 and 22 ppb) were found in domestic wells drilled into Tertiary sediments under the Spokane Bench in the eastern part of Helena Valley. Possible sources of arsenic are aerially-deposited smelter emissions, irrigation water, and dissolution of arsenic-bearing minerals. In contrast to the permeable alluvial aquifer in the western part of the valley, the Tertiary aquifer has low permeability and probably does not transmit sufficient volumes of groundwater to dilute arsenic.

Helena Valley Regulating Reservoir

Water from Canyon Ferry Reservoir was sampled at the inlet to HVRR in July 1995 (Kendy et al. 1998). This water did not exceed Montana aquatic-life criteria for any nutrient or trace element, including arsenic (Acute – 340 ppb; Chronic – 150 ppb). Water collected at the HVRR outlet site contained a dissolved arsenic concentration of 31 ppb, the highest of any site sampled. Mangelson and Brummer (2002) reported arsenic concentrations exceeding drinking water standards in water sampled from HVID canals that ranged from 20.9 to 26.7 ppb.

Arsenic and copper concentrations were elevated in mallard livers collected from HVRR. Arsenic concentrations in the livers of three of four mallards collected exceed maximum concentrations in livers of seven mallards collected elsewhere in Montana. Copper concentrations in all four mallard livers were elevated. The median copper concentration of 150 micrograms/gram dry weight in mallard livers collected equals the maximum recorded amount from mallards collected elsewhere in Montana. Cadmium, lead, and zinc concentrations in the mallard liver samples did not exceed the maximum or median concentrations of these metals in mallard liver samples collected elsewhere in Montana.

Arsenic, cadmium, copper, lead, and zinc concentrations in the single northern shoveler liver from HVRR were not elevated compared to maximum concentrations found in northern shoveler livers collected elsewhere in Montana; however, cadmium and zinc concentrations did exceed the geometric mean concentrations compared to other Montana northern shoveler livers. It is not known if the difference between the few mallard and northern shoveler samples collected in HVRR resulted from site-specific differences in arsenic and copper concentrations in water bird food organisms, from species-specific feeding methods, or from assimilation characteristics unique to the few individuals sampled.

Arsenic, cadmium, lead, and zinc concentrations in the livers of these birds sampled from HVRR do not indicate a threat to water bird health. While arsenic and copper concentrations were elevated compared to water bird tissue samples from other Montana water birds, concentrations do not indicate concerns for chronic or acute toxicity and/or reproductive impairment Threats to water bird health due to elevated copper concentrations could not be determined because risk levels have not been established for water bird livers.

Lake Helena

Lake Helena receives water from Prickly Pear, Silver, and Tenmile creeks, irrigation water from HVID canals and drains, and backwater from Hauser Reservoir. Samples indicate Montana aquatic-life criteria for nutrients and trace elements were not exceeded.

Arsenic samples collected between March and July 1995 contained arsenic concentrations ranging from 5-17 ppb that increased from west to east. This trend has been attributed to the mixing of water in the eastern part of Lake Helena with water from Hauser Reservoir that contains arsenic derived from the Missouri River (Kendy et al. 1998). Arsenic concentrations at all sites were lower than HVID's water supply from the Canyon Ferry Reservoir and well below the EPA and Montana Department of Environmental Quality (DEQ) aquatic life chronic criterion.

Zinc concentrations decreased from 9 ppb on the west side to less than 3 ppb on the east. This distribution of zinc might be attributable to inflows from zinc-enriched Prickly Pear Creek.

Pesticides are routinely applied to farms and residential areas in the Helena Valley; however, persistence of pesticides in the hydrologic system is unknown. Pesticide concentrations were determined from a July 1995 water sample from the western part of Lake Helena. The sample was analyzed for six organochlorine herbicides: Picloram; 2,4-D; 2,4,5-T; Silvex; Dicamba; and 2,4-DP. Results indicate that 2,4-D was present at a concentration of 0.02 ppb that is well below the MCL of 70 ppb. None of the other five pesticides exceeded detection levels of 0.01 ppb.

Montana DEQ is currently developing a total maximum daily load (TMDL) water quality restoration plan for the greater Lake Helena watershed that is scheduled to be completed in late 2004. The Lake Helena watershed (Prickly Pear, Tenmile and Silver creek drainages and Lake Helena)includes 23 water quality-limited segments for which TMDLs must be developed. Water quality-limited water bodies are those streams and lakes that do not meet, or are not expected to meet, state water quality standards for one or more state designated beneficial water uses. Water quality issues of concern include impairment associated with heavy metals, nutrients, sediment, and water temperature. To date, an inventory of available water quality information, a watershed characterization document, a sampling and analysis plan to fill voids in available water quality information, and a preliminary assessment of pollution sources in the Lake Helena watershed have been completed. In addition, water quality status reviews for all of suspected impaired stream and lake segments and development of water quality restoration goals that can be used to gauge attainment of water quality standards and full support of all designated beneficial uses are at various stages of completion.

The next stage in the process will be to develop the pollution allocations, the actual TMDLs, a restoration strategy, and a long-term monitoring plan. TMDLs will be developed for sediment, nutrients, metals, and water temperature and will be expressed as acceptable loads, or reductions in loads, of the pollutants of concern. TMDLs are required to consider all significant sources of pollution including natural background sources and will include a margin of safety to account for any uncertainty in underlying assumptions.

Lake Helena Bottom Sediment

National databases of bottom-sediment chemistry are sparse, and national criteria for biological risk have not been established for bottom sediment. Comparisons to available data for soil and bottom sediment from other areas of Montana and the western United States indicate that Lake Helena bottom sediment has relatively high concentrations of some trace elements, including arsenic. Arsenic, copper, lead, and zinc concentrations in bottom sediment greatly exceeded mean values and are near the upper end of ranges reported for more than 700 soil samples from the western United States. Cadmium, copper, lead, and zinc concentrations in Lake Helena bottom sediment exceeded maximum values reported for sediment sampled from headwater floodplains in mineralized area of western Montana. Arsenic concentrations were similar to those of the mineralized headwater areas. Arsenic, chromium, copper, lead, mercury, and zinc concentrations in bottom sediment were comparable to bottom sediment sampled from seven mining impaired wetlands and were greater than 73 unimpaired wetlands sampled throughout Montana.

Concentrations of several trace elements were higher in Lake Helena bottom sediment than in soil samples collected from Helena Valley indicating some trace elements may be accumulating in Lake Helena sediment. It should be noted that more than one-half of the soil samples collected in the entire valley were within a few miles of the community of East Helena where soil is affected by aerial deposition from the lead and zinc smelter. Possible sources of trace elements in Lake Helena bottom sediment include stream transport from upstream mining areas and the Missouri River and mobilization of aerially-deposited smelter emissions from irrigated soils. Another potential source of arsenic is excess irrigation water that spills directly into the lake. However, the specific effects of each potential source can not be differentiated with available data.

Tenmile Creek
Fourteen abandoned mine sites in the Tenmile Creek drainage are considered priority for remediation by EPA. Tenmile Creek loses water to groundwater as it enters Helena Valley. Flows from the creek recharge groundwater (Briar and Madison 1992). Arsenic from historical mining in the Tenmile Creek drainage is likely to be a primary source of arsenic to surface and groundwater in the Tenmile Creek watershed. (Kendy et al.1998). Hot springs discharge into Tenmile Creek and contain arsenic (Leonard et al. 1978). Arsenic loads also increase during the irrigation season in comparison to the non-irrigation season and increase downstream during the irrigation season. Increasing arsenic loads with decreasing flows during the irrigation season suggest other sources of arsenic are contributing to arsenic loads and concentrations.

Three impaired segments of Tenmile Creek were identified in 2002 as part of the TMDL water quality restoration plan for the Lake Helena watershed. The restoration plan lists probable sources of contamination as forest practices, resource extraction, hydromodification of flows, agriculture, construction, and habitat modification. Probable causes of contamination include arsenic, cadmium, copper, lead, mercury, zinc, nutrients, siltation, and alteration of flows.

Negotiations are underway between the Helena, MFWP, and EPA regarding a long-term agreement for future management and instream flows. These negotiations involve changing Helena’s primary source of M&I water from Tenmile Creek to the Missouri River through Canyon Ferry Reservoir and HVRR. This switch would allow Helena to keep natural flows in Tenmile Creek in Helena National Forest to dilute trace elements and improve aquatic habitat.

Other Streams
Prickly Pear Creek rises in the Elkhorn Mountains, flows for about 32 miles, and then receives Tenmile Creek before entering Lake Helena. It drains a mining and agricultural region and transports much of HVID’s return flows to Lake Helena and the Missouri River. Prickly Pear Creek, from its headwater to the confluence with Lake Helena, is identified as impaired in Montana DEQ’s *2002 Montana 303(d) List of Threatened and Impaired Stream on Need of Restoration.*

The creek from Highway 430 to the Helena Wastewater Treatment Plant discharge is listed for impairments due to metals, siltation, nutrients, thermal modifications, flow alterations, dewatering, fish habitat degradation, riparian degradation, and other habitat alterations. The segment of the creek from the treatment plant discharge to Lake Helena is listed for impairments due to metals, siltation, nutrients, thermal modifications, un-ionized ammonia, flow alterations, dewatering, fish habitat degradation, bank erosion, and other habitat alterations.

The Helena Valley Canal passes under Prickly Pear Creek through a HVID siphon. This area has historically been dewatered during the irrigation season by farmers not served by HVID.

Silver Creek begins at Marysville and flows eastward six miles before entering Lake Helena. Silver Creek, from its headwaters to Lake Helena, is identified as impaired on Montana DEQ's list for impairments due to metals, priority organics, flow alterations, and other habitat alterations. The lower section of Silver Creek is in HVID and is typically dewatered during the irrigation season by farmers not served by HVID.

Warm Springs Creek flows into the Missouri River downstream of the Community of Toston. The TID has converted all open laterals to buried pipe and has largely eliminated seepage and evaporative losses. TID is currently irrigated with 90% sprinkler application. Excess water moved through Toston Canal is wasted into Warm Springs Creek causing periods of increased flow, channel degradation, and sedimentation. Canal waste also contributes to arsenic concentrations in Warm Springs Creek.

Toston Irrigation District

Kirkpatrick and Bauder (2004) assessed previous research of arsenic behavior in the Missouri and Madison rivers focusing on lands and past investigations in HVID. The western areas of HVID and TID share similar soil types, land use, irrigation practices, and physical and climatological conditions. Because arsenic and other water quality data are not readily available for TID, Reclamation is applying the results of research conducted in the Helena Valley to TID to describe potential effects to soil and water resources from Missouri River irrigation water containing naturally-occurring arsenic.

Soils of the TID and the western section of the Helena Valley have many physical attributes in common including the presence of the Chinook, Mussel, and Thess soil series. Similarities between the irrigation districts suggest that conclusions made about arsenic behavior in HVID can, in general, be applied to the TID where both background and applied arsenic concentrations are lower.

Kirpatrick and Bauder (2004) reviewed and interpreted investigations in the Helena Valley watershed. They concluded that similarities between irrigation districts allow for the transfer of knowledge regarding arsenic transport, mobilization, and behavior of potential effects in HVID to TID. Much of this discussion applies to HVID as well.

Previous investigations generally indicate irrigated soils remove arsenic from water through three processes: volatilization from near-surface soil layers, deep percolation and dilution by ground water, and adsorption onto soil particles and organic matter. It can be concluded that irrigation with water from the Missouri River doesn't adversely affect arsenic concentrations in

TID soils because arsenic concentrations in irrigation water are relatively low and volatilization and leaching remove substantial quantities from soil profiles. It is expected that arsenic concentrations in soils of TID would not accumulate to toxic levels as long as soil physical properties and good land-use practices are maintained.

An important aspect of arsenic behavior is volatilization. Results of studies in HVID indicate irrigation with water from the Missouri River has not substantially increased arsenic concentrations in groundwater or return flows in the western area of HVID (Mangelson and Brummer, 1994; Kendy, et al., 1995). One of the conclusions of Mangelson and Brummer (1994) was that an equilibrium condition in the soil apparently exists as irrigation-applied arsenic builds up to a level where loss by volatilization and other removal mechanisms approximates the amount of applied arsenic each year.

Arsenic in TID is derived from irrigation water from the Crow Creek Pumping Plant at the Broadwater-Missouri Diversion Dam. Arsenic in irrigation water is transported in the least bioavailable (mobile) and toxic state. Once applied to the soil, it is has a tendency to concentrate in the top eight inches of the soil profile. Soil layers near the surface contain the majority of iron, aluminum, and organic matter. Arsenic can be removed from irrigation water by adsorption to soil or sediments by iron, aluminum, clays, and organic matter. Arsenic can then be removed from the soil by at least three mechanisms. It can be leached below the root zone by water, it can be volatilized into the atmosphere, or it can be taken up by plants and removed through plant harvesting, although this mechanism has not been studied in detail.

Volatilization has the potential to remove substantial quantities of arsenic from soils and water, especially in the top eight to eighteen inches of the soil profile where most of the applied arsenic is sequestered. Volatilization can be enhanced by sprinkler irrigation that increases microbial processes and increased by annual plowing that aerates the soil. There is very little in the literature on rates of volatilization and the fate of volatilized arsenic, and more information is needed to determine the impact volatilization has on arsenic concentrations in soils. A Canadian study in 1978 indicates that 17 to 60% of arsenic in soils can be volatilized (Mangelson and Brummer 1994).

Prolonged flood irrigation results in reducing conditions that prompts desorption and reduction of arsenic to a more mobile and toxic state. This is a fairly rapid process that even short-term inundation may induce. Flood irrigation applies more water (therefore more arsenic) than is needed resulting in higher return flows. This may lead to higher amounts of arsenic in ground and surface water as available sorption sites become saturated.

Much less water (and arsenic) is applied through sprinkler irrigation. Under sprinkler irrigation, leaching and return flows are minimized, and sorption sites may not become saturated as quickly allowing for sorption of greater amounts of arsenic.

Cropping patterns can also influence arsenic behavior. Without soil amendments, intensive cropping can deplete soil of organic matter and other nutrients. As mentioned above, organic matter provides sorption sites for arsenic, so as long as care is taken to insure replenishment of organic matter, soils should retain its ability to sequester arsenic.

TID soils have a high hazard for wind erosion. Available data indicate arsenic accumulates in the top eight inches of soils. Wind-induced erosion may transport arsenic to other areas, in effect removing arsenic from one part of the system and adding it to another. There is very little information on wind erosion and arsenic mobility and transport. Reclamation does not know if wind-induced arsenic transport poses an environmental hazard.

Soils in TID are typically low in phosphorous. Phosphorous amendments are rarely added. Impacts of phosphorous amendments on arsenic behavior involve displacement from sorption sites as a result of phosphorous competition. Even when over saturated, phosphorous will not occupy all the sorption sites available. In the TID, phosphate-based fertilizers and soil amendments are rarely used, and application rates and times are likely not sufficient to cause mobilization of sorbed arsenic.

Specific plant species have been identified as bioaccumulators of arsenic (Mangelson and Brummer 1994; USDA 1977). Data are limited on this issue with few documented instances of elevated arsenic levels in crops or forages. It is believed that most of the arsenic is stored in plant roots. Considering the relatively low levels of arsenic in applied water and soils of the area, it is unlikely that arsenic levels approach toxicity or have adverse effect (2-5 miligram/ kilogram dry weight).

Mangelson and Brummer (1994) reported that return flows and downstream waters had lower concentrations of arsenic than the applied irrigation water. This indicates arsenic is being removed by sorption, dilution, and/or volatilization. If pH values of irrigation water were to decline, or conditions were to become anoxic, the potential for arsenic mobilization into ground water or return flows would increase due to decreased sorption and change to a more mobile state. Maintaining slightly alkaline and aerobic conditions and enriching organic matter can decrease the likelihood of arsenic mobilization into groundwater or return flows. Managed properly, arsenic concentrations in groundwater and waters downstream of the TID should not pose an environmental risk.

Kirkpatrick and Bauder (2004) outlined several best management practices to minimize potential effects from arsenic to land irrigated with Missouri River water. These include:

1. <u>Increased irrigation efficiency</u> This practice results in less arsenic leaching through soil profiles and into return flows or groundwater;
2. <u>Cover cropping between growing seasons with winter wheat and/or winter legumes</u> This introduces organic matter while preventing wind erosion;
3. <u>Annual plowing</u> This practice aerates soils and can increase volatilization of arsenic from near-surface soils;
4. <u>Minimizing the use of phosphate-based fertilizers and soil amendments</u> This practice prevents excessive arsenic from being released into ground or surface waters;
5. <u>Consistent monitoring of soil and water in the area, coupled with management practices to maintain soil physical properties such as pH, oxidation-reduction potential, and organic matter</u> This practice should identify any concerns associated with arsenic-laden irrigation water diverted from the river for TID.

Fisheries

Concerns expressed about the effects of contract renewal on fisheries in the river and reservoirs were:

- How would contract renewal affect fish and other aquatic species in Canyon Ferry Reservoir? HVRR? Missouri River downstream of Canyon Ferry Dam? Prickly Pear, Silver, Tenmile, and Warm Spring creeks?

- How would changing operation of HVRR affect retention time and aquatic productivity?

- Would changing operation of HVRR entrain more fish into the canal?

Indicators chosen for fisheries effects were populations, trends, quantity and quality of spawning habitat, and ability of the habitat to support continuation of management goals.

Fisheries are managed by MFWP in accordance with the *Upper Missouri River Reservoir Fisheries Management Plan*, *2000-2009* in January 2000. This report presented status and trend information, goals, and strategies to achieve the goals for Canyon Ferry, Hauser, and Holter reservoirs and the Missouri River from Toston to Townsend and between Hauser and Holter reservoirs. Unless otherwise cited, information used in this section comes from that report.

Species in the Missouri River and Canyon Ferry/Hauser/Holter reservoirs system are comprised primarily of rainbow trout, brown trout, yellow perch, kokanee salmon, walleye, mountain whitefish, and burbot. Smallmouth bass, largemouth bass, and northern pike are present but are not abundant enough to provide significant sport fisheries. Non-game species include common carp, longnose sucker, white sucker, and Utah chub. Canyon Ferry, Hauser, and Holter reservoirs are typically among the top five most-heavily fished waters in Montana.

Missouri River: Broadwater-Missouri Diversion Dam to Canyon Ferry Reservoir

This reach of river is managed to provide naturally-reproducing brown and rainbow trout for recreational fishing and to provide spawning and rearing conditions for the Missouri River/Canyon Ferry Reservoir system. While managed for wild trout since 1973, stocking of Canyon Ferry Reservoir has resulted in substantial runs of hatchery fish into this reach. Rainbow trout populations appear to have increased between 1991 and 1999. There has been a noticeable increase in rainbow trout over 18 inches, and increased spawning activity has been noted near the tributaries. Warm Springs, Dry, and Deep creeks provide spawning habitat for trout in the Missouri River/Canyon Ferry Reservoir. The value of Warm Springs Creek as spawning habitat may be limited by return flows from the TID that increases flows in the creek that contributes to increased channel degradation, erosion, and sedimentation (Ron Spoon, pers. comm. 2004). Warm Springs Creek is also used as a migration corridor for trout moving from the Missouri River to Marsh Creek, a tributary to Warm Springs Creek, that is a spawning destination.

Brown trout populations tended to decline over the same time period. This fishery appears to be comprised of one population that completes its entire life cycle in the tributaries and another population that depends on the river and tributaries for reproduction yet spends the rest of their lives in Canyon Ferry Reservoir.

Past management has focused on rehabilitating degraded tributaries to enhance spawning and rearing habitat. MFWP's goal of sustaining a high density of brown and rainbow trout appear to be limited by quality spawning and rearing habitat.

Canyon Ferry Reservoir

Canyon Ferry Reservoir is managed as an ecological system with the Missouri River downstream from the Broadwater-Missouri Diversion Dam and associated tributaries. Many species do not complete their life cycles within any single component of the system. The management goal for Canyon Ferry Reservoir is to maintain a cost-effective multi-species fishery that maintains current level of angler use during both the open water and ice fishing season. Managers attempt to maintain historically-desirable species such as trout, perch, and burbot while trying to integrate the expanding walleye population.

The reservoir fishery was historically maintained through annual stocking of hatchery trout. Stocking continues and the rainbow trout population remains relatively stable. Brown trout populations have remained at relatively low levels since the reservoir first filled in 1955. Recent management has focused on rehabilitation of degraded tributaries to enhance spawning and recruitment of wild trout as well as experimentation with various stocking techniques.

Yellow perch have been one of the most abundant species the reservoir for the past 30 years with populations fluctuating over time. They have been popular with anglers both in open water and ice fishing. Perch are a preferred prey for walleye and other fish-eating species in the lake and may also be limited by spawning habitat. Efforts are being made to place structures in the reservoir to provide more spawning habitat.

Walleye recently became a large component of the Canyon Ferry Reservoir fishery. This species was not observed in samples until 1989 and since then has shown a rapid increase in population. There is concern that walleye reproductive potential in the reservoir is very high so they could deplete prey species including yellow perch and rainbow trout. Management has focused on suppressing the walleye population expansion with liberal angler harvest while enhancing the reproduction and survival of prey species. More anglers are targeting walleye as the desired species.

Burbot (ling) are another component of the reservoir fishery and are a popular native fish that compliments the winter sport fishery. Little is known about the dynamics or limiting factors of the population. Management includes data collection and maintaining current angler harvest unless further study warrants a change.

Forage fish are a key component in the reservoir fishery. Forage fish may be limited by reproductive potential and food availability. Monitoring of plankton is conducted to ensure the food supply for these species remains adequate. Sucker species and yellow perch supply most forage for walleye. No introductions of forage species are planned.

Tributaries to the reservoir include Duck Creek, Confederate Gulch, and Magpie Creek from the east. Beaver Creek flows into Canyon Ferry Reservoir from the west. While efforts to rehabilitate tributaries for spawning have resulted in sizeable spawning runs of wild rainbow trout, natural production still produces less than 10% of the reservoir's rainbow trout.

Helena Valley Regulating Reservoir

The primary fishery in HVRR is kokanee salmon. This reservoir receives 5,000 angler-days of use annually with 4,000 of those in winter. This non-native fishery is entirely put, grow, and take. Natural reproduction doesn't occur, and adults die after attempting to spawn.

Retention time—the time water remains in HVRR to influence primary productivity—is one of the indicators for kokanee. The historical mean monthly retention times for HVRR in typical wet, average, and dry years are listed in Table 3.1.
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Table 3.1: HVRR Retention Time (days)

	May	June	July	August	September
1997 (Wet)	**30.5**	**26.4**	**18.7**	**19.7**	**20.0**
1999 (Average)	**18.7**	**22.9**	**14.8**	**15.2**	**24.0**
2001 (Dry)	**18.3**	**23.9**	**19.6**	**17.0**	**19.2**

Retention times under past operational conditions are provided for comparison purposes in Chapter 4 because it's known that historic retention time was sufficient to support the productivity necessary to provide food base for kokanee growth.

Hauser Reservoir and Tributaries

Fisheries in this reservoir are managed as part of a complex system. Lake Helena is a large, shallow water body that is connected to Hauser Reservoir by an arm of the reservoir and receives flows from Prickly Pear, Tenmile, and Silver creeks. The HVRR receives water pumped from Canyon Ferry Reservoir and releases it throughout the irrigation season into the canal system. Excess HVID water flows into Lake Helena and Hauser Reservoir through Prickly Pear Creek.

Important tributaries to Hauser Reservoir include Spokane, Trout, and McGuire creeks. Management for Hauser Reservoir focuses on maintaining a cost-effective multi-species fishery with the chance to catch rainbow trout, kokanee, walleye, and yellow perch.

Rainbow trout and kokanee have been the most abundant game fish in Hauser Reservoir in the past, but walleye have become increasingly abundant. Brown trout, suckers, and yellow perch have also been abundant.

Much of the angling pressure has been directed towards the kokanee fishery. Kokanee were first introduced, albeit unsuccessfully, into Hauser Reservoir in the early 1950's. The population that established could have originated from fish flushed from Canyon Ferry Reservoir or were flushed into Lake Helena and then into Hauser Reservoir from HVRR when it was drained in 1978. Since then, kokanee populations have expanded dramatically but experience large annual fluctuations. The population has recently declined (MFWP 2004) possibly because of the flushing of fish over the dam during the 1997 high runoff. Spawning success may be affected by low dissolved oxygen below Canyon Ferry Dam during late summer, and kokanee survival may be affected by flushing through the dam.

The rainbow trout fishery has been maintained by stocking. Wild trout contribute very little to the fishery mainly due to poor spawning habitat in tributaries, so stocking continues to supply most of the fishery. Prickly Pear and Tenmile creeks could provide quality trout spawning habitat, but both suffer chronic dewatering due to irrigation withdrawals. Tenmile Creek also is heavily polluted with mine water and seepage from tailings to the point that much of it in uninhabitable by fish. Tenmile Creek has good public access and, with rehabilitation, could support a good creek fishery.

Brown trout are present in Hauser Reservoir in limited numbers and have trophy potential. Brown trout are protected from harvest to allow rebuilding of the population through natural recruitment.

Walleye continue to provide good fishing in Hauser Reservoir. Populations were established by stocking and are maintained through natural recruitment and flushing from Canyon Ferry Reservoir. Burbot, as well as introduced largemouth bass and yellow perch, also provide fishing in the reservoir and the causeway arm based on wild production.

Management for all Hauser Reservoir fish species includes further study of the effects of/solutions for low dissolved oxygen below Canyon Ferry Dam. Low dissolved oxygen concentrations are noticed in late summer as Canyon Ferry Reservoir stratifies and water low in oxygen is released from deep in the reservoir.

Flushing of fish into and out of Hauser Reservoir is also a continuing issue. Management for trout continues to focus on rehabilitation of tributaries to enhance spawning habitat so that more of the fishery can be provided by natural recruitment.

Missouri River: Hauser Dam to Holter Reservoir

There are about 4.5 miles of flowing river from Hauser Dam to the impounded water of Holter Reservoir. This reach flows through a narrow, high-walled gorge and is designated a Class I Blue Ribbon sport fishery. It also provides spawning habitat for brown trout, rainbow trout, kokanee, and mountain whitefish.

The section has been managed as a wild trout fishery in the past, but flushing of fish from Hauser Reservoir influences populations. Brown trout can be found here but are probably limited by spawning competition with kokanee. Restrictive fishing regulations enhance brown trout numbers and results in a trophy fishery. The kokanee population results from limited wild production and flushing from Hauser Reservoir. Walleye flushed from Canyon Ferry Reservoir have established a limited fishery in this reach with consequent concern about the effects on the wild trout fishery. Another concern is the high chance of wild fish produced in this reach being exposed to whirling disease.

Holter Reservoir

Holter Reservoir is another run-of-the-river reservoir downstream of Hauser Reservoir. The Holter Reservoir fishery is similar to that in Hauser Reservoir with rainbow trout, walleye, kokanee, yellow perch, and suckers. Past management included stocking rainbow trout and kokanee with varying success. Walleye have established in the reservoir after being flushed from Canyon Ferry and Hauser reservoirs with similar benefits and consequences to the fishery as in Hauser Reservoir. In contrast to Hauser Reservoir, the historical kokanee harvest was not as high, and brown trout have never become an important part of the fishery.

Spawning tributaries to Holter Reservoir provide substantial wild fish production. Beaver Creek is the main contributer with Elkhorn and Cottonwood creeks also providing spawning habitat. Factors limiting natural spawning include stream degradation due to logging, agricultural development, recent fires, and roads as well as habitat access issues due to beaver dams on Beaver Creek. As with Hauser Reservoir, whirling disease is also a concern.

Missouri River: Downstream of Holter Reservoir

The Missouri River below Holter Reservoir gradually transitions to a warm-water fishery with a diversity of native species as well as introduced game fish. From Holter Reservoir downstream to about Great Falls, the river continues to support a fishery of rainbow trout, brown trout, and mountain whitefish although walleye are becoming more prevalent in this reach. Downstream of Great Falls, there tends to be a strong introduced smallmouth bass and walleye fishery. Native sauger, blue sucker, paddlefish, pallid sturgeon, channel catfish, and other warm-water fish typical of large rivers inhabit the Missouri River from about Loma downstream to Ft. Peck Reservoir (Bill Gardner, pers. comm.2004). Other native species include minnow and sucker species.

Wildlife

Issues identified during scoping concerning the effects of contract renewal on wildlife include:

- How would contract renewal affect migratory birds and other wildlife?
- How would changing operations of HVRR affect wildlife and migratory birds?
- How would inclusions into HVID and TID affect migratory birds and other wildlife?

Indicators for the potential effects include:

- Numbers of nests lost for overwater nesting birds at HVRR.
- Acres of habitat loss for nesting waterfowl in the Canyon Ferry Wildlife Management Area.
- Extent of exposed substrate for shorebird use at HVRR during migration.
- Acres of degraded riparian habitat at HVRR.
- Acres of habitat converted to agricultural land.

Helena Valley Irrigation District

HVID is located in the Helena Valley and is rimmed by mountains. This intermontane valley is about 25 miles from north to south, 35 miles east to west, and has an average elevation of about

4,000'. The surrounding mountains range from 7,000-9,000' in elevation. Prickly Pear, Tenmile, and Silver creeks flow across the valley into Lake Helena and ultimately into the Missouri River.

The Helena Valley and area surrounding HVID are used mainly for agricultural purposes including irrigated pasture, crops, and fallow. Streams, reservoirs, and wetlands are scattered throughout the Helena Valley and generally support deciduous riparian forests consisting of cottonwood and willow species. Native and tame grasslands are found throughout the Helena Valley.

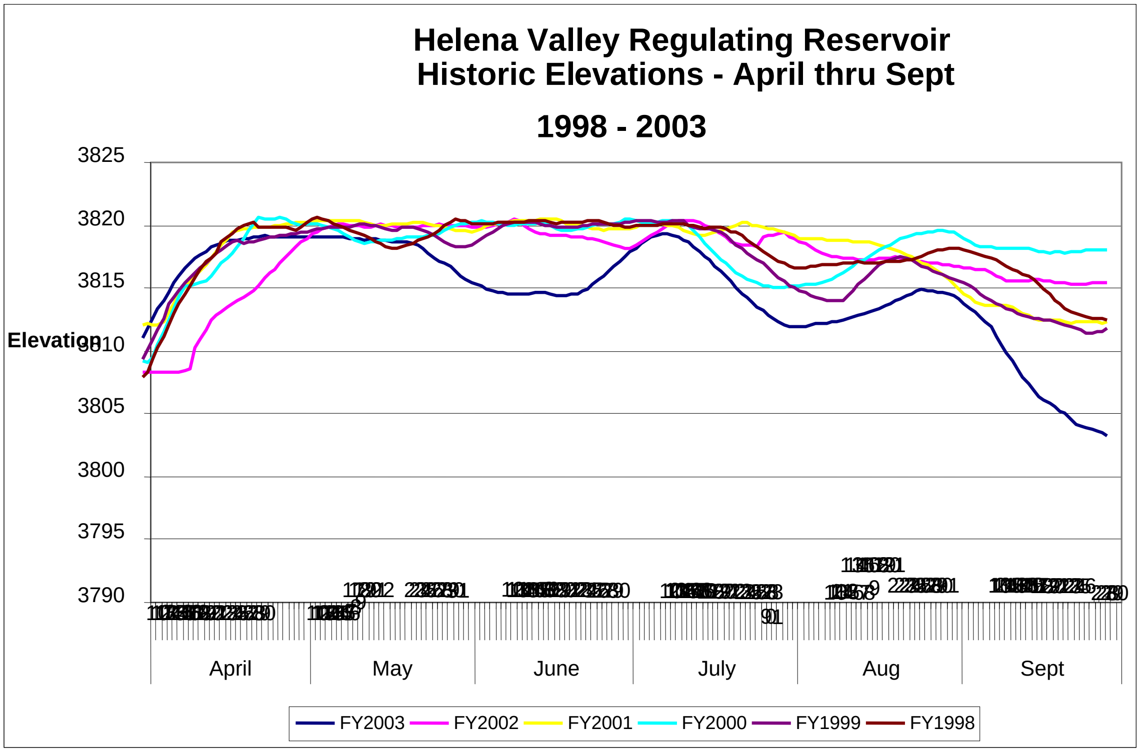
Wildlife habitat in the Helena Valley has experienced substantial modification since settlement of the area in the early 1800s. Increases in shrublands and other colonizers have created more habitat for some species, particularly mule and white-tailed deer. Wetlands and riparian habitats have been reduced, but the extent of loss is not known. Grasslands and open dry forests may have suffered the greatest decrease. These habitats have been altered primarily due to expansion of agriculture and urbanization.

HVID is located on the western edge of the Central Flyway and provides important habitat for migratory bird species. Over 150 species of birds use some portion of the area over the course of the year (Ranchland 2004). Common upland species include the long-billed curlew, horned lark, western meadowlark, cedar waxwing, gray catbird, mountain bluebird, and house wren. Black-tailed prairie dogs provide habitat for several uncommon bird species including mountain plover and burrowing owl. Migratory waterfowl found in the area include Canada goose, snow goose, mallard, pintail, American widgeon, green-winged teal, common merganser, common loon, and Barrow's goldeneye. Western and red-necked grebes are known to nest at HVRR (Ranchland, 2004). Raptors include bald eagle, golden eagle, northern harrier, sharp-shinned hawk, osprey, red-tailed hawk, American kestrel, and great-horned owl.

Bird watchers and other naturalists visit the Helena Valley from mid-October to mid-December to view bald eagles below Canyon Ferry Reservoir near the HVPP and Riverside Campground. These migrating eagles stop over in the area for several days to feed on introduced kokanee salmon. Kokanee die after attempting to spawn, and migrating eagles use this plentiful food source.

Water levels fluctuate in HVRR throughout the year, exposing mudflats, and provide habitat for shorebirds during spring and fall migrations (Figure 3.4). Exposed mudflats and shallow water around the reservoir produce an abundance of macroinvertebrates that serves as the primary food source for migrating shorebirds. Shorebird species commonly found during these migrations include killdeer, spotted sandpiper, and long-billed curlew.

Figure 3.4: HVRR Surface Elevations (1998-2003).



Except for the water impoundment dikes, HVRR is surrounded by riparian vegetation ranging in width from 15 to 120 feet. This habitat consists primarily of willows (*Salix exigua*) and cottonwoods (*Populas deltoides*). Cottonwoods form a very narrow band from 15 to 30 feet wide along the perimeter of the riparian area. Between the cottonwoods and HVRR is a band of willows between 45 and 90 feet wide (Figure 3.5).

Cottonwoods at lower elevations and most of the willows are inundated when HVRR is at full pool. Water levels in excess of elevation 3,819 inundate most cottonwoods, and the resulting anaerobic soil conditions contribute to cottonwood mortality.

The surrounding lands are generally rolling and treeless. The riparian area and upland buffer provide unique bird habitat in the otherwise arid setting of the Helena Valley. Cottonwoods and willows provide nesting, roosting, and foraging habitat for many bird species including the western grebe, yellow warbler, lazuli bunting, and American goldfinch. A great blue heron rookery is located on the island near the northeast corner of HVRR, and bald eagles seasonally use the area for roosting and feeding. Other birds using the area include American pelican, sandhill crane, and American avocet.

Red-necked and western grebes nest at HVRR. These species attach nests to inundated willow and other emergent species. Willows surrounding the reservoir are typically inundated each year as HVRR is filled and provides areas of emergent vegetation in which grebes build nesting platforms (Figure 3.6). Fluctuating reservoir levels result in frequent inundation, stranding of nests, and nest failure. Optimum reservoir surface elevations for overwater nesting birds is a stable elevation between 3818.6 and 3820. Stable water levels at the lower range of these elevations permits overwater nesting without inundating the adjacent riparian areas to the point of mortality. Lower water levels after nests have been established strand nests leading to nest loss and abandonment. Higher water levels after nests have been established flood nests resulting in egg mortality and nest failure. During the nesting season of 2003, 13 pairs of western grebes and 18 pairs of red-necked grebes were observed on HVRR with zero nest success (Ranchland 2003).

Figure 3.5: Typical view of riparian habitat at HVRR -- lighter color of the lower level vegetation depicts high water mark

Figure 3.6: Example of overwater nest of western grebe

HVRR attracts large numbers of other migratory water birds and waterfowl and serves as a migration stopover. Spring migration surveys were conducted between March 14 and April 26, 2003 (Ranchland 2003). Birds appeared in the area as soon as open water was available. The surveys found a daily average of 1,954 waterfowl and water birds between April 1 and April 24, 2003. At the peak of spring migration, HVRR supports about 3,000 birds.

Fall migration surveys began September 18, 2003 and continued until HVRR completely froze on December 12, 2003 (Ranchland 2004). These surveys showed daily migratory waterfowl numbers to average 4,294 within a range of 4,845–9,267 birds. Most birds were ducks (400-5,930), Canada geese (50-2,500), and American coot (30-3,000).

Table 3.2: Species observed at HVRR during 2003 spring and fall migration surveys (Ranchland 2004)

Spring Species (3/14-4/26)	Breeding Surveys (5/10-8/4)	Fall Species (9/18-12/12)
American coot	American coot	American coot
American goldeneye	American goldeneye	American white pelican
American widgeon	American widgeon	American widgeon
Bald eagle	American white pelican	Blue-winged teal
Bufflehead	American avocet	California gull
California Gull	Bald Eagle	Canada goose
Canada Goose	Blue-winged teal	Common goldeneye
Canvasback	Bufflehead	Common loon
Cinnamon Teal	California Gull	Double-crested cormorant
Common goldeneye	Canada goose	Gadwall
Common merganser	Cinnamon teal	Green-winged teal
Common loon	Common loon	Killdeer
Dark-eyed junco	Double-crested cormorant	Mallard
Great blue heron	Gadwall	Northern shoveler
Green-winged teal	Great blue heron	Osprey
Lesser scaup	Green-winged teal	Red-necked grebe
Mallard	Horned grebe	Ring-billed gull
Northern pintail	Killdeer	Snow goose
Northern shoveler	Lesser scaup	Whistling swan
Red-breasted merganser	Mallard	
Red-winged blackbird	Northern shoveler	
Redhead duck	Red-breasted merganser	
Ring-billed gull	Red-necked grebe	
Rick-necked duck	Redhead duck	
Ring-necked pheasant	Ring-billed gull	
Robin	Spotted Sandpiper	
Snow goose	Western grebe	
Tundra swan	Western sandpiper	
Western meadowlark	Wood duck	
Whimbril		
Whistling swan		
Wood duck		

The Service has identified migratory and non-migratory birds of concern to encourage active, coordinated conservation efforts among federal, state, and private partners. The overall goal of the list is to identify species in greatest need of conservation before they require the protection of the Endangered Species Act (ESA). Table 3.3 lists species of conservation concern that can be found at or near HVRR.

Table 3.3: Species of Conservation Concern at HVRR and Lake Helena

Birds of Conservation Concern	Waterfowl of Special Management Concern	Water Birds of Conservation Concern
Peregrine falcon	Northern pintail	American white pelican
Prairie falcon	Greater scaup	Bonaparte’s gull
Long-billed curlew	Lesser scaup	Western grebe
Black-billed cuckoo	Trumpeter swans	Black tern
Burrowing owl		California gull

Recognizing the importance of wetlands and migratory waterfowl to North America and the need for international cooperation to recover a shared resource, the United States, Canada, and Mexico have developed a strategy to restore waterfowl populations through habitat protection, restoration, and enhancement. This strategy is outlined in the North American Waterfowl Management Plan (NAWMP) that promotes partnerships to conserve migratory birds and their habitat. This reach of the Missouri River and Helena Valley falls within the boundaries of the Intermountain West Joint Venture of the NAWMP. Table 3.3 identifies migratory waterfowl of special management concern and water birds of special concern that can be found at or near HVRR.

Lake Helena Wildlife Management Area The Lake Helena Wildlife Management Area (WMA) is located on southwest section of Lake Helena. The area encompasses 157 acres and provides boat launching and general access to the 2,100-acre lake. HVID turnouts near the end of the delivery system provide a water source to the Lake Helena WMA. The management goal of the area is to improve waterfowl production potential and to provide and maintain public hunting and recreational access to the lake (MFWP 2004). Seasonal opportunities exist to hunt waterfowl and for year round bird watching and wildlife observation. The Lake Helena area supports many of the same bird species found at or near HVRR.

Tosten Irrigation District

TID is located near the upper Missouri River upstream of Canyon Ferry Reservoir. Warm Springs Creek traverses TID and drains into the Missouri River. TID is bordered by mountains to the east and west and by the Missouri River valley to the south. Average elevation in TID is about 4,000’ with the surrounding mountains ranging from 7,000-9,000’.

This intermontane valley provides a diversity of habitats for wildlife species including native grassland, irrigated pasture, juniper and sagebrush dominated shrublands, wetlands, and deciduous riparian forest. Many species reside in the valley year-round while others use the area only part of the year. The surrounding mountains provide habitat for about 300 vertebrate species of wildlife.

Both game and non-game species inhabit the area. Elk, white-tailed deer, and mule deer are common. Predators include red fox, coyote, and cougar. Smaller mammals are abundant and include beaver, muskrat, rabbits, badger, mink, weasel, raccoon, porcupine, striped skunk, and several bat species.

Canyon Ferry Wildlife Management Area

The Canyon Ferry WMA is located at the southern end of the reservoir and encompasses approximately 5,000 acres. In the 1970’s, a dike system was constructed by Reclamation to reduce dust problems during reservoir drawdown and mudflat exposure. The result was a four-pond system totaling 1,925 acres containing 325 islands. The ponds and surrounding uplands are managed by MFWP. Since construction, management emphasis has been on improving habitat to maximize migratory waterfowl production. These ponds are approximately 360-380 acres in size having a maximum depth of seven feet and average depth of three feet.

Management of water levels in the ponds is important for dust abatement, isolation of nesting islands from predators, and providing water proper levels to maximize aquatic vegetation.

Suggested elevations are shown in Table 3.4. These elevations best support nesting waterfowl and also benefit the establishment and production of emergent and submergent vegetation.

Table 3.4: Suggested water level elevations by time period for Canyon Ferry WMA ponds

Time Period	Pond 1 elevation (ft)	Pond 2 elevation (ft)	Pond 3 elevation (ft)	Pond 4 elevation (ft)
March	3796.2	3795.3	3796.0	3796.2
April	3796.2	3795.3	3796.0	3796.2
May	3795.5	3795.0	3795.5	3795.5
June-August	3795.5 ±.2-.3	3795.0 ±.2-.3	3795.5 ±.2-.3	3795.5 ±.2-.3
Sept-Freeze	3795.5	3794.5	3795.0	3795.0

Canyon Ferry Reservoir water levels in excess of the recommended levels seep through the dikes until water levels in the ponds and reservoir stabilize. Reservoir elevations in excess of those recommended may prevent attainment of management objectives.

Before construction of the dikes, a population of 40 to 50 pairs of Canada geese occupied the area but were limited by the lack of suitable nesting habitat (MFWP 1992). With the addition of the new habitat, geese nests increased to 560 (MFWP 1992). Modest numbers of American pelicans, double-crested cormorants, Caspian terns, American avocets and common terns use the islands for nesting.

The Canyon Ferry WMA is part of Montana's *Watchable Wildlife Program*. The area supports many of the mammal and bird species found around HVRR.

Wetlands

Issues regarding wetlands in the area related to contract renewal include:

- How would contract renewal affect canal seepage and seep-supported wetlands both in the short and long-terms?
- How would changing operations at HVRR affect wetlands at the reservoir?

Indicators used to predict effects on wetlands are:

- Changes in wetland acreage.
- Changes in riparian habitat.
- Change in HVRR water levels.

Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands constitute a productive and valuable resource. Unnecessary alteration or disruption of wetlands is regarded as contrary to the public interest.

The combination of shallow water, high nutrient levels, and primary productivity in wetlands is ideal for development of organisms forming the base of the food web. Wetlands attract an immense variety of insects, amphibians, reptiles, birds, fish, and mammals. More than one-third of federally-listed threatened and endangered species in the United States live only in wetlands with nearly one-half using wetlands at some point in their lives (EPA 2004). Many other plants and animals depend on wetlands for survival.

Wetlands improve water quality, offer flood protection, and control erosion. Runoff passing through wetlands is filtered removing sediments, excess nutrients, and some pollutants. Wetlands function as natural sponges that trap and slowly release surface flood water. Some wetlands discharge ground water and maintain stream flows during dry periods while others replenish groundwater.

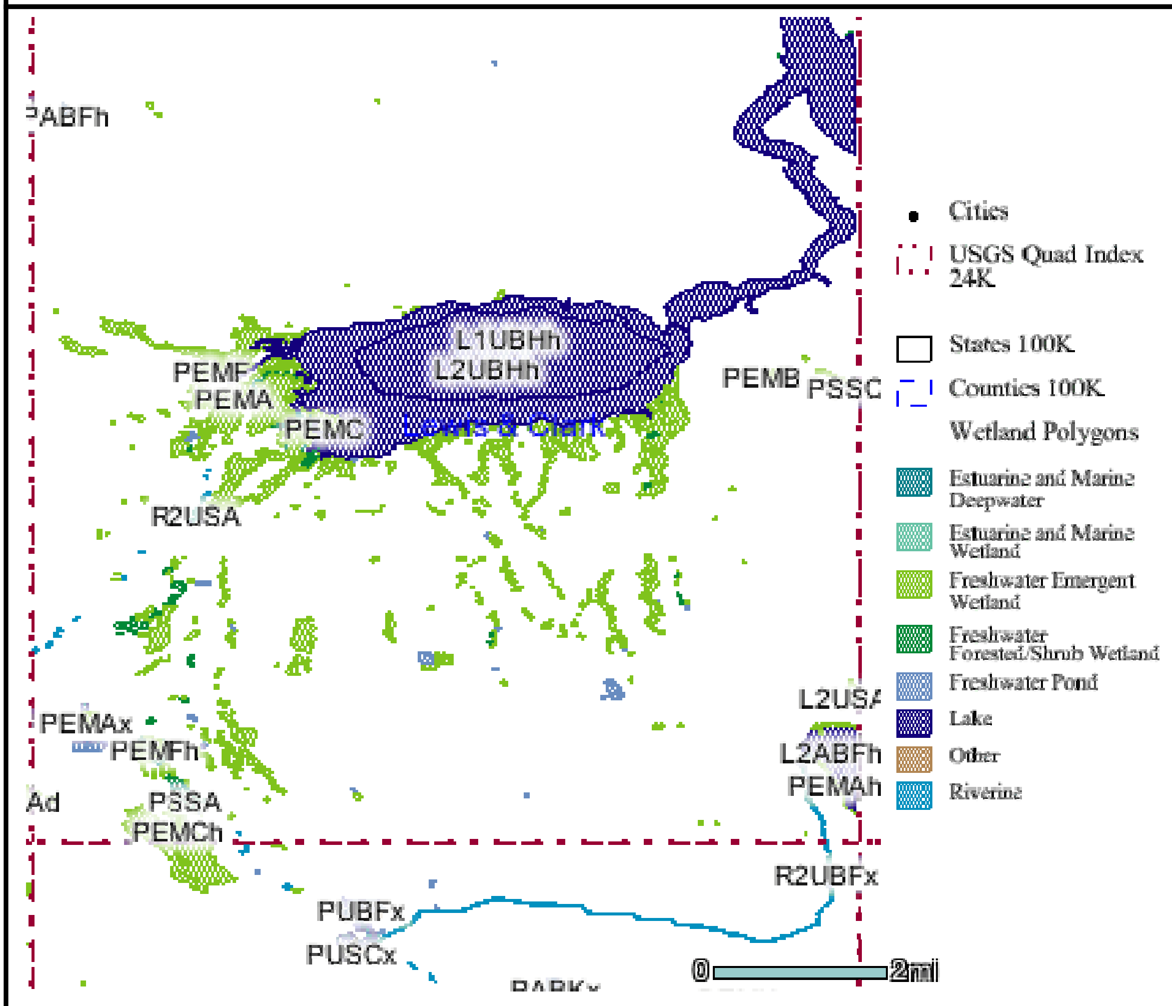
More than one-half of all adults (89 million) in the United States use wetlands for hunting, fishing, bird watching, and wildlife photography spending a total of $59.5 billion annually (EPA 2004).

The upper Missouri River and Helena Valley support a variety of wetlands. The Service has completed National Wetland Inventory (NWI) mapping for the HVID area, but not for TID. These maps, while not of sufficient resolution for regulatory purposes, are designed to provide the location, size, and type of wetlands based on hydrologic, geomorphic, chemical, or biological factors.

The NWI identified riverine, lacustrine, and palustrine wetlands in and around the HVID (Figure 3.7). The first symbol in each code, identifies the type of wetland. Palustrine wetlands begin with “P”, lacustrine with “L”, and riverine with “R”. Code following the type provides additional information related to vegetation and bottom composition.

Figure 3.7: National Wetlands Inventory Map of the Helena Valley (FWS 2004).

Lacustrine, palustine and riverine wetland locations within the Helena Valley.



Riverine wetlands are those associated with stream channels exclusive of surrounding areas dominated by trees, shrubs, persistent emergents, or mosses. Palustrine wetlands are those frequently referred to as marsh, swamp, fen, bog, or prairie pothole. Palustrine wetlands are the most common in the districts and are found along the lakes and reservoirs, including the riparian area surrounding the HVRR. Lacustrine wetlands are deepwater habitats and shorelines associated with a topographic depression or dammed river channel. Larger reservoirs in the area--such as Canyon Ferry Reservoir and the HVRR—support lacustrine wetlands.

Wetlands are found associated with canals, laterals and drains throughout both irrigation districts and around the periphery of Canyon Ferry Reservoir, HVRR, and Lake Helena. Wetlands are also found associated with the Missouri River and its tributaries.

Most wetlands associated with irrigation features rely on canal seepage or agricultural return flows as a water source. Water seeping from the canal prism flows underground providing a water supply during and after the irrigation season. Wetlands associated with the Missouri

River, Silver Creek, Prickly Pear Creek, Tenmile Creek and Warm Springs Creek rely on natural stream flows for water supply. Palustrine riparian wetlands generally rely on bank storage and flood flows for their water supply. Adjacent wetlands generally rely on flood flows for their water supply. Wetlands associated with the HVRR and Lake Helena both rely on water in the reservoir or high reservoir levels for hydrologic support.

Threatened and Endangered Species

Federally-listed species and their current listing status are shown in Table 3.4. Having the status of threatened or endangered means a species is afforded full protection under the ESA, and Reclamation must ensure actions don't jeopardize the continued existence of these species. Candidate species are those for which there is enough information to propose listing as threatened or endangered but are precluded from listing action by higher listing priorities. Candidate species are being considered in this EA so they would be covered if the species becomes listed before implementation of the Proposed Action.

Table 3.4: T& E Species

Common Name	*Species*	Current Status
Bald Eagle	*Haliaeetus leucocephalus*	Threatened
Black-footed Ferret	*Mustela nigripes*	Endangered
Gray Wolf	*Canis lupus*	Threatened
Pallid Sturgeon	*Scaphinhynchus albus*	Endangered
Ute's ladies tresses	*Spiranthes diluvialis*	Threatened
Fluvial Arctic Grayling	*Thymallus arcticus*	Candidate

Indicators vary according to species:

- Bald eagle--populations, trends, and human disturbance
- Black-footed ferret--effects to black-tailed prairie dog habitat
- Gray wolf--human interaction
- Pallid sturgeon--magnitude, duration, and timing of spring peak flows and change in summer flows
- Ute ladies' tresses--the success of wetlands
- Fluvial Arctic grayling--suitability of the water for reintroduction, water quality and quantity, effects to non-native species.

The Canyon Ferry area contains habitat for federally-listed and candidate species. Effects of the Proposed Action to listed species were evaluated for the action area (area that may be directly or indirectly affected by the Proposed Action Alternative). This analysis was conducted for a larger geographical area than the analysis for other species to evaluate any possible indirect effects to listed species that may be present downstream of Canyon Ferry Reservoir.

Bald Eagle

Canyon Ferry, Hauser, and Holter reservoirs, as well as Lake Helena and HVRR, are all potential habitat for bald eagles. Many eagles, including nesting pairs, are sighted in these areas every year. Bald eagles are attracted by fish and waterfowl supported by these areas. The area below Canyon Ferry Dam had become a popular stop for migrating eagles in the early 1990's primarily due to the abundance of kokanee. In response to declining kokanee populations in Hauser Reservoir, migratory eagle concentrations have decreased as well. In 1991, the bald eagle concentration had grown to over 300 eagles (Reclamation 1994). Surveys in the same areas in October-December of 2003 observed only 7-16 eagles (Harmata, unpublished data) indicting little or no use by migrating eagles. The indicators chosen for bald eagle effects were populations, trends, and human disturbance.

Black-footed Ferret

Originally, the black-footed ferret ranged throughout much of eastern Montana; however, only a reintroduced population is present. They are not known to migrate, but juveniles disperse in the late summer, and adults use a 100-acre range semi-nomadically. Their habitat is limited to grassland, steppe, and shrub steppe. They are closely linked to prairie dogs, and populations have only been found in association with prairie dogs. Only large complexes of thousands of acres of closely-spaced colonies are large enough to sustain a breeding population of black-footed ferrets, and it is estimated that 40-60 hectares (99-148 acres) of prairie dog colony are needed to support one ferret (Montana Natural Heritage Program 2004a). It is possible that ferrets could be associated with any of the prairie dog towns along the Missouri River floodplain downstream of Canyon Ferry Reservoir. The indicator chosen for effects on black-footed ferret was qualification of effects to black-tailed prairie dog habitat.

Gray Wolf

Gray wolves were almost extirpated from Montana and the western United States in the early 1900s. Wolves began re-colonizing the area around Glacier National Park in 1979 and have since colonized much of northwestern Montana as a result of dispersal from Canada and Glacier National Park. In 1996 and 1997, wolves were reintroduced into Yellowstone National Park and central Idaho. Wolves from these reintroductions have expanded into other areas in Montana, and they continue to expand in numbers and distribution. The gray wolf is not migratory but may move seasonally within its territory. Young wolves disperse widely. Wolves establishing new packs in Montana have demonstrated a higher tolerance of human presence and disturbance than previously thought typical. They now establish territories where prey is more abundant that is often at lower elevations. They are opportunistic carnivores and prey predominantly on large ungulates such as deer, elk, moose, and bison (Montana Natural Heritage Program 2004b). It is possible to encounter individual wolves in the action area as they disperse from known packs.

Pallid Sturgeon

A small population of pallid sturgeon inhabits the Missouri River from the mouth of the Marias River downstream to Fort Peck Reservoir. The *Pallid Sturgeon Recovery Plan* (Recovery Plan) (Service 1993) indicates the species is extremely rare, may be close to extinction, and lists destruction and alteration of big-river ecologic functions and habitat loss once provided by the Missouri and Mississippi rivers as the primary threat. This population is estimated to be about 30 adults (Upper Basin Workgroup 2002) supplemented by hatchery-raised juvenile fish. This area is identified as a Recovery Priority Management Area by the *Recovery Plan* (Service 1993).

Pallid sturgeon migrate to spawn. Discharge and photoperiod are considered important environmental cues for timing of migration and other movements (Bramblett and White 2001). There is also concern for low flows in summer drought years causing stress to adult and juvenile pallid sturgeon and their forage species (Bill Gardner, pers. comm. 2004). Forage species for pallid juveniles include sturgeon chub, young channel catfish, other cyprinids, and juvenile fish (Paul Gerrity, pers. comm. 2004) These forage species are found as far upstream as the Missouri/Marias river confluence. Indicators chosen to indicate effects to pallid sturgeon spring spawning cues and habitat availability were magnitude (measured in cfs) and timing of spring peak flows as well as change in minimum base flows (cfs). Although a base flow has not been established for pallid sturgeon above Ft. Peck Reservoir, minimum instream flows of 4,300 cfs at Virgelle were determined to be suitable for other native fish in the area (Montana Department of Natural Resources and Conservation 1991).

Ute's Ladies'-tresses

The Ute Ladies'-tresses is a perennial orchid found at the margins of meander wetlands and swales in broad, open valleys with calcareous carbonate accumulation. These orchids flower from July through early September. This orchid has been documented in Broadwater County near the Missouri River between the Crow Creek Pumping Plant and Canyon Ferry Reservoir (Montana Natural Heritage Program 2004c).

Fluvial Arctic Grayling

Though currently found only in the Bighole River in southwestern Montana, fluvial arctic grayling were historically found in the Missouri River from the headwaters downstream as far as Great Falls (Byorth 1996). Habitat degradation, introduction of non-native salmonids, climate change, and exploitation by anglers were considered to be factors leading to range-wide decline of this species. Currently, adverse effects to the remaining population in the Bighole River include reduction in water quality and quantity, competition with introduced species, predation, habitat degradation, and impacts of angling. The current management includes possible future reintroductions into historical habitat using broodstock from the remaining Bighole River population. Indicators of effects to this species were chosen to reflect the suitability of the river for reintroduction and include qualification of effects to water quality and quantity and effects to non-native species (negative effects to non-natives indicating a positive effect to grayling).

Recreation

Concerns about effects on recreation include:

- How would contract renewal affect recreation at Canyon Ferry Reservoir and HVRR?
- How would contract renewal affect aesthetics at Canyon Ferry Reservoir and HVRR?
- How would making HVRR Helena's main source of M&I water affect recreational access?

Effects to recreation were evaluated for Canyon Ferry Reservoir and HVRR. Other public and private recreation areas downstream of Canyon Ferry Reservoir would not be affected.

Canyon Ferry Reservoir

Canyon Ferry Reservoir is a major recreational facility known state-wide, but most visitors live within 120 miles (Reclamation 2003). Major cities within this distance include Helena, Great Falls, Butte, Missoula, and Bozeman.

Canyon Ferry Reservoir has three developed marina concessions, thirteen designated campgrounds, and twelve designated day-use areas. Marina concessions provide a range of services and facilities for public use including rental docks, boat rentals, boat launch ramps, campgrounds, fuel, food, and other supplies. Table 3.5 describes facilities and services provided at Reclamation-managed campgrounds and day-use areas.

Canyon Ferry Reservoir averages about 259,000 visitors annually. While recreational use occurs year-round, the primary season runs from May to September with peak use occurring on Memorial Day, Independence Day, and Labor Day weekends. Major recreational activities include swimming, camping, fishing, boating, picnicking, birding and wildlife watching, and hunting. Popular winter activities include ice fishing and ice schooner racing.

Reclamation completed the *Canyon Ferry Reservoir Resource Management Plan/Environmental Assessment* in 2003. For a comprehensive discussion of Canyon Ferry Reservoir recreation, refer to this report.

Helena Valley Regulating Reservoir

The HVRR is managed by MFWP for recreation and fish and wildlife under a 50-year agreement with Reclamation. HVRR is classified as a fishing access site and is not a state park so only basic or primitive recreational facilities have been developed. These facilities include two small parking areas, an unpaved boat launch ramp, vault toilets, shelters, and picnic tables. No potable water supply exists. Except for the toilets, most improvements are not accessible. There is an unimproved foot path around the reservoir. No concessions or rental services are provided nor are there private or public boat docks.

Recreational use is about 50,000 visits annually. Most visits occur during the late spring and summer months of May to September and during the winter months of December to March when the ice is safe for fishing. Primary day-use recreation activities include picnicking, fishing, self-propelled boating, and wildlife watching. Bow hunting is allowed, but it’s a minor activity. Overnight camping, swimming (by people or pets), and hunting with rifle or shotgun are not allowed. Ice fishing is the primary winter use.

No major recreational developments or improvements are planned for HVRR for the foreseeable future. Because of its proximity to Canyon Ferry Reservoir, visitation should grow at a rate similar to that expected for Canyon Ferry Reservoir.

Other Resource Issues

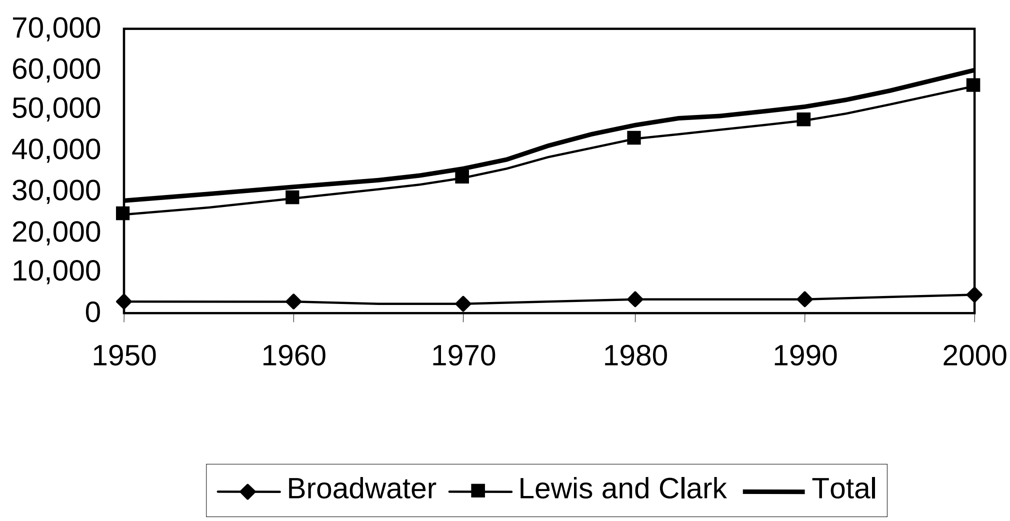
Social and economic conditions, power generation, water conservation, prime and unique farmland, noxious weeds, cultural resources, and environmental justice were not determined to be significant issues requiring in-depth investigation as they related to the federal action in this EA. Still, they were either brought up in public scoping meetings or during team meetings.

Social and Economic Conditions

Helena and HVID are in Lewis and Clark County while the TID lies in Broadwater County. Social and economic factors studied for this report were population, income and employment, recreation, and agriculture.

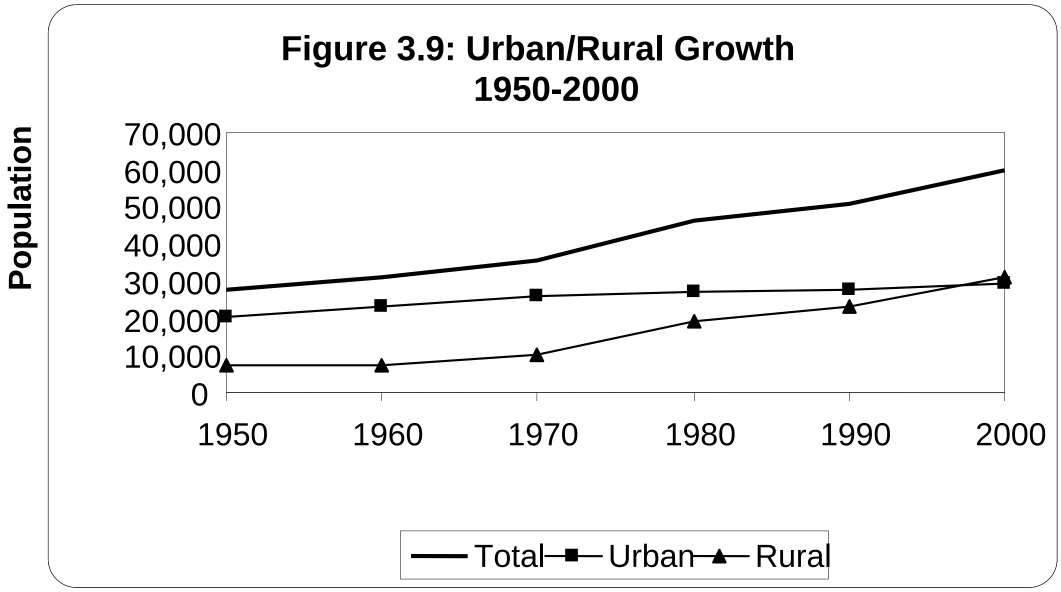
Population Overall population has steadily grown in the region. In the fifty years between 1950-2000, the population grew from 27,462 to 60,101, an increase of 119% (Figure 3.8). Most growth was in Lewis and Clark County where Helena is located.

Figure 3.8: Historical Population 1950-2000



Most growth—particularly in Lewis and Clark County—is in rural unincorporated areas. Total population in the incorporated cities of Helena, East Helena, and Townsend grew from 20,113 in 1950 to 29,289 in 2000, or 46%, while total population in the rest of the region grew from 7,349 in 1950 to 30,812 in 2000, or 319%. As Figure 3.9 shows, population in the rural unincorporated areas exceeded the population in the incorporated cities by 2000.

Current annual birthrates (calculated as annual births/1,000 population aged 18-40) are about 40/ thousand (this figure and other estimates in the paragraphs below are taken from Helena's *Growth Policy Plan*—see "References Cited"). Expected future births were determined by projecting this rate onto the present age profile of Lewis and Clark County. Total deaths are also

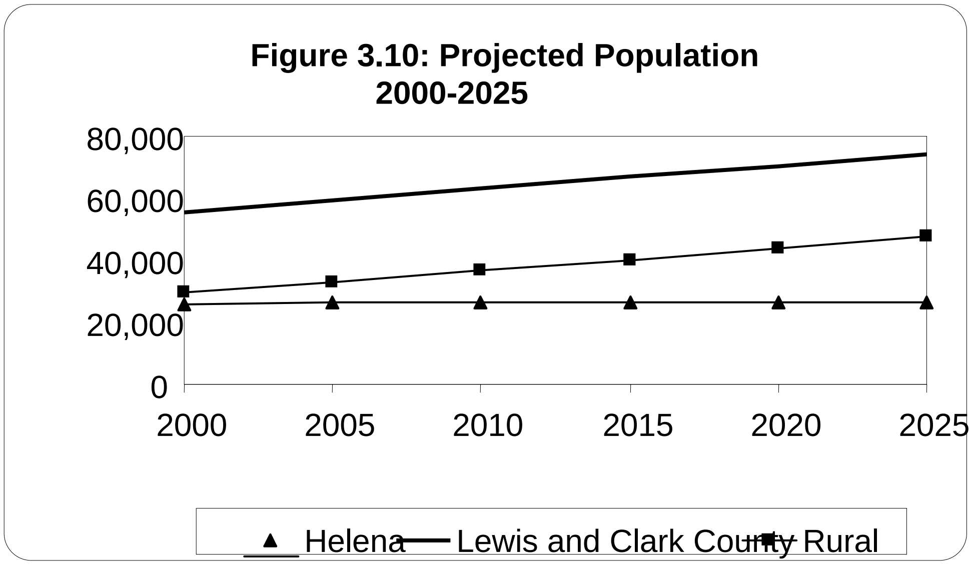


expected to increase, and at a faster pace, particularly after 2012. Current annual death rates (calculated as average annual decrease in cohort size/thousand population aged 67-85) are about 50/1,000 today. The number of expected deaths was estimated by projecting this rate onto the present age structure of Lewis and Clark County.

The difference between current birth and death rates calculated by this method was adjusted to match the current, known rate of natural increase for Lewis and Clark County (5.4/1,000) estimated from Census data. Rates of natural increase were then estimated by making the same adjustment on estimates of future births and deaths. As a result, the rate of natural increase is expected to decline from the present 5.4 to 1.4/1,000 population by 2017.

Net migration typically constitutes the largest share of population growth, but predicting it is much less certain than birth/death rates. Future migration used in this study was based on past rates in Helena and in Lewis and Clark County. The projections (shown in Figure 3.10) were based on the average annual population increase from1980-2000, adjusted for expected changes in the natural birth/death rate. This 20-year span is similar to the long term used for this report and has the advantage of including periods of both faster and slower growth.

These estimates suggest that Lewis and Clark County will grow to more than 74,000 by 2025. If the recent annual growth of 1.6% were to continue, the population of the county would reach 83,000 by 2025.



Four things could affect migration and therefore overall projections of greater Helena and the balance of growth between incorporated and unincorporated areas:

- Performance of the economy in the future in relation to other locations which could constrain long-term growth

- Changes in living preference--as well as uncertainty in residential markets and environmental constraints--would could affect the attractiveness of the incorporated areas

- Effects of housing tenure and turnover on the growth of neighborhoods (concentrations of similar-aged families can make a big difference in neighborhood population counts, for instance, the departure of children from a neighborhood can create population losses and subsequent rebounds. Demographers estimate that neighborhoods gain one new student for every three homes sold after being in same ownership for over 20 years.)

- Public policies concerning annexation and land use, in addition to the financial capacity to build and maintain infrastructure, limit overall population density and help determine whether future growth will be in- or outside of city limits.

Income and Employment

Total personal income was $1,508,871,000 in the region in 2000, increasing to $1,644,697,000 in 2002. Table 3.5 shows total personal income and income/person (per capita income) for 2000-2002.

Table 3.5: Total Personal and Per Capita Income[1]

	2000		2001		2002	
	Total Personal (x1,000)	**Per Capita**	**Total Personal** (x1,000)	**Per Capita**	**Total Personal** (x1,000)	**Per Capita**
Lewis and Clark County	$1,424,378	$25,493	$1,485,204	$26,398	$1,550,400	$27,453
Broadwater County	$84,493	$19,317	$88,955	$20,212	$94,297	$21,436
Total	$1,508,871	$25,044	$1,574,159	$25,950	$1,644,697	$27,018

[1] Source: Montana Department of Commerce, Census and Economic Information Center, Historical Population Data, Counties, 2004.

Lewis and Clark County had 30,189 people in the civilian labor force in 2000 and Broadwater County had 2,129. The civilian labor force is people 16 years of age or older either employed or actively seeking employment, excluding those not seeking employment and those in the armed forces. Lewis and Clark County had 1,538 unemployed people in 2000 equating to an unemployment rate of 5.09%, while Broadwater County had 97 unemployed for an unemployment rate of 4.56%. Total for the two counties was 32,318 employed, 1,635 unemployed, with a total unemployment rate of 5.06%.

Private employment has accounted for 75% of jobs in Lewis and Clark County, 71% of jobs in Broadwater County. Since Helena is the state capitol, government jobs play a large role in Lewis and Clark County with 23% of the jobs in government and government enterprises, in comparison to 14% in Broadwater County. Farming plays an important role in Broadwater County. Fifteen percent of jobs are directly associated with farming compared to 2% in Lewis and Clark County.

Recreational Economy

Canyon Ferry Reservoir offers excellent fishing for rainbow trout, perch, ling, and walleye. Concrete boat ramps, campgrounds, day-use areas, shelters, swimming, and three marinas are available for recreational use.

The reservoir is one of the best in the country for viewing bald eagles in the fall and winter. The Canyon Ferry WMA at the south end is managed by MFWP and is home to a colony of terns and pelicans. Barrow´s Goldeneye winter along the Missouri. Upland areas around the reservoir provide habitat for chestnut-collared longspurs and long-billed curlews as well as pronghorn antelope.

The 518-surfaceacre HVRR adjoining Helena and 3.5 miles west of Canyon Ferry Dam, offers fishing for kokanee salmon. The six miles of shoreline includes picnic shelters and other primitive improvements.

Agricultural Economy

Canyon Ferry Reservoir stores water for irrigation in the upper Missouri River basin. Full irrigation development provides for more intensive land use and greater diversification through the production of potatoes, alfalfa, grain, and irrigated pasture. Livestock are mostly cattle.

Prime and Unique Agricultural Land

Prime farmland, as defined by the U.S. Department of Agriculture (1993), is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

Much of the irrigated lands in the HVID and TID are categorized as prime farmland, unique farmland, or farmlands of local or state importance. In many instances, these lands would not meet the criteria if they were not irrigated. For definitions of the other classifications of farmland, readers should consult the *Soil Surveys of Broadwater County* (1977) and *Soil Survey of Lewis and Clark County Area* (2003).

Water Conservation

Section 210(b) of the Reclamation Reform Act of 1982 requires "each district that has entered into a repayment contract or a water service contract pursuant to Federal Reclamation law…shall develop a water conservation plan which shall contain definite goals, appropriate water conservation measures, and a time schedule for meeting the water conservation objectives." According to Reclamation *Directive and Standards*, water conservation plans are to be updated and submitted every five years, beginning in 2001. Both HVID and TID are required to complete water conservation plans.

Noxious Weeds

Noxious weeds are weeds capable of rapid spread and render lands unfit for beneficial uses or greatly limit beneficial uses. The Montana State Noxious Weed List, maintained by the Montana Department of Agriculture under the County Noxious Weed Control Act (Montana Department of Agriculture, 2001) lists noxious weeds under three categories: Category 1 – Currently established and generally widespread in many counties; Category 2 – Recently introduced and rapidly spreading; and Category 3 – Not detected in Montana or found only in small, scattered, localized infestations. The list is updated as necessary.

HVID contracts weed management to a private applicator. They have a weed management plan on file with the Lewis and Clark Weed District. TID manages noxious weeds on district lands with district personnel.

Cultural Resources

Cultural resources are the physical remains of a people's way of life that archaeologists and historians study to try to interpret how those people lived. Federal historic preservation laws protect and promote scientific study of cultural resources, specifically historic properties. Historic properties are defined as ". . . any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior." Examples of historic properties that might be located in the area affected by the water service contracts include prehistoric archaeological sites such as tipi rings, bison kills, or camp sites and historic period sites such as homesteads, mines, or bridges.

Federal agencies are required to comply with provisions of the National Historic Preservation Act (NHPA) and other laws and executive orders regarding cultural and trust resources. The NHPA requires Reclamation identify any historic properties that might be affected by the proposed water contracts and consult with the State Historic Preservation Officer, Native American tribes, interested parties, and the public regarding any effects to historic properties.

Before identifying historic properties, Reclamation must first determine the area of potential effects (APE) defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." Reclamation has determined that the APE includes areas served by HVID and TID. However, Reclamation has determined that the APE does not include areas served by Helena. This determination is based on discussions with Helena staff and studies conducted by Helena that indicate the availability of water will not drive population growth in and around Helena, and that the population will grow regardless of the source of water.

Indian Sacred Sites

Executive Order No. 13007 requires that each agency of the Executive Branch will to the extent possible accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and avoid adversely affecting the physical integrity of such sites. The order applies only to federal lands.

Reclamation has contacted the tribes regarding sacred sites on Reclamation-managed lands in the Helena and Townsend valleys. No Indian Sacred Sites have been reported for federal lands associated with the Proposed Action.

Indian Trust Assets

Indian Trust Assets (ITA) are defined as "legal interests in property held in trust by the United States for Indian Tribes or individuals". ITAs are properties, interests, or assets of an Indian tribe or individual over which the Federal government has a fiduciary interest either administratively or through direct control. Examples of ITA's include lands, minerals, timber, hunting rights, fishing rights, water rights, in-stream flows, and other treaty rights. No ITA's have been identified in the area.

Environmental Justice

Executive Order 12868 requires Federal agencies to identify and address “disproportionately high and adverse human health and environmental effects of its programs, policies, and activities on minority populations and low-income populations.” CEQ guidance recommends that environmental justice be evaluated using three criteria:

- Whether impacts are significant or above generally-accepted norms;
- Whether the proposed program, policy, or activity poses a significant environmental hazard to a minority or low-income population that appreciably exceeds the risk to the population in general; and
- Whether impacts, when combined with effects of other projects, pose a cumulative environmental hazard to a minority or low-income population.

Chapter 4
ENVIRONMENTAL CONSEQUENCES

This chapter analyzes effects of the alternatives described in Chapter 2. Effects of the No Action Alternative are presented first followed by the Proposed Action. The chapter concludes with a section on cumulative impacts of the alternatives.

Hydrology

No Action Alternative

Missouri River between Canyon Ferry Reservoir and Broadwater-Missouri Diversion Dam

There are no changes in flows in the river upstream of Canyon Ferry Reservoir under the No Action Alternative compared to current conditions.

Canyon Ferry Reservoir

This alternative would provide the TID with its full contracted supply and water for 810 acres currently served with temporary contracts. The volume of water pumped at the Crow Creek Pumping Plant would not change from current conditions, would not affect the volume of water flowing into Canyon Ferry Reservoir, and would not affect reservoir elevations or releases.

HVID would continue to receive their full supply along with water necessary to supply lands currently being irrigated through temporary contracts and other long-term water service contracts. Reclamation assumed Helena would use their full contracted supply of 5,680 AF from Canyon Ferry Reservoir through HVRR by 2044.

Helena Valley Regulating Reservoir

In the No Action Alternative, HVID would receive a full supply to irrigate 15,608 acres under a long-term water service contract, 1,324 acres under temporary contracts, and 899 acres under other Reclamation long-term contracts. Reclamation also assumes an additional 2,980 AF would be provided to Helena by 2044. The hydrology model shows that HVRR fall water elevations would be 3.9’ higher than current conditions because HVRR would be filled in the fall to accommodate Helena’s anticipated demand.

Because operations under the No Action Alternative would be similar to current operations, Reclamation assumed nesting migratory birds would be adversely impacted in this alternative. Since these impacts may violate the Migratory Bird Treaty Act (MBTA), Reclamation assumed HVID would implement measures to avoid and/or minimize these impacts. Reclamation believes it is reasonably foreseeable that HVID would implement the following operational scenario to avoid violations of the MBTA.

By the end of March and through June when possible, HVID would fill HVRR to elevation 3,820.1 (10,500 AF).

By the end of July, HVRR would be filled to elevation 3,815.0 (8,044 AF).

By the end of August, HVRR would be filled to elevation 3,812.0 (6,833 AF).

By the end of September, HVRR would be filled to elevation 3,820.1 (10,500 AF).

Small Streams

Since HVID will be operated in a manner similar to current conditions, there would no change in flows in Prickly Pear, lower Tenmile, or Silver creeks compared to current conditions.

Warm Springs Creek would likely continue to receive return and waste flows from TID. Channel degradation would be expected to continue; however, Reclamation would likely continue working with TID to improve conditions.

Helena would continue to use water from the Tenmile Creek watershed to supplement water provided through Canyon Ferry Reservoir and HVRR. Tenmile Creek would continue to experience low flow and/or dewatered conditions during portions of the year.

Groundwater and Domestic Wells

The volume of water supplied to HVID and TID would remain similar to current conditions. Groundwater elevations would not be expected to change from current conditions. Groundwater elevations in the Helena Valley may increase as Helena converts domestic wells to treated water.

Proposed Action Alternative

Missouri River between Canyon Ferry Reservoir and Broadwater-Missouri Diversion Dam

There would be no changes in flows in the river upstream of Canyon Ferry Reservoir compared to the No Action Alternative.

Canyon Ferry Reservoir

Inflows to Canyon Ferry Reservoir would be the same as in the No Action Alternative. Providing water for 412 acres of lands not currently being irrigated would require 1,240 AF from Canyon Ferry Reservoir through HVRR. Helena’s demand would require an additional 5,620 AF from Canyon Ferry Reservoir through HVRR.

Table 4.1 displays the effects of the Proposed Action Alternative on average EOM elevations at Canyon Ferry Reservoir.

Table 4.1
Canyon Ferry Reservoir
Average EOM Elevation in Feet

	No Action	Proposed Action	Difference (feet)
January	3787.3	3787.2	-0.1
February	3786.4	3786.4	0.0
March	3786.7	3786.6	-0.1
April	3780.4	3780.4	0.0
May	3781.4	3781.5	0.1
June	3794.9	3794.9	0.0
July	3795.8	3795.8	0.0
August	3791.3	3791.2	-0.1
September	3788.8	3788.5	-0.3
October	3788.2	3788.0	-0.2
November	3788.9	3788.8	-0.1
December	3788.7	3788.6	-0.1

The difference in the average releases from Canyon Ferry Reservoir range from a decrease of 2,800 AF (0.1 %) in May to an increase of 5,100 AF (1.9 %) in September. The difference in releases is relatively small compared to releases expected under the No Action Alternative and would have no adverse impacts on flows in the Missouri River downstream of the dam. Table 4.2 displays the effects of the Proposed Action on average monthly releases from Canyon Ferry Reservoir.

Total releases from Canyon Ferry Reservoir represent all of the discharges through the facility for each month. This would include releases to the HVPP turbines, spills, power releases, and operational releases for downstream demands.

Helena Valley Regulating Reservoir

Demands for water from HVRR were adjusted to include an additional 412 acres of lands not currently irrigated and Helena's total demand of 11,300 AF/year. Additionally, HVID and the Service agreed to work cooperatively to try to maintain stable reservoir elevations during water bird nesting season. Some operational constraints were established to ensure enough water would be delivered from Canyon Ferry Reservoir to meet the needs of HVID and Helena. The following plan accommodates these operational elements.

By the end of March and through June when possible, HVID would fill HVRR to elevation 3,820.1 (10,500 AF).

By the end of July, HVRR would be filled to elevation 3,815.0 (8,044 AF).

By the end of August, HVRR would be filled to elevation 3,812.0 (6,833 AF).

By the end of September, HVRR would be filled to elevation 3,820.1 (10,500 AF).

Table 4.2
Canyon Ferry Reservoir
Average Total Reservoir Release in AF

	No Action	Proposed Action	Difference
January	252,900	250,900	-2,000
February	226,600	224,400	-2,200
March	248,300	252,900	4,600
April	526,100	535,400	-7,00
May	564,900	562,100	-2,800
June	541,200	542,400	800
July	344,400	344,700	300
August	286,400	286,600	200
September	267,700	272,800	5,100
October	240,500	238,700	-1,800
November	232,900	231,100	-1,800
December	215,600	215,600	0

It was assumed the maximum diversion from the HVPP would be 21,421 AF in June and 22,135 AF in July and August. If the volume of water necessary to fill HVRR to the desired target elevation was greater than pump and canal capacity, the maximum volume would be delivered and HVRR would be drawn down according to demand.

Figure 4.1 displays the average differences in EOM elevations between No Action and the Proposed Action alternatives at HVRR.

Surface elevations are lower in winter because of increased Helena demand and because the HVPP does not operate year round. Once the HVPP is shut down in October, no water would be diverted from Canyon Ferry Reservoir to HVRR.

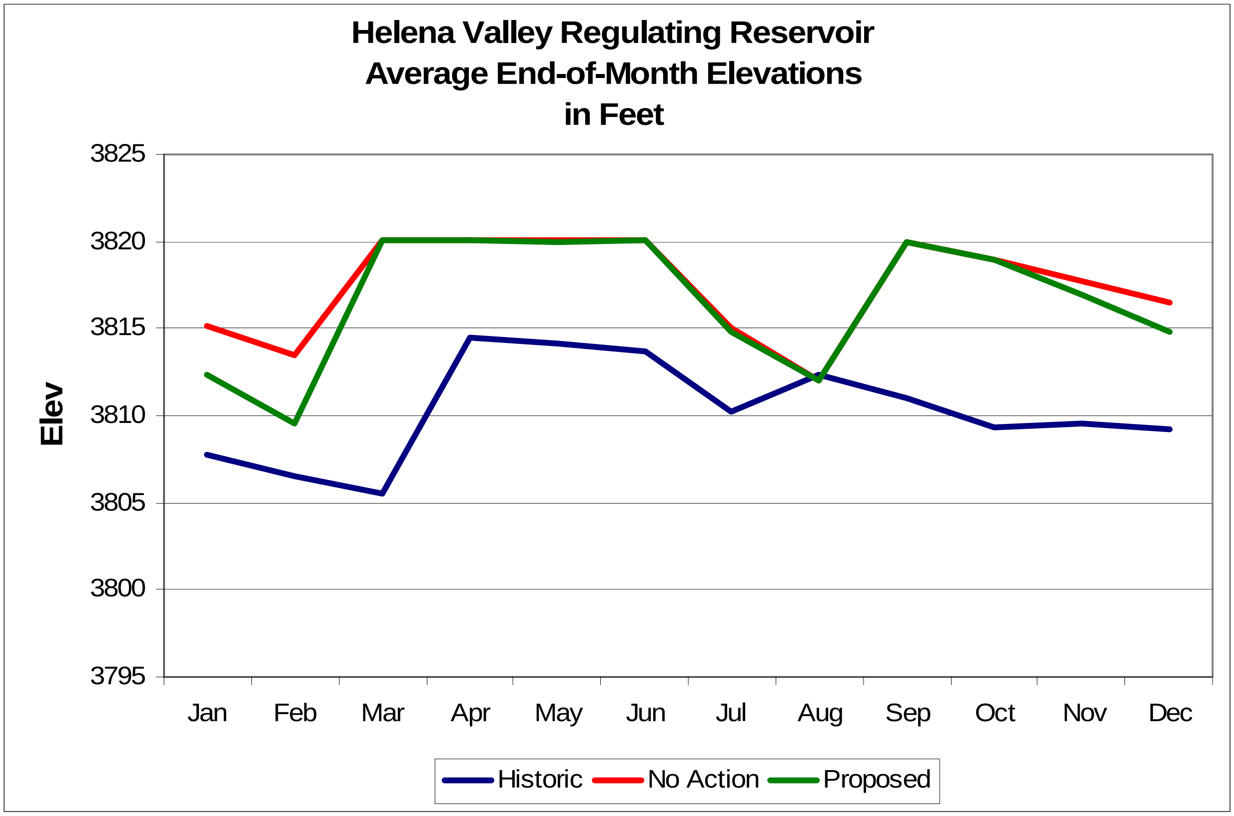
Small Streams

Because of increased return flows from lands not currently irrigated, flows would increase less than 0.1 % in Prickly Pear and lower Tenmile creeks. Reclamation anticipates cooperative efforts with TID would reduce waste and return flows to Warm Springs Creek. It is not possible to determine whether Silver Creek would be affected.

Groundwater and Domestic Wells

The volume of water supplied to HVID would increase slightly. TID would receive the same volume of water. Groundwater elevations in the Helena Valley may increase as Helena converts domestic wells to treated water.

Figure 4.1



Water Quality

No Action Alternative

Canyon Ferry Reservoir and HVRR would continue to be operated in a manner similar to current conditions. Current water quality trends and conditions are expected to continue.

Canyon Ferry Reservoir/Missouri River
Above Canyon Ferry Reservoir

Reclamation assumes that naturally-occurring arsenic levels in the Missouri River and in Canyon Ferry Reservoir would not substantially vary from values measured for the period of record. Arsenic concentrations in the Madison River where it leaves Yellowstone National Park range from 120 to 380 ppb. Elevated arsenic concentrations persist downstream and into the Missouri River. Arsenic concentrations below Canyon Ferry Dam range from 22 to 34 ppb. Because sources of arsenic in the Missouri River are produced by natural sources, it is expected that arsenic load and concentrations in the Missouri River and in water diverted from Canyon Ferry Reservoir would not change.

Helena Valley

Some aquatic invertebrates, fish, and water birds from the Helena Valley have elevated concentrations of arsenic, cadmium, copper, lead, and zinc. However, only a few samples had concentrations high enough to indicate biological risk. Trace-element concentrations in water bird livers, as well as organochlorine residues in young and old fish, pose no threat to the overall health of these organisms or to higher food web consumers. Based upon current data, information, and trends, Reclamation is unable to determine whether concentrations will reach levels indicating biological risk or whether high concentrations will become more widespread.

Under this alternative, irrigation water containing arsenic from the Missouri River would continue to be applied to lands in the HVID. Based on studies conducted by Mangelson and Brummer (1994), Reclamation believes arsenic concentrations in these soils has reached an equilibrium with the volume of arsenic applied to the soil being lost to volatilization to the atmosphere and sorbtion to soil particles.

In contrast, cadmium concentrations in invertebrates may pose a threat to higher food web consumers. Also, cadmium and lead concentrations in some fish from this area exceeded concentrations considered potentially-harmful to higher food web consumers if consumed on a sustained basis. Under this alternative, Reclamation assumes this condition will continue, but is unable to determine whether concentrations will increase or whether high concentrations will become more widespread.

Helena Valley Groundwater

In the western part of the HVID where shallow alluvial aquifers are the main source of drinking water, infiltrated irrigation water containing arsenic apparently is either diluted by regional groundwater or is hydraulically prevented by the horizontal movement of shallow alluvial groundwater from moving deeper into the aquifer. Some arsenic may also sorb to aquifer material.

The net result of these processes is that arsenic concentrations in most domestic wells in western Helena Valley alluvial aquifers are much lower than drinking water standards. Based upon present data, information and trends, Reclamation is unable to determine whether groundwater used for domestic consumption, partly recharged by irrigation water, would pose a public health risk in the western part of HVID in the future under this alternative.

In the eastern part of HVID where the aquifer is located in deeper Tertiary sediments, samples from two deep (100-foot and 180-foot) wells had arsenic concentrations of 22 and 17 ppb, respectively. Relatively few wells are drilled into Tertiary sediments in the eastern part of HVID. Because of the greater depth to groundwater in the eastern part of HVID, Reclamation believes it is unlikely irrigation water is contributing to arsenic levels in domestic wells.

Helena Valley Regulating Reservoir

Based upon current information, Reclamation is unable to determine whether arsenic, cadmium, lead, or zinc concentrations in water bird livers using HVRR would increase to levels that would threaten water bird health in the future. Arsenic and copper concentrations are likely to continue to be elevated; however, it is not known whether concentrations would reach a level that would indicate chronic or acute toxicity and/or reproductive impairment. Threats to water bird health due to elevated copper concentrations could not be determined because risk levels have not been established for copper in water bird livers.

Lake Helena

Arsenic concentrations at all sites sampled in Lake Helena were lower than HVID's water supply (inlet canal) from the Canyon Ferry Reservoir and the measured concentrations were well below the EPA and Montana DEQ aquatic life chronic criterion. Arsenic inputs would continue, and concentrations may increase in the future under this alternative.

Pesticide concentrations in Lake Helena are currently well below MCL standards, and many did not exceed detection levels. Reclamation does not have analytical methods available to model and predict future pesticide levels in Lake Helena.

Montana DEQ is currently developing a TMDL water quality restoration plan for the greater Lake Helena watershed that is scheduled to be completed in late 2004. Under DEQ leadership and direction, the next step in the TMDL process will be development of pollution allocations, the actual TMDLs, a restoration strategy, and a long-term monitoring plan. TMDLs will be developed for sediment, nutrients, metals, and water temperature and will be expressed as acceptable loads, or reductions in loads, or the pollutants of concern. TMDLs, required to consider all significant sources of pollution including natural background sources, will include a margin of safety to account for any uncertainty in underlying assumptions.

Lake Helena Bottom Sediment

Concentrations of several trace elements are higher in Lake Helena bottom sediment than in soil samples collected from Helena Valley indicating some trace elements may be accumulating in Lake Helena bottom sediment. It is likely that concentrations of trace metals will continue to accumulate in Lake Helena bottom sediments.

Tenmile Creek and Other Steams

Arsenic from historical mining in the Tenmile Creek drainage is most likely the primary source of arsenic to surface and groundwater in the Tenmile Creek watershed. (Kendy et al. 1998). Hot springs discharge arsenic into Tenmile Creek (Leonard et al. 1978). Increasing arsenic loads with decreasing flows during the irrigation season indicate that other non-irrigation sources of arsenic are contributing to arsenic loads and concentrations. Arsenic will continue to be discharged into Tenmile Creek contributing to floodplain and groundwater concentrations.

Segments of Tenmile and Prickly Pear creeks were identified in 2002 as part of the TMDL water quality restoration plan for the greater Lake Helena watershed. Reclamation has no specific information to indicate whether the impaired segments would improve or be further impaired although successful TMDL plan implementation could contribute to a long-term water quality improvement.

Return flows would continue to be diverted to Warm Springs Creek in TID. Channel degradation and increased sediment transport and deposition would continue. Reclamation would likely continue to work with TID to address these issues.

Toston Irrigation District
Under this alternative, irrigation water containing arsenic from the Missouri River would continue to be applied to lands in the TID. Based on studies conducted by Mangelson and Brummer (1994), Reclamation believes arsenic concentrations in these soils has reached an equilibrium with the volume of arsenic applied to the soil being lost to volatilization to the atmosphere and sorbtion to soil particles. As a result of changing from flood irrigation to primarily sprinklers, less arsenic-bearing water percolates to groundwater because sprinklers apply smaller volumes of water to crops that would increase the probability that arsenic is volatilized or sorbed.

Proposed Action
Canyon Ferry Reservoir and the districts would continue to function in a manner similar to the No Action Alternative. This alternative would result in water quality impacts similar to those described for the No Action Alternative. However, increased return flows from additional irrigated acres in HVID under this alternative may result in an increase of up to 0.1 % in Prickly Pear Creek. The additional flow would likely be used by irrigators with senior water rights.

There would be no effect on water quality in Warm Springs or Silver creeks.

Fisheries

No Action Alternative
Under this alternative, Canyon Ferry Reservoir would continue to be operated similar to current conditions. Reclamation assumed current fisheries management and trends would continue.

Missouri River: Broadwater-Missouri Diversion Dam to Canyon Ferry Reservoir
This reach of the river would continue to provide naturally-reproducing brown and rainbow trout fisheries as well as provide spawning habitat for the Canyon Ferry Reservoir system trout fishery. The value of Warm Springs Creek may continue to be limited by current return flow issues. Reclamation assumed the current trends of increasing rainbow trout over 18 inches and decreasing brown trout would continue. The quantity and quality of spawning habitat available to fisheries would be similar to current conditions.

Canyon Ferry Reservoir
Management of Canyon Ferry Reservoir would continue to be maintained by stocking rainbow trout that would remain relatively stable if effects of an increasing walleye population could be managed. Efforts to encourage yellow perch recruitment would continue to provide forage for other species as well as a sport fishery. The increasing

walleye trend would probably continue but might stabilize if management actions were successful. Tributaries would continue to provide some spawning habitat for trout species at about the current level.

Hauser Reservoir and Tributaries
Current stocking and management would continue to provide a kokanee-trout-walleye-perch fishery similar to current conditions. The kokanee fishery would probably continue to fluctuate in response to such things as fisheries management and water conditions. Current management of brown trout would likely continue to provide a trophy fishery.

Under the No Action Alternative, Tenmile Creek would continue to be the primary water source for Helena and would continue to be subject to the current water quality problems that inhibit its ability to support fisheries. Under this alternative, these problems would continue and likely worsen as City demands increased over time resulting in flow reduction of 27%. Prickly Pear Creek would also continue to suffer chronic dewatering and continue to be a poor trout production creek.

Helena Valley Regulating Reservoir
HVRR would operate as described in the Hydrology section. The reservoir would probably continue to be managed by MFWP as a put-grow-take kokanee fishery. The fishery trends would probably continue with fluctuating kokanee and yellow perch populations. Unknown quantities of fish, likely equal to current losses, would continue to be entrained in the canal and probably transferred through the system to Lake Helena and eventually Hauser Reservoir. Retention times would be similar to current conditions with the only change being attributed to additional water taken by Helena. Figure 4.5 shows retention times for the historic record along with the No Action and Proposed Action alternatives.

The No Action Alternative assumes Helena's water use would continue to increase until Helena uses its entire presently-contracted volume of water. Currently, Helena only uses an average 2,700 AF/year. The hydrology model shows that HVRR fall water elevations would be about four feet higher than current because the reservoir would be filled in the fall to accommodate Helena's full needs. This higher winter elevation might increase overwinter survival of kokanee but might reduce ice-fishing success due to fish being spread out through more water.

Missouri River: Hauser Dam to Holter Reservoir
The Blue Ribbon trout fishery in this river reach would remain similar to current conditions.

Missouri River Downstream of Holter Reservoir
Flows below Holter Reservoir would probably not be noticeably different than they are currently. The fishery should remain a salmonid fishery to about Great Falls then transition to a warm-water fishery dominated by smallmouth bass and walleye down to about the Marias River. From the Marias River to the upper end of Ft. Peck Reservoir,

the native-dominated warm-water fishery would be expected to continue near current populations and trends.

Proposed Action

Under this alternative, the only element that would be expected to affect fisheries would be any change in the hydrograph or operations that could affect water quality (particularly temperature or dissolved oxygen), productivity, retention time, or reservoir levels. Reservoir fisheries would be affected if water levels were changed, and fisheries downstream of Canyon Ferry Dam could be affected if releases from the reservoir were changed. Hauser and Holter reservoirs are *run-of-the-river* reservoirs with about the same volume of water flowing in as is released. Because these reservoirs receive water from Canyon Ferry Reservoir, the fisheries in the entire system downstream of Broadwater-Missouri Diversion and Canyon Ferry dams would be affected if the operation of Canyon Ferry Reservoir changed. HVRR and Hauser Reservoir fisheries would also be affected by operational changes of the HVID system.

Canyon Ferry Reservoir elevation modeling shows that the reservoir would be expected to be slightly lower in low- to average-flow years with an average EOM elevation of less than a tenth of a foot lower than present and a maximum EOM elevation difference of 0.3’. In high-flow years, the water level would increase or decrease up to 0.1’ monthly with an average of no change. This means elevations would be essentially unchanged from current levels. These slight changes would have little or no biological effect (Ron Spoon, pers. comm. 2004).

Due to more water use proposed by Helena, there may be minor changes in releases from Canyon Ferry Reservoir by 2044 that were assumed to flow through Hauser and Holter reservoirs without further regulation. Holter Reservoir releases were modeled to show changes to the Missouri River system downstream. These slight changes would be expected to have little, or no, biological effect. The expected releases from Holter Reservoir in dry, average, and wet years are shown in Figures 4.2, 4.3, and 4.4, respectively.

Figure 4.2

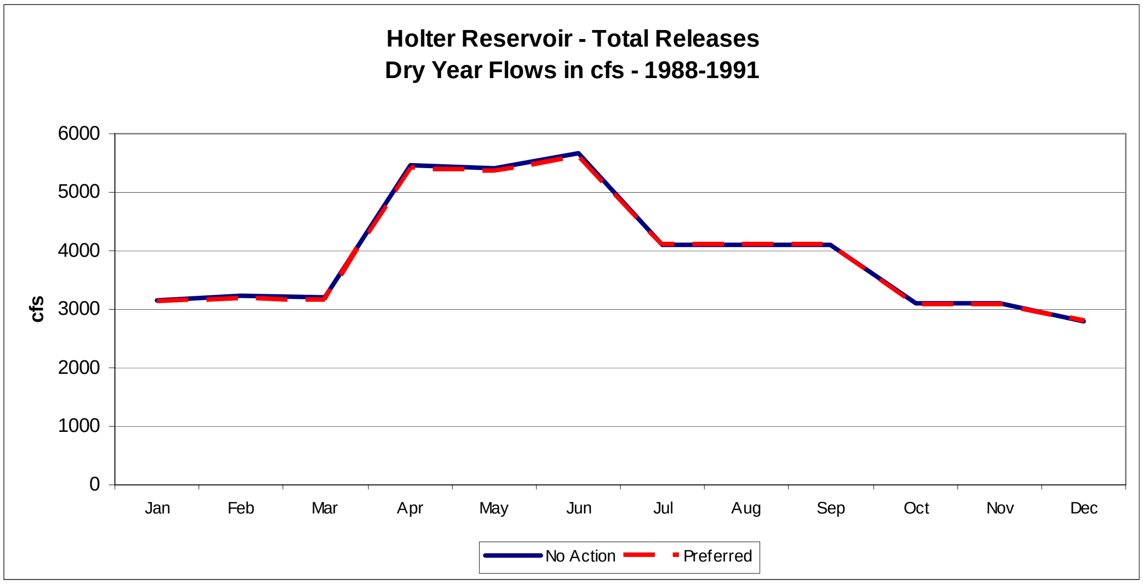


Figure 4.3

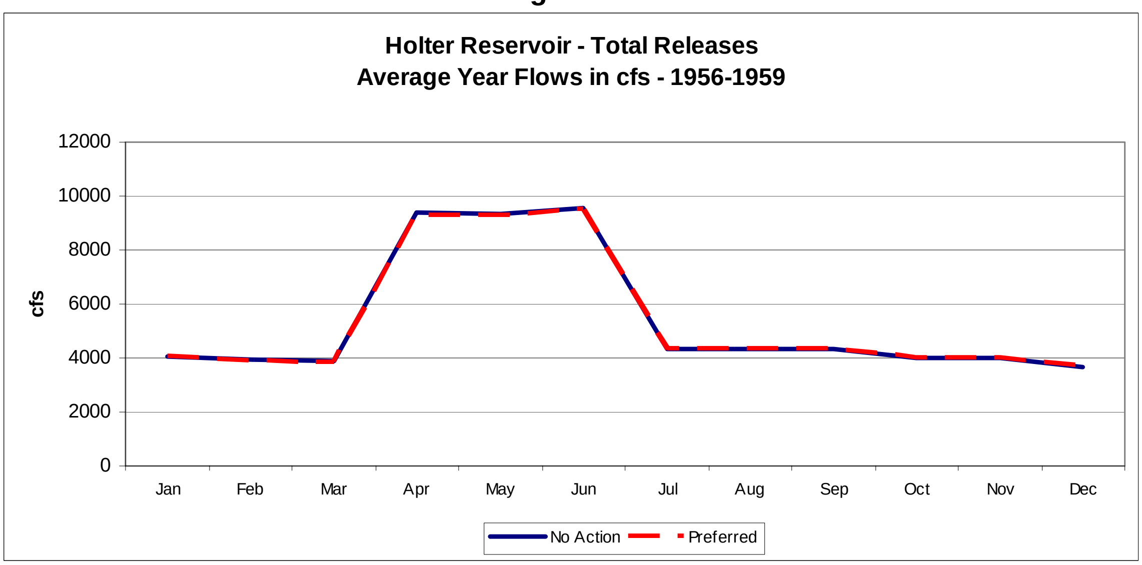
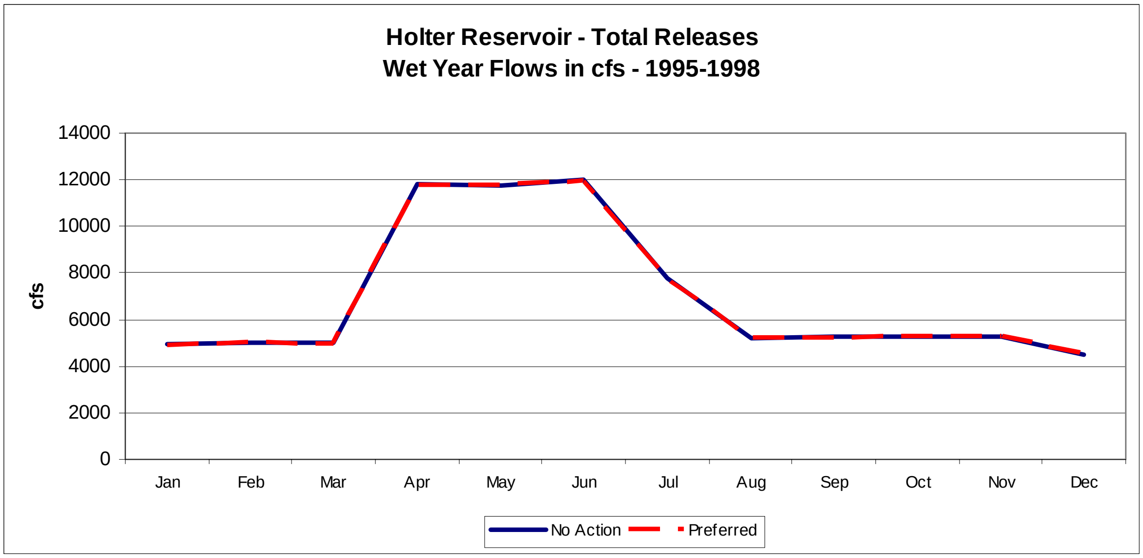


Figure 4.4



Missouri River: Broadwater-Missouri
Diversion Dam to Canyon Ferry Reservoir

Flows in the Missouri River from Broadwater-Missouri Diversion Dam to Canyon Ferry Reservoir would be the same as flows under the No Action Alternative. No new water use is proposed. This reach of the river would continue to provide naturally-reproducing trout and provide rearing habitat for Canyon Ferry Reservoir trout. Reclamation and TID would continue to investigate measures to improve return flows currently limiting the fishery potential of Warm Springs Creek.

Canyon Ferry Reservoir

The minor change to the hydrology under this alternative would not be expected to appreciably change the water quality, productivity, or spawning habitat available for fisheries. Current management actions would be expected to continue, and current population trends would be expected.

Hauser Reservoir and Tributaries

The small change in releases from Canyon Ferry Reservoir would not be expected to diminish fisheries in Hauser Reservoir. The reservoir would continue to support a multi-species fishery that would remain similar to the No Action Alternative. HVID operation would be the same as No Action because inclusions are already irrigated by temporary contracts.

Prickly Pear Creek would continue to provide drainage for HVID return flows to Hauser Reservoir through Lake Helena at about the same rate as the No Action.

Tenmile Creek, currently Helena's main water supply, would become a secondary source under this alternative. Flows remaining in the creek could alleviate the water quality problems by dilution. Flows would be increased by 27% annually. Helena, MFWP, and EPA are discussing means to protect the increased flow. With adequate flows and improvement in water quality, upper Tenmile Creek could be rehabilitated into a quality trout stream.

Helena Valley Regulating Reservoir

The operation of HVRR would not change under the Proposed Action. Water would be pumped to HVRR in the spring to fill the reservoir and continually pumped throughout the summer as water demands for both HVID and Helena increased. The reservoir level would be expected to drop through July and August as demands exceed inflows into HVRR. Once irrigation demands decreased in the fall, HVRR would then be filled again to make water available for Helena to use during the winter. It is important to remember these changes were modeled on Helena's projection of demand in 2044. These changes would not be effective immediately; rather, they would be phased in as demand increases over time.

Primary indicators of effects to the HVRR kokanee fishery are water levels and retention time. By 2044, HVRR could be expected to reach a low of elevation 3809.6 during the winter before refilling in the spring. Although lower than in No Action, this level is well within the range of current operations that have supported the fishery in the past. The historic average low elevation is 3,805.5. This alternative would result in little or no effect to the kokanee fishery as a result of winter water levels (Steve Dalbey, pers. comm. 2004).

Mean monthly retention time was modeled for the Proposed Action and No Action alternatives for May through September for representative dry (2001), average (1999), and wet (1997) years. In most cases, retention time for the Proposed Action is expected to be identical to No Action. Most of the additional water under the Proposed Action is expected to be delivered in winter months when retention time would equal the entire non-irrigation season because there are no inflows. Retention times are displayed in Table 4.3.

Table 4.3

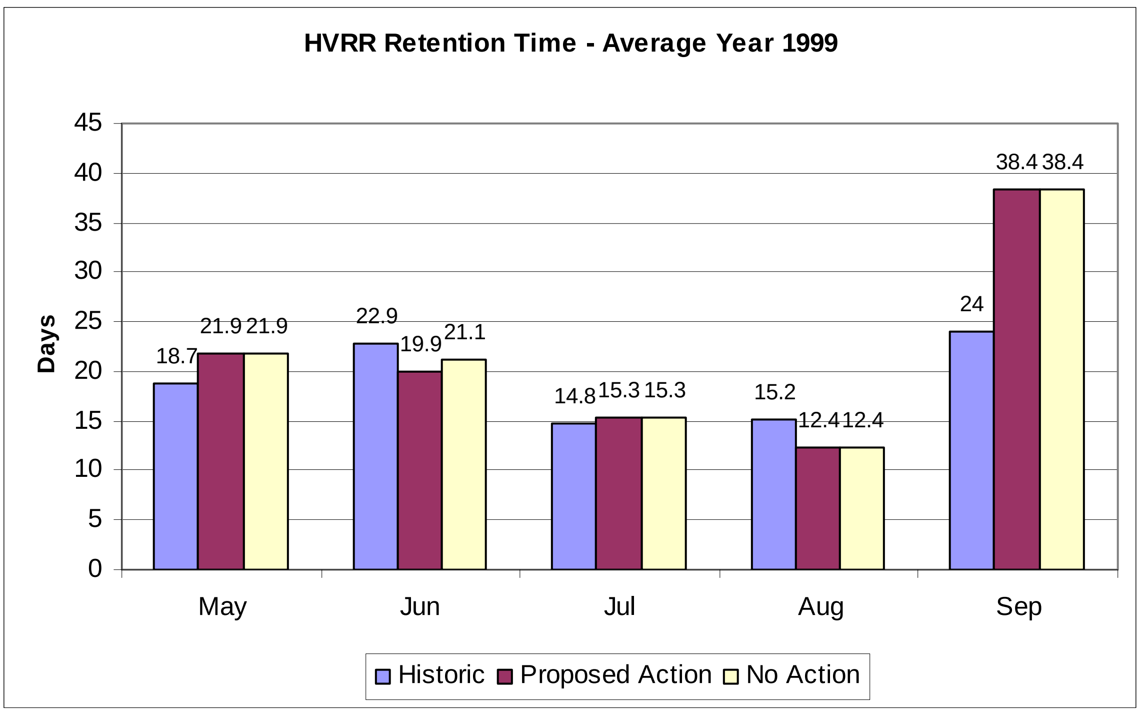
HVRR Retention Times (Days)

		May	June	July	August	September
Dry Year (2001)	Historic	18.3	23.9	19.6	17.0	19.2
	No Action	19.6	22.6	16.2	14.8	29.9
	Proposed Action	19.6	22.6	16.2	14.8	29.9
Average Year (1999)	Historic	18.7	22.9	14.8	15.2	24.0
	No Action	21.9	21.1	15.3	12.4	38.4
	Proposed Action	21.9	19.9	15.3	12.4	38.4
Wet Year (1997)	Historic	30.5	26.4	18.7	19.7	20.0
	No Action	31.0	25.4	15.1	16.4	31.0
	Proposed Action	31.0	25.4	15.1	16.4	31.0

The shortest retention times are in July and August for all water years as water is released to meet irrigation demands faster than it can be pumped in. The lowest overall values for July and August would be in an average year; however, retention time would be similar for No Action and Proposed Action. These are also critical growing season months for kokanee. Average year values for May, June, July, August, and September for No Action, Proposed Action, and historic are displayed in Figure 4.5.

Historic retention times are included for reference since it is presumed it was sufficient to support productivity necessary to provide food for kokanee growth. The No Action Alternative differs from historic because it is assumed Helena would increase demand to their contracted amount, so by 2044, the reservoir would be operated slightly differently than it has been historically. This difference in operation also accounts for considerably

Figure 4.5



higher retention times in September of each year because more water is pumped into HVRR than historically to provide water necessary to meet the increased Helena demand. This increased retention time in September would be beneficial if it increases forage base for kokanee.

There is no baseline information on productivity in the reservoir. Reclamation believes that the slight decrease in summer retention time would remain sufficient for production of phytoplankton for forage and would not likely affect the fishery. As part of this alternative, Reclamation has agreed to study baseline water quality, including productivity in HVRR. Such a study would facilitate future monitoring of reservoir conditions that may result from this alternative and help identify the need for any future corrective actions.

Another indicator of the health of the HVRR fishery is fish losses. Fish losses to the irrigation outlet would be expected to remain similar to the No Action Alternative. The extra water being delivered to Helena would be through their existing outlet that currently is not screened for fish but has a grate covering the opening. Fish have not been observed by Helena personnel at their screening site in the water treatment plant. As Helena changes operations in the future to receive more water from HVRR, increased velocities could attract kokanee to the intakes where they may become lost. Helena has stated it is willing to monitor and document current and future fish losses to establish a baseline against which to measure any changes in the amount of entrainment. If increased fish loss occurs, Helena will work with Reclamation and MFWP to install fish screens on the intakes.

Missouri River: Hauser Dam to Holter Reservoir
The trout fishery in this section would remain similar to No Action. Wild production and fishing regulations would continue to provide a trophy trout fishery. Kokanee and walleye flushed from Hauser Reservoir would continue to provide fishing opportunities.

Holter Reservoir
As another run-of-the-river reservoir, the fishery in Holter Reservoir would not be affected by the Proposed Action.

Missouri River Downstream of Holter Reservoir
The slight change in releases would not adversely affect downstream fisheries. The salmonid fishery downstream to Great Falls and the smallmouth bass/walleye sport fishery below Great Falls would remain similar to No Action. The native-dominated fishery below the Marias River may be affected if spills from Canyon Ferry Reservoir were appreciably reduced. However, analysis of hydrology for pallid sturgeon shows no measurable change in flows at Virgelle.

Wildlife

No Action Alternative
This alternative predicts conditions that would exist in the future if irrigation water was supplied to 17,831 acres in HVID and 6,489 acres in TID. This alternative also predicts conditions that would exist if Helena used 5,680 AF/year. Since Canyon Ferry Reservoir, HVRR, HVID, TID, and Helena would continue to operate in a manner similar to current conditions, it is expected that current wildlife habitat trends would continue.

Helena Valley Irrigation District
Table 4.4 contains EOM elevations for HVRR necessary to ensure an adequate supply of water to meet irrigation and M&I needs. Throughout the irrigation season, water levels

would fluctuate with daily irrigation demands and precipitation patterns. Water levels would be brought up to about elevation 3820.1 in April, and they would typically drop to elevation 3,812 by the end of August. Following irrigation season, deliveries from the HVPP would refill the reservoir to elevation 3,820.1. Evaporation, seepage, and water deliveries to Helena would then gradually bring water levels down to approximately elevation 3,813.5 by March. It is anticipated that effects to the riparian buffer and wetlands associated with the HVRR during the growing season would be similar to current conditions. Cottonwood mortality is expected to continue as water levels exceed, and are maintained above elevation 3,819. Cottonwoods are expected to reestablish at slightly higher elevations around HVRR. The additional water delivered during the winter season, outside of the growing season, would have no effect on these areas

Table 4.4: EOM elevations in HVRR for the No Action Alternative (feet msl)

	Feb.	March	April	May	June	July	August	Sept	Oct
Wet Year (1997)	3813.5	3820.1	3820.1	3820.1	3820.1	3815	3812	3820.1	3818.9
Average Year (1999)	3813.5	3820.1	3820.1	3820.1	3820.1	3815	3812	3820.1	3818.9
Dry Year (2001)	3813.5	3820.1	3820.1	3820.1	3820.1	3815	3812	3820.1	3818.9

The quantity and quality of habitat at HVRR and HVID is expected to be similar to current conditions for species dependent upon riparian and upland habitat. It is assumed HVID would implement measures to avoid inundation of migratory water bird nests and violation of the MBTA.

Lake Helena Wildlife Management Area Under this alternative, wildlife habitat at the WMA would be similar to current conditions. Water would continue to be delivered through the existing infrastructure. No changes to wildlife habitat are expected.

Missouri River Above Canyon Ferry Reservoir/ Toston Irrigation District

Wildlife habitat near TID would remain similar to current conditions. Due to water conservation measures and consistent irrigation demand, the quantity and quality of wildlife habitat on TID lands would be similar to current conditions.

Canyon Ferry Wildlife Management Area

Wildlife habitat associated with Canyon Ferry WMA and the Missouri River would remain similar to current conditions.

Proposed Action

This alternative includes the acreage included in No Action and 412 acres of additional croplands in HVID. These acres would be converted from dry land farming to irrigated lands. No additional acreage would be included in TID. Additionally, the maximum quantity of water provided to Helena will be increased from 5,680 to 11,300 AF.

Helena Valley Irrigation District

HVID, Reclamation, and the Service have agreed to work cooperatively in managing water levels to benefit overwater nesting birds. To realize this benefit, HVRR will be filled to elevation 3,820 immediately following ice-out. This early fill will precede the arrival of nesting western and red-necked grebes and minimize nest establishment at lower elevations and future inundation. When possible, HVID will maintain water levels at or near 3,820' throughout May and June or until demands exceed input and the reservoir begins to draft. As a result of cooperative management, water level fluctuations will be less than for No Action. Figures 4.6-4.8 show fluctuations of the Proposed Action in an average water years compared to No Action.

Cottonwoods are expected to reestablish at slightly higher elevations. During the irrigation season and winter, HVRR would be managed for less fluctuation. Available habitat during the spring shorebird migration would be similar to No Action. Fall shorebird migration habitat would remain similar to conditions under No Action or slightly increase as fall progresses.

Figure 4.6: Graph comparing EOM water elevations (Average Year)

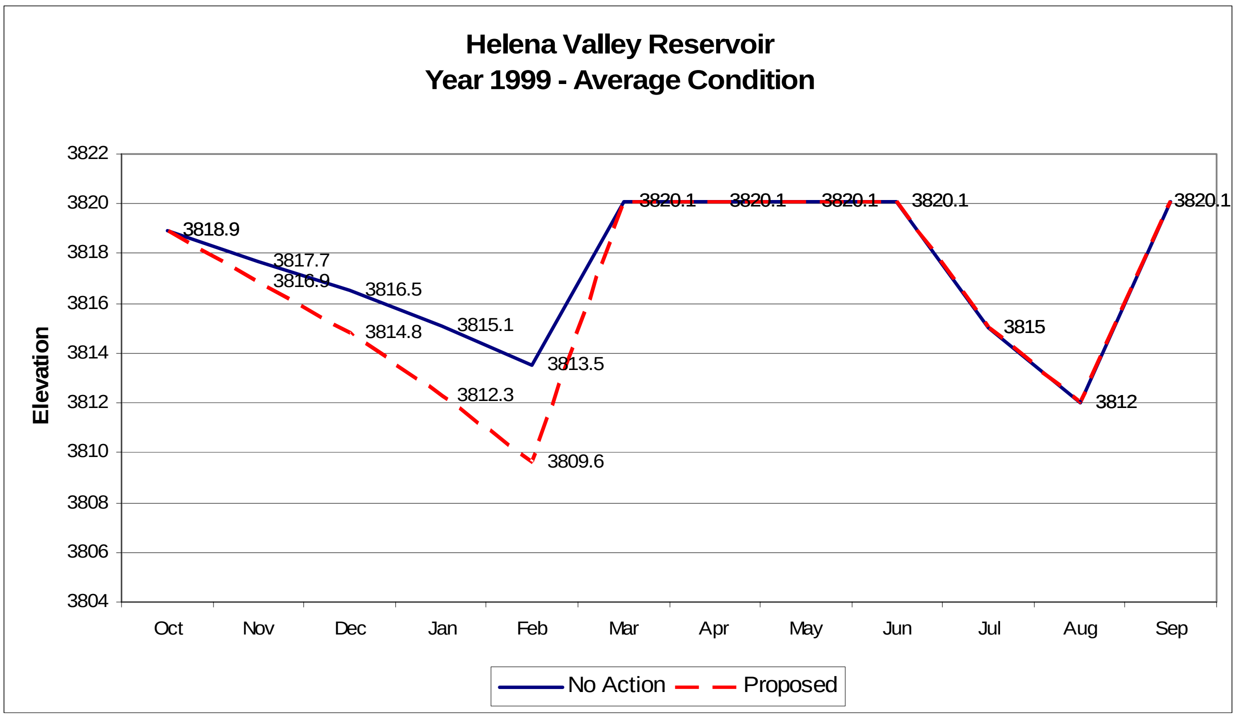


Table 4.5 shows average EOM reservoir elevations necessary to ensure an adequate supply of water to meet irrigation and M&I needs and minimize effects on nesting

Figure 4.7: Graph comparing EOM water elevations (Wet Year)

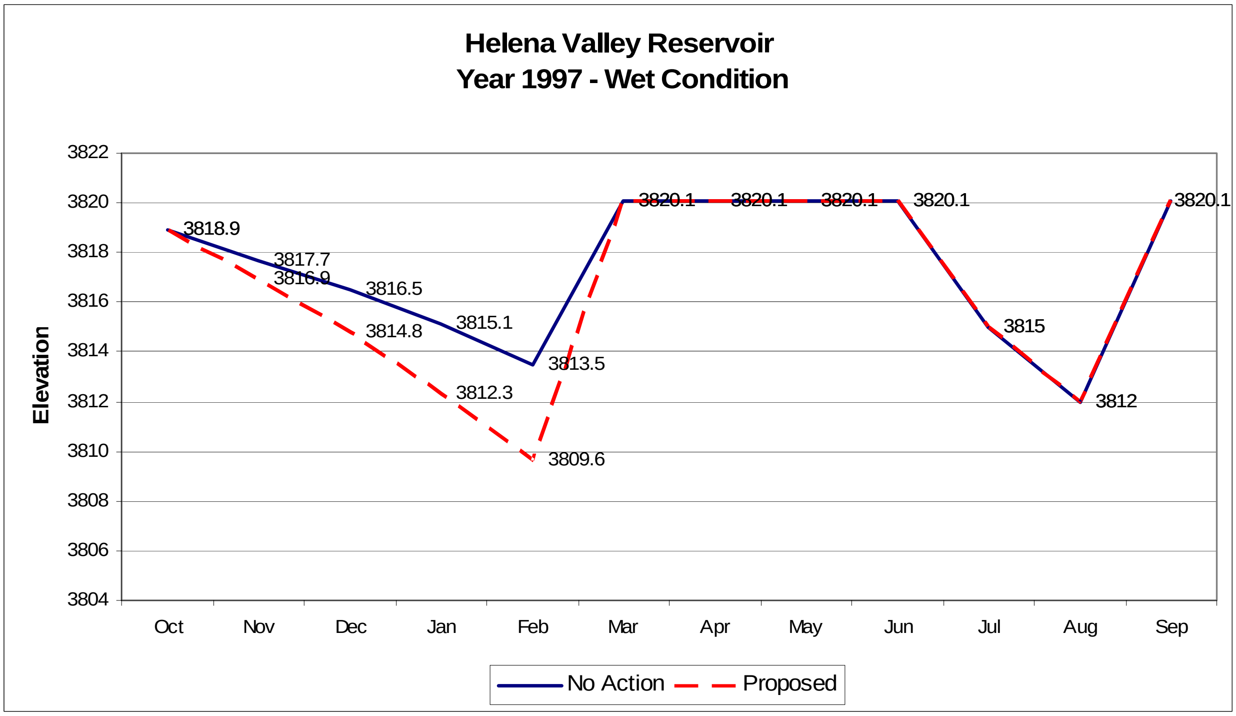
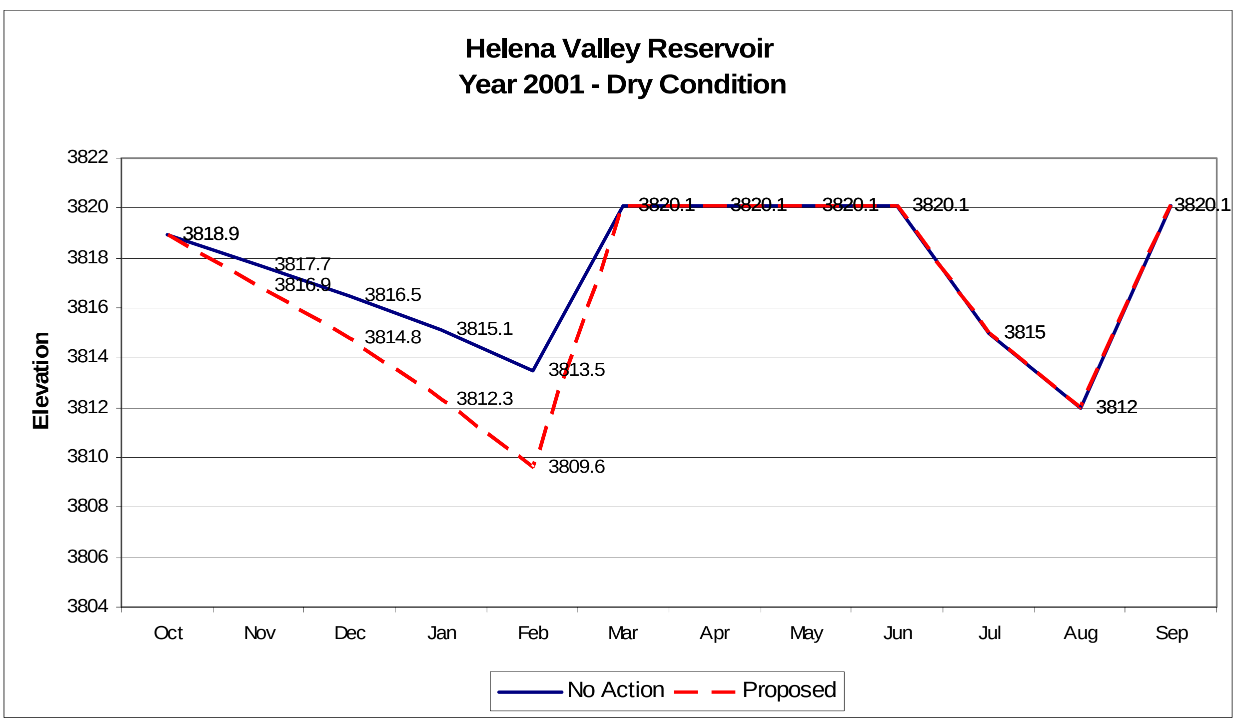


Figure 4.8: Graph comparing EOM water elevations (Dry Year)



waterbirds. Throughout the irrigation season, water levels would fluctuate as daily irrigation demands and precipitation patterns varied.

Table 4.2: EOM water elevations in HVRR for the Proposed Action Alternative

	Feb.	March	April	May	June	July	August	September	October
Wet Year (1997)	3809.6	3820.1	3820.1	3820.1	3820.1	3815	3812	3820.1	3818.9
Average Year (1999)	3809.6	3820.1	3820.1	3820.1	3820.1	3815	3812	3820.1	3818.9
Dry Year (2001)	3809.6	3820.1	3820.1	3820.1	3820.1	3815	3812	3820.1	3818.9

Table 4.6 shows the water elevation difference between the No Action and Proposed Action alternatives. The growing season generally begins near the end of April. Water elevations at that time would be the same as No Action. Water elevations in May through June would be the same as the No Action Alternative. Cottonwood mortality would be the same as No Action. It is expected that cottonwoods will reestablish at higher elevations. Cottonwood health will be monitored beginning in 2005 and in subsequent years to evaluate effects of higher elevations. Water elevation for the remainder of the growing season would be similar between the No Action and Proposed Action alternatives.

Table 4.6: Elevation Difference (feet) in EOM Water Elevation in HVRR: No Action compared to Proposed Action

	Feb.	March	April	May	June	July	August	September	October
Wet Year (1997)	-3.9 ft	0.0 ft	0.0 ft	+0.1 ft	+1.0 ft	0.0 ft	0.0 ft	0.0 ft	0.0 ft
Average Year (1999)	-3.9 ft	0.0 ft	0.0 ft	+0.7 ft	+1.1 ft	0.0 ft	0.0 ft	0.0 ft	0.0 ft
Dry Year (2001)	-3.9 ft	0.0 ft	0.0 ft	+0.7 ft	+1.1 ft	0.0 ft	0.0 ft	0.0 ft	0.0 ft

Lake Helena Wildlife Management Area Wildlife habitat on the WMA would remain similar to current conditions. Water would continue to be delivered through the existing infrastructure. No changes to wildlife habitat are expected.

Canyon Ferry Wildlife Management Area and Canyon Ferry Reservoir

Due to increased water use by Helena, there would be minor changes in releases from Canyon Ferry Reservoir. Flows for the Proposed Action Alternative would be the same as those in the No Action Alternative. Impacts to wildlife and their habitat as a result of this change would be negligible.

Missouri River above Canyon Ferry Reservoir/ Toston Irrigation District

There would be no change in wildlife habitat or populations between the Proposed Action and No Action.

Wetlands

No Action Alternative

This alternative predicts conditions that may exist in the future under current management direction and intensity. Approximately 17,831 acres in HVID and 6,490 acres in TID would continue to be irrigated. No Action would maintain deliveries from both districts at current rates and the current trends in wetlands would be maintained. The M&I contract with Helena would also continue under No Action and would likely constitute their full supply of water of 5,680 AF from HVRR. The additional water would be withdrawn throughout the year and would have no adverse effects on wetlands associated with the HVRR, HVID, TID or Canyon Ferry Reservoir.

Table 4.4 contains EOM reservoir elevations that have been identified to ensure an adequate supply of water is available to meet irrigation and city needs. Throughout the irrigation season, water levels would fluctuate as daily irrigation demands and precipitation patterns vary. Water levels would reach elevation 3,812 by the end of August. Following irrigation season, deliveries from the HVPP would continue and refill the reservoir to elevation 3,820.1. Evaporation, seepage and water deliveries to Helena would then gradually bring water levels down to elevation 3,813.5 in March. Effects to the riparian buffer and wetlands associated with the HVRR during the growing season would be similar to current conditions. The additional water delivered during the winter season would have no effect on these areas because the growing season will have ended.

The TID has converted all of their open laterals to buried pipe systems that has eliminated seepage and evaporative losses. The TID is currently irrigated with 90% sprinkler application. While a gradual increase of on-farm irrigation efficiency may be expected, it is expected to be minor. With these practices currently in place, there are no expected effects to wetlands. Because of these water conservation measures and consistent irrigation, the quantity and quality of wetlands at TID would be similar to current conditions.

Wetlands associated with the irrigation districts would continue to receive similar quantities. The quantity and quality of wetlands habitat would remain similar to current conditions.

Proposed Action

This alternative includes all acreages included in the No Action and 412 acres of additional croplands in HVID. These acres would be converted from dry land farming to irrigated lands. No additional acreage would be included in TID. Additionally, the maximum quantity of water provided to Helena would be increased from 5,680 to 11,300 AF.

Due to the additional water use by Helena and the inclusion of additional acreage, there would be minor changes in releases from Canyon Ferry Reservoir. Flows under the Proposed Action would be the same as the No Action Alternative. Effects to wetlands associated with Canyon Ferry Reservoir and the Missouri River will be negligible.

Because this alternative includes increasing the maximum quantity of water provided to Helena from 5,680 to 11,300 AF and the inclusion of additional irrigated acreage, there would be additional water delivered to and removed from HVRR. Larger quantities of water would be pumped in April, May, June, and October resulting in higher beginning and ending elevations in HVRR. During the irrigation and winter seasons, conditions would be similar to No Action. Additional water delivered during the winter season would have no effect on these areas because the growing season has ended.

The Proposed Action would require additional water to be moved through the HVID canal systems. Under this scenario, additional seepage would occur to the wetlands that rely on seepage for their water source. The quantity and quality of wetland habitat would be slightly increased compared to the No Action.

Helena's dependence on Tenmile creek for M&I water would be reduced by 5,300 AF/yr. This decrease in use would increase flow 27% in upper Tenmile Creek. Increased flows in Tenmile Creek through HVID would likely be less than 0.1%.

No change in canal volume is expected in TID. No adverse impacts are expected to wetlands or riparian habitat.

Threatened and Endangered Species

The ESA requires Reclamation to consult on adverse effects of discretionary proposed actions to listed species. According to the ESA, the effects of the proposed action are the effects (direct, indirect and cumulative) that will be added to the "environmental baseline." The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02) For this EA, the environmental baseline includes the present state of the affected environment as described in Chapter 3.

No Action Alternative

Under the No Action alternative, the effects on federally-listed species that may be found in the action area would be similar to current conditions.

Bald Eagle

It is expected that current trends, populations, and human disturbance levels would continue similar to current conditions. The area would remain good habitat for bald eagles. The migratory population below Canyon Ferry Dam would remain fairly low unless other factors cause kokanee populations to increase. Increased spawning runs result in an abundance of kokanee carcasses to attract migrating eagles.

Black-footed Ferret
The alternative would not result in any change of quantity or quality of current habitat for prairie dogs and would no effect on black-footed ferrets.

Gray Wolf
There would remain the possibility of a wolf dispersing through the area, but no effects are anticipated.

Pallid Sturgeon
This alternative would not result in changes from the environmental baseline condition in pallid sturgeon habitat in the Missouri River downstream from Canyon Ferry Dam. Spring spawning cues and summer habitat flows would remain similar to current conditions. The small population of adult pallid sturgeon would probably continue to age and, without natural recruitment or reintroduction, would likely be extirpated from the Missouri River above Ft. Peck Reservoir. Recovery efforts would continue through hatchery propagation and release of juvenile pallid sturgeon.

Ute's Ladies'-tresses
A population of orchids exists near the action area, but there would be no change to project operation and no effect to this species.

Fluvial Arctic Grayling
The fluvial Arctic grayling is not currently found in this reach of the Missouri River. The stable/increasing population of non-native trout would continue as a negative factor in the suitability of the area for grayling introduction. This is no change from current conditions.

Proposed Action Alternative

This alternative was compared to the environmental baseline described in Chapter 3 to determine the effects of this alternative. Under this alternative, the effects on listed species that may be present in the action area are described below.

Bald Eagle
The slight change in water use would not cause a noticeable change in current bald eagle trends, populations, or human disturbance levels, and the area would remain good bald eagle habitat. If the population of kokanee downstream of Canyon Ferry Dam increases, migratory bald eagles may increase. However, any change in kokanee population would be unrelated to the proposed action. This alternative would have no effect on bald eagles.

Black-footed Ferret
Because the black-footed ferret relies heavily on large prairie dog colonies, the success of prairie dog colonies is indicative of the success of the black-footed ferret. This alternative would not affect downstream prairie dog towns would be expected from the Proposed Action. There would be no effect on black-footed ferrets.

Gray Wolf
Human interaction with gray wolves is a concern for this species. The change in water use and contracts wouldn't directly affect gray wolves, but livestock raised in the area could be potential prey for dispersing wolves and cause negative human interaction. However, agricultural production is expected to remain similar to current conditions, so there would be no effect to wolves from the Proposed Action.

Pallid Sturgeon
For this alternative, Reclamation used the following analysis approach to determine potential impacts on pallid sturgeon. Pallid sturgeon impact indicators are: (1) spring flows for migration cues; and (2) base flows for habitat. Pallid sturgeon rely on high spring flows to cue spawning migrations. Any appreciable reduction of flows in April, May, or June may diminish spawning cues. If the proposed action resulted in summer flow decreases, those flow decreases could result in higher water temperatures that could decrease the habitat suitability for pallid sturgeon. Any reduction in fall/winter base flows would reduce overwinter habitat.

The volume of water associated with the long-term water service contracts under this alternative is a relatively small portion of the total Canyon Ferry Reservoir water storage and operations. As a result, there would be no change in how the reservoir is operated under the proposed action. The water delivered for additional contract amounts under this alternative would slightly reduce water levels and volumes in the reservoir available to spill in the spring runoff, resulting in slightly lower releases from Holter Reservoir in these months.

The effects of this alternative on Hauser Reservoir releases and spring spills (when water is allowed to flow over the spillway at Canyon Ferry Reservoir rather than through the power plant resulting in a pulse of higher water) were modeled. The area of pallid sturgeon habitat is about 200 miles downstream from this reservoir. Using available modeling, Reclamation is unable to incorporate all accretions, return flows, and flow regulation between Canyon Ferry Dam and the habitat area to accurately predict how the change in releases from Canyon Ferry Dam would affect flows 200 miles downstream.

Return flows from HVID and Helena and decreased depletions from Tenmile Creek resulting from this alternative would also be expected to increase flows in the Missouri River, but Reclamation is unable to predict how these increases would interact on a temporal scale with depletions. Therefore, for the purposes of this analysis, Reclamation assumed that any change in flows released through Holter Reservoir incorporates spills from Canyon Ferry Reservoir and represents identical flow changes in the pallid sturgeon habitat. This would approximate the maximum flow change scenario by which to evaluate effects for this alternative. If no adverse effects were expected under this scenario, then there would likely be no adverse effects expected from the most probable flow scenario.

Historic flows at Virgelle (USGS 2004) were considered because it is the furthest upstream gaging station with a historical record actually located within pallid sturgeon habitat. Assuming the difference in Holter Reservoir releases would be applicable downstream to the Virgelle gage, the difference was then computed as a percentage of the total flow to determine if it could be "measurable" by hydrologic standards. For purposes of this analysis and consistent with the ESA, if an effect is not measurable, it is not likely to adversely affect the species.

Table 4.7 shows the model output change in Holter Reservoir releases resulting from the Proposed Action, historical flows at Virgelle, and the difference computed as a percentage of the Virgelle flows. All flows are in monthly average cfs. The model runs on monthly inputs whereas the actual flows are from historical real-time data, so the timing of modeled flow changes does not exactly match flow records. The April, May, and June data were averaged to compensate for this temporal variation between the model and historical data for analysis purposes.

Table 4.7

			Difference in Modeled Holter Release (cfs)	Historical Flows at Virgelle (cfs)	Difference As a % of Flows at Virgelle
Median Water Years	1956	April	-109	7,129	-1.53%
		May	-111	12,540	-0.88%
		June	-113	14,779	-0.76%
	1957	April	-34	7,471	-0.45%
		May	-34	9,475	-0.36%
		June	-32	17,210	-0.19%
	1958	April	-114	7,829	-1.46%
		May	-117	11,760	-1.00%
		June	-114	14,299	-0.80%
	1959	April	-34	6,810	-0.49%
		May	-33	13,680	-0.24%
		June	-34	20,770	-0.16%
		Average	**-73**	**11,673**	**-0.63%**
High Water Years	1995	April	-34	7,441	-0.45%
		May	-33	17,690	-0.18%
		June	-34	23,870	-0.14%
	1996	April	-34	14,990	-0.22%
		May	-33	15,179	-0.21%
		June	-34	26,510	-0.13%
	1997	April	-34	10,620	-0.32%
		May	-33	19,070	-0.17%
		June	-34	32,179	-0.10%
	1998	April	-34	9,213	-0.36%
		May	-33	9,283	-0.35%
		June	-34	15,320	-0.22%
		Average	**-33**	**15,454**	**-0.22%**

High flow years are important because spring spills during these years are critical to trigger pallid sturgeon spawning. Modeling indicated that in high flow years, such as 1995-1998, that average April, May, and June Virgelle flows were 15,454 cfs historically. The model showed a difference in Holter Reservoir releases due to the Proposed Action to average 33 cfs for these three months. This calculated to be 0.22% of the average flow at Virgelle.

Virgelle flows in April, May, and June of the median flow year period 1956-1959 averaged 11,673 cfs. Flows would be expected to be an average of 73 cfs lower in those three months due to the decreased spill resulting from the proposed action. This is a change of 0.63 %. In low flow years, there would rarely be spills under either the Proposed Action or No Action alternatives, and high spring flows would not be available to stimulate pallid sturgeon spawning.

In summary, during high and median flow years, there would be a slight decrease in the magnitude of the spill from Canyon Ferry Reservoir resulting in slightly decreased releases from Holter Reservoir. Under this alternative, assuming no return flows and equal transfer of the flow difference downstream to the pallid sturgeon habitat, the flow decrease would average less than 1% of the Virgelle flow in high and median flow years. It should be noted that the accuracy of the USGS gaging station at Virgelle is within 5%-10% accuracy, and manual flow measurement equipment is considered between 1%-2% accurate (Mel White, pers.comm. 2004). The maximum change scenario under this alternative would therefore likely be immeasurable at the Virgelle gaging station and would not be likely to adversely affect pallid sturgeon.

Another impact indicator for pallid sturgeon is the effect on any changes in base flows to either pallid sturgeon or their prey species. Because base flow releases are determined by operational criteria not related to, or affected by the proposed contract renewal, the operation of Canyon Ferry Reservoir would be unchanged under the Proposed Action alternative. Again, for modeling purposes, affects to pallid sturgeon were based on the assumption that any change in Holter Reservoir releases resulted in an equal change at Virgelle. Return flows were not included in the model and represents the least likely flow scenario. Projected base releases from July through March were averaged for wet, dry, and median years and in all cases equaled a change of less than one-half of one percent of the flow at Virgelle. This would be considered immeasurable by USGS accuracy standards.

During a sustained drought, the effect of additional depletions in the Missouri River basin over a period of years could lead to releases being reduced to drought levels earlier in the season. The additional water delivered to Helena as a result of the proposed action would result in withdrawal of less water from Tenmile Creek and other possible sources that drain into the Missouri River through Hauser Reservoir. This would result in no net loss of water from the basin under this alternative. A potential cumulative effect could occur if the additional water remaining in Tenmile Creek was diverted by actions unrelated to the proposed action before it reached the Missouri River, thereby resulting in lower base flows in the Missouri River. This potential effect would probably be within the margin of error of measuring equipment. Between Canyon Ferry Dam and the pallid sturgeon habitat, there are several tributaries including the Sun, Teton, and Marias rivers, as well as other depletions, that may cumulatively change flow levels in the area of pallid sturgeon habitat. The Missouri River basin is closed to any adjudication of new water rights, so no new additional depletions would be expected to occur that could contribute to cumulative effects.

Under this alternative, spring flows and base flows at Virgelle may be slightly affected. Reclamation believes that the proposed action may affect, but is not likely to adversely affect pallid sturgeon.

Ute Ladies'-tresses

Ute ladies'-tresses have been documented near the river in the area between the Broadwater-Missouri Diversion Dam and Canyon Ferry Reservoir. However, the Proposed Action does not change flows in this reach so neither the documented population nor any potential habitat would affected.

Fluvial Arctic Grayling

The suitability of the Missouri River in the action area as grayling introduction water would not be affected by the Proposed Action. Water quality and the status of non-native species would determine whether this reach of the river is suitable grayling habitat, and these would not change under the Proposed Action. The Proposed Action would not affect fluvial Arctic grayling.

Recreation

No Action Alternative

Canyon Ferry Reservoir

This alternative would result in no effects to land or water-based recreational activities. Operation of the reservoir would continue similar to current conditions with water levels fluctuating based upon inflow and project operations.

Concessionaires would continue to operate marinas by adjusting buoys, moving docks, and placing or replacing anchors to meet changing water levels. Serviceability of boat ramps would depend on water elevations to which they were constructed. If the reservoir reached new lows, Reclamation and/or the concessionaires might extend boat launch ramps further out as the terrain permits. Boating activities or other water-based recreational activities would continue depending on the water levels, serviceability of boat launch ramps, and capability of concessionaires to maintain marina services. The public's access to and use of lands and water at Canyon Ferry Reservoir for recreation would not be affected. There would be no changes to the view shed (scenery).

Visitation at Canyon Ferry Reservoir is expected to increase yearly based upon population growth and availability of facilities and services (Bureau of Reclamation 2003). Changes to recreational facilities and services in the future would generally depend on population growth within the 120-mile service area, changes in public use trends, expectations and technologies, and access, matters that are beyond the scope of water contract negotiation. As private businesses develop at and around Canyon Ferry Reservoir and public recreational use increased, there might be an expectation of stable water levels during the recreation season that may conflict with the timing of water deliveries to meet contract obligations.

Helena Valley Regulating Reservoir
No effects to recreation would result from this alternative. Fluctuations in HVRR water levels would continue as they currently do depending on water deliveries to HVID and Helena. HVRR elevations, however, would be more stable in April, May, and June. Water-based recreational activities would not be affected nor would use of lands for recreation. The view shed (scenery) would not change.

Visitation is expected to increase yearly based on population growth and availability of facilities and services; however, any unanticipated decline in the kokanee fishery would result in reduced fishing opportunities and visitation rates. Changes in the future would generally depend on matters beyond the scope of water contract negotiation such as population growth around or near HVRR as well as changes in public use trends, expectations and technologies, and access. Due to its size, depth, and use limitations, there is little likelihood that water-based recreational activities would change in the future. Land-based recreation facilities and services might improve, but probably only minimally given HVRR's designation only as a fishing access site and its close proximity to Canyon Ferry Reservoir's greater recreational opportunities.

Proposed Action
Canyon Ferry Reservoir
The effects of the Proposed Action would be similar to those described for No Action. The release of an additional 5,000 AF on average from Canyon Ferry Reservoir at or near the end of the summer would lower water levels about 0.1', or 0.04%, representing a negligible impact to any recreation activities. Fluctuating water levels would continue in the same manner as they currently do due to deliveries to satisfy contracts and other project operations. These changes would not impact the cabin owners' ability to access domestic water from Canyon Ferry Reservoir.

Helena Valley Regulating Reservoir
This alternative would result in HVRR water levels fluctuating similar to the No Action Alternative. Water levels would gradually drop to a maximum od 3.9' in February. Given the routine annual variations in water levels, there should be no impacts to water or land-based recreation. The view shed (scenery) would not be affected.

Potential ice hazards during the winter months will remain the same as those experienced now and will not pose any additional risk to users. After the surface freezes and as the water level dropped due to deliveries, the surface ice would lose its water support and settle with the declining water level. This settling action would make the surface ice more susceptible to cracking and heaving. Given HVRR's surface area, it would be unlikely that a *bridge effect* (where the water level drops leaving the ice suspended) would occur. The ice that cracked and settled near the shoreline (known as an *ice hinge*) would have the potential of settling so that the bridge effect could occur between the water and the shore. In addition, due to the slope of the shoreline, the ice hinge would present a slip hazard to anglers as they crossed it to reach other parts of HVRR. Cracking, cleavage, and refreezing of the surface ice near the shoreline might make the ice difficult or dangerous on which to walk.

Changing the designation of HVRR from the city's secondary source of M&I water to its primary source should not impact recreation access to HVRR. Water treatment requirements would remain the same, and no new recreation restrictions are anticipated.

Other Resource Issues

Social and Economic Conditions

No Action Alternative

Helena has projected population growth for Helena and surrounding Helena Valley. In 2044, Helena projected water would be necessary to serve about 65,000 people within anticipated corporate limits (*HAWT Plan* 1998). Water service necessary to meet the projected demand of about 14,300 AF in 2044 would be provided with supplies from the Tenmile Creek watershed (4,750 AF), from currently undeveloped groundwater wells for which Helena possesses a groundwater reservation (3,900 AF), and from Canyon Ferry Reservoir (5,680 AF). Developing Helena's groundwater rights is anticipated to be controversial because the aquifer also provides water for shallow domestic wells in the Helena Valley.

The effects on He;ena would be minor, if any, since under the No Action Alternative, Canyon Ferry Reservoir would be operated in a manner similar to current conditions. No Action would not affect Helena's ability to pump its allocation of water from HVRR as a supplemental source of M&I water.

Irrigated acreage would not change. The No Action Alternative would have no effect on regional or agricultural economics.

Proposed Action

Helena projects water service population to be about 65,000 people in 2044. Water necessary to meet these projected demands of about 14,300 AF would be provided primarily with water from Canyon Ferry Reservoir (11,300 AF) with the Tenmile Creek watershed (3,000 AF) serving as a secondary source. Increasing the volume of water contracted to Helena from 5,680 to 11,300 AF would have no effect on population and growth in Helena or in the surrounding Helena Valley.

The effects of the Proposed Action on the regional economy would be based mostly on 412 acres land irrigated with federal water that is currently dry-land farmed. Based on studies conducted in 2002, per acre agricultural benefits for HVID are $20.50. The benefits of providing federal water to these lands would be $8,446. The economic multiplier would be approximately 1.8 and would result in about $15,200 annually to the local economy. Power generation would decrease by 1.5% (5,901 MWh), and power revenues would be reduced by $84,000.

Prime and Unique Agricultural Lands

No Action Alternative

Under No Action Alternative, the acreage of prime farmland in HVID and TID would remain unchanged.

Proposed Action Alternative

Under the Proposed Alternative, prime farmland acreage would increase if soils on the lands to be newly irrigated with HVID water meet the designation criteria.

Noxious Weeds

No Action Alternative

Generally, no changes in noxious weed management would be expected in this alternative as the County Noxious Weed Act would still be in effect. Although the districts could change, law would still require that noxious weeds be controlled.

Proposed Action Alternative

Effects to noxious weeds in this alternative would be similar to the effects in No Action.

Water Conservation

No Action Alternative

Helena Valley Irrigation District In the No Action Alternative, the HVID would continue a gradual increase of overall system efficiency. Under provisions of the Reclamation Reform Act and according to Reclamation policy, irrigation districts are required to update their water conservation plans and submit them to Reclamation for review and comment on a cycle not to exceed five years. The water conservation plans are expect to contain goals and objectives along with a schedule for implementation of measures identified in the water conservation plans. This requirement is expected to continue into the future for the HVID.

Existing water conservation measures currently utilized by the HVID are expected to continue in the No Action Alternative. This includes a water measurement and accounting system that keeps track of the water delivered to each individual delivery point throughout the irrigation season. Individual irrigators would continue to be notified of seasonal water use by the issuance of monthly water usage statements. The HVID is expected to maintain the water measurement infrastructure that currently exists within the water conveyance system.

One of the goals of the HVID is to reduce the water conveyance system loss that is estimated at 7,000 AF/year. This would be accomplished through lining of selected sections of the main canal and laterals and through the conversion of some open laterals to piped systems.

Over the past several years, irrigation in the district has increasingly changed from flood irrigation to sprinkler. About 65% of district lands are now irrigated by sprinkler, and 35% are irrigated by flood irrigation.

The HVID would continue to encourage individual irrigators to increase their on-farm irrigation efficiency. Individual irrigators are expected to continue to adopt systems that increase irrigation efficiency. Incentives to increase irrigation efficiencies include avoiding excess water charges from HVID and providing a more uniform application of water to the crops. The gradual increase of irrigation system efficiencies would lead to a reduction of groundwater recharge attributable to deep percolation of irrigation water.

Toston Irrigation District In the No Action Alternative, the TID would continue a gradual increase of overall system efficiency. Existing water conservation measures currently utilized by the TID are expected to continue under the No Action Alternative. The TID has converted all of their open laterals to buried pipe systems that has eliminated seepage and evaporative losses from that portion of the water conveyance system. The TID is not expected to pipe their main canal due to cost, but may decide to line high-seepage portions of their main canal.

Future water conservation measures being contemplated by the TID include the implementation of a water measurement and accounting system that keeps track of individual on-farm deliveries and the installation of a variable-speed drive system for their pumping plant. The variable-speed drive system would allow TID to manage the water conveyance system to better match the water pumped from the Missouri River with actual demand.

The TID is currently irrigated with 90% sprinkler application. A majority of the sprinkler application is with low pressure center pivot systems. While a gradual increase of on-farm irrigation efficiency may be expected, it is expected to be minor.

City of Helena Helena does not currently have a comprehensive water conservation plan according to current Reclamation policy, but is expected to develop one. Under the No Action Alternative, the existing water conservation measures adopted by Helena are expected to continue. As the population of the water service area continues to grow, Helena would likely consider additional water conservation measures to reduce the average per capita demand when existing supplies were no longer sufficient to meet the demands. Additional water conservation measures would prolong the need to develop additional supplies. However, water conservation measures alone would not likely be sufficient to meet the water demands of the projected population growth anticipated over the term of the contract.

Proposed Action

Helena Valley Irrigation District Under the proposed action alternative, water conservation is expected to mirror the No Action Alternative. The additional demands placed on the HVID's infrastructure by Helena's need for water may necessitate water conservation measures be implemented in the future in order for the existing system to meet all of the demands. Implementation of measures to increase the water conveyance system efficiencies, such as the lining of the canals and laterals in selected reaches, along with on-farm type efficiency improvements, could help reduce the stress on the system. A 3% increase of system efficiency through implementation of water conservation measures would yield approximately 2,700 AF/year.

Toston Irrigation District Under the proposed action alternative, water conservation is expected to mirror the No Action Alternative. The TID would have the ability to meet the peak demands of the acres under the No Action Alternative plus the additional acres being proposed under this alternative.

City of Helena Under the Proposed Action Alternative, water conservation is expected to continue similar to existing conditions. Helena would continue to promote water conservation with its existing water service customers and would likely extend similar efforts to the additional customers as the population grew within existing boundaries and the proposed annexations.

Cultural Resources

The effects on cultural resources have been evaluated and compliance with cultural resource statutes and executive orders focused on the following issues related to contract renewal:

- How would contract renewal affect historic and prehistoric cultural resources within the APE in the Helena Valley and Townsend Basin?
- How would contract renewal affect Indian Sacred Sites on lands managed by Reclamation in the Helena Valley and Townsend Basin?
- How would contract renewal affect Indian Trust Assets?

Cultural resources or historic properties would not be affected by either the Proposed Action or the No Action alternative because HVID and TID have been farmed and irrigated for over 40 years and the acres to be added have either been irrigated under temporary contracts for at least ten years or have been inventoried for cultural resources with no resources discovered.

Reclamation has determined that none of the above resources are present within the defined areas and, therefore, both the Proposed Alternative and the No Action Alternative would have no effect on those resources.

Environmental Justice

No Action Alternative

This alternative would have no effect on irrigated agriculture and no effect on minority or low-income populations.

Under this alternative, Helena would continue to get most of its water from the Tenmile Creek watershed and Canyon Ferry Reservoir. Other available sources (like ground water) would be developed as population and growth demanded. It was assumed the City currently distributes treated water in an equitable manner and that an equitable pattern of distribution would continue over the next 40 years. It is unknown how growth and annexation would affect conversion of shallow groundwater wells to treated Helena water and whether such conversions would disproportionately affect low-income or minority populations.

Proposed Action Alternative
This alternative would have the same effects as the No Action Alternative.

Cumulative Effects

Cumulative effects are effects on the environment which result from incremental effects of an action when added to other past, present, and reasonable foreseeable future actions regardless of what agency or person undertakes them.

Water Quality
Results of studies in Helena Valley indicate that irrigation with arsenic-laden water from the Missouri River has not adversely affected arsenic concentrations in groundwater or return flows in the western part of the district. One conclusion reported by Mangelson and Brummer (1994) was that an equilibrium occurs as irrigation-applied arsenic accumulates in the soil to a level where loss by volatilization and removal mechanisms equals the amount or arsenic applied annually.

As indicated by more than 50 years of irrigation, cumulative effects therefore would not be adverse. Equilibrium conditions would continue to occur as long as present land area and management practices were maintained.

Fish and Wildlife
Effects to wildlife under the Proposed Action are beneficial. Increasing conservation easements within riparian and river corridors will likely improve wildlife habitat as well.

Cumulative impacts to wildlife in the HVID area will likely result from increased subdivision of irrigated and non-irrigated lands and increased irrigation efficiency that may affect seep wetlands. At this time, it is impossible to quantify the wildlife habitat that may be lost to these future changes.

During a sustained drought, the effect of additional depletions in the Missouri River basin over a period of years could lead to releases being reduced to drought levels earlier in the season. The additional water delivered to Helena as a result of the proposed action would result in withdrawal of less water from Tenmile Creek and other possible sources that drain into the Missouri River through Hauser Reservoir. This would result in no net loss of water from the basin under this alternative. A potential cumulative effect could occur if the additional water remaining in Tenmile Creek was diverted by actions unrelated to the proposed action before it reached the Missouri River, thereby resulting in lower base flows in the Missouri River. This potential effect would probably be within the margin of error of measuring equipment. Between Canyon Ferry Dam and the pallid sturgeon habitat, there are several tributaries including the Sun, Teton, and Marias rivers, as well as other depletions, that may cumulatively change flow levels in the area of pallid sturgeon habitat. The Missouri River basin is closed to any adjudication of new water rights, so no new additional depletions would be expected to occur that could contribute to cumulative effects.

Wetlands

No effects to wetlands are expected as a result of contract renewal.

Chapter 5
CONSULTATION AND COORDINATION

Chapter 5 contains information about consultation and coordination with the public and other agencies during development of this EA.

Scoping

An open house was held in Townsend, Montana, March 16, 2004. The public was encouraged to submit written comments, and members of the study team were available to answer questions. Twenty-one people attended the meeting. Similar meetings were held in Helena March 18 and March 30, 2004. Sixteen people attended the first meeting, and 23 people the second.

An announcement, press releases, and paid advertisements in February and March preceded the meetings. In addition, a Reclamation Web site was established in February and was continuously updated.

Not all issues were pertinent to negotiation of contracts. The issues, their disposition, and location in the EA if pertinent are listed in Table 5.1.

Table 5.1: Issues and Location in the EA

	Issues	Location in the EA (if pertinent)
New Contracts	Would water use outside of irrigation districts continue through temporary contracts?	Chapter 2, "No Action" and "Proposed Action" Alternatives.
	Would district boundaries be changed to reflect inclusions?	Chapter 2, "Proposed Action."
	Would new contracts be flexible enough to allow for changing needs and uses?	Chapter 2, "No Action" and "Proposed Action" Alternatives.
	Accountability for costs?	Costs of contract negotiation would be settled among the districts and Reclamation.
	What would the effects be on water rights?	Water rights are a state responsibility and, as such, are beyond the scope of this EA.
Irrigation Districts	What would be the continued effectiveness of the districts' water conservation programs?	Chapter 3, "Water Conservation."
	What would be the effectiveness of the districts' weed program?	Chapter 3, "Weed Control."
Water Volume	What would effects be of changed water flows?	Chapter 3, "Water Volume."

	What would be effects of changes in water levels?	Chapter 3, “Water Volume.”
	What would be effects of seepage on groundwater and wells outside district?	Chapter 3, “Water Volume.”
	Would flows in Prickly Pear Creek be enhanced?	Chapter 3, “Water Volume.”
	What are cumulative effects of water usage?	Chapter 3, “Cumulative Effects.”
Water Quality	What would be the effects of reservoir withdrawals and return flows?	Chapter 3, “Water Quality.”
	What would effects of contract renewal be on water quality (nutrient discharges, etc.) in relation to Lake Helena Water Quality Restoration Plan?	Chapter 3, “Water Quality.”
Erosion	Would changes to Warm Springs Creek cause erosion?	
Fish and Wildlife	What would be the effects of reservoir withdrawals on reservoir fisheries?	Chapter 3, “Fish.”
	What would be the effects of withdrawals on river fisheries?	Chapter 3, “Fish.”
	What would the effects of irrigation be on riparian habitat?	Chapter 3, “Wildlife.”
	What would the effects of withdrawals be on Federally-listed and other sensitive species?	Chapter 3, “Wildlife.”
	What would the effects of irrigation be on migratory birds, nesting water birds?	Chapter 3, “Wildlife.”
Wetlands	What would be the effects of drains and other effects on wetlands?	Chapter 3, “Wetlands.”
Social and Economic Conditions	What would the effects of withdrawals be on recreational economy?	Chapter 3, “Social and Economic Conditions”
	What would be the effects be on power generation?	Chapter 3, “Social and Economic Conditions.”
Recreation	What would the effects of withdrawals on reservoir levels be?	Chapter 3, “Recreation.”
	What would the effects of withdrawals on marinas, boat ramps, other recreation, be?	Chapter 3, “Recreation.”
	Would changes in levels affect fishing in Helena Regulating Reservoir?	Chapter 3, “Recreation.”
	What would the effects of withdrawals be on aesthetics?	Chapter 3, “Recreation.”
	What would effects be of making canal and ditch roads available for hiking, biking, and horseback riding?	Chapter 3, “Recreation.”
	What would effects be of non-motorized paths along Canyon Ferry?	Chapter 3, “Recreation.”

Indian Trust Assets	What would the effects on property, interests, or assets of Indian tribes?	Chapter 3,
Environmental Justice	Would there be disproportionate effects on minority or low-income populations?	Chapter 3,
Prime and Unique Farmlands	Would any prime farmland or unique farmland be affected?	Chapter 3,

Reclamation advetised the availability of this draft EA and an open house and public meeting in the Helena, Townsend, Three Forks, and Bozeman newspapers.

Coordination

Fish and Wildlife Coordination

Several meetings were held with the Service and MFWP. Both agencies also reviewed a preliminary draft of the EA.

Cultural Resources

Over the past ten years, Reclamation has consulted with the Montana State Historic Preservation Officer (SHPO) when additional lands have been added to those irrigated by HVID and TID. No cultural resources have been found on any of those additional lands.

Informal consultation with the SHPO has taken place while the document was being prepared. This informal consultation addressed the definition of the APE for the proposed action. Formal consultation as required by the NHPA will take place when the draft document becomes available.

Formal Government to Government consultation has taken place with the following tribes regarding cultural resources and Indian Sacred Sites: Kiowa Tribe of Oklahoma, Shoshone-Bannock Tribe, Salish and Kootenai Tribes, Nez Perce Tribe, Eastern Shoshone Business Council, Blackfeet Tribe, Crow Tribe, Fort Belknap Indian Community, and the Chippewa-Cree Tribe of the Rocky Boy's Reservation.

If the HVRR needed modification in the future, or pipelines to the water treatment plant were changed, or certain other federal actions were necessary, NEPA and NHPA compliance and a *Class III Cultural Resource Survey* would be required. It should be noted that these actions are neither proposed nor anticipated at present.

Other Coordination

Irrigation Districts

Meetings were held with both the HVID and TID and both districts were provided an opportunity to review a preliminary draft EA.

City of Helena

Meetings were held with Helena and they were provided an opportunity to review a preliminary draft EA.

Recreation
The following individuals were consulted concerning recreation.

Mr. Robert Haehnel, Research Mechanical Engineer, Corps of Engineers Cold Regions Research and Environmental Laboratory

Mr. Craig Marr, MFWP

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Appendix A

Canyon Ferry Reservoir

Contract Renewal Evaluation
Includes Helena Valley Irrigation District, Toston Irrigation District and Helena Valley Reservoir
September, 2004

Purpose

The Helena Valley and Toston Irrigation District water supply contracts for Missouri River water in Canyon Ferry Reservoir will expire at the end of December, 2004. The hydrology analysis was to evaluate the effects of a variety of alternatives as they pertained to the contracts and the operations of Canyon Ferry and Helena Valley Reservoirs.

Determination of Historical and Present Level Depletions

There are 14 node basins in the basin above Canyon Ferry Reservoir. Both historical and present level depletions have been calculated for these node basins. The period of record for evaluation in this study was 1929 through 2002.

There are three reservoirs within the basin. They are Clark Canyon, Canyon Ferry and Helena Valley Reservoirs. Each of the reservoirs was modeled individually to determine the effects of their operation on the water supply in the basin.

Clark Canyon Reservoir

Clark Canyon Reservoir is located on the Beaverhead River near Dillon, Montana and was constructed in 1964. There are 2 node basins above the reservoir. They are the Beaverhead River at Clark Canyon and Red Rock Creek at Lima Reservoir.

Depletions were calculated using the CONUSE52 computer model. Input parameters, including climatological data and irrigated acres, for the basins above Clark Canyon were updated to year 2002 and the model was run to generated historic and present level depletions.

The depletions associated with the operation of Clark Canyon Reservoir were calculated by taking the difference of the reservoir outflow from the operation using natural inflows and present level inflows. This difference would constitute the present level effect of the reservoir. Natural flows were generated by adding the historical depletions calculated in the CONUSE52 model output to the historical flow into the reservoir. Present level flows are calculated by subtracting the present level depletions from the natural flows.

A Reservoir Operation Model (ROMs) for Clark Canyon Reservoir was used to model the reservoir operations under natural and present level flow conditions.

Canyon Ferry Reservoir

Canyon Ferry Reservoir is located on the Missouri River near Helena, Montana. It was constructed by the Bureau of Reclamation in 1955. Canyon Ferry Reservoir provides irrigation and municipal water to Helena Valley Regulating Reservoir. In addition, releases from the reservoir are coordinated with Montana Department of Fish, Wildlife and Parks for instream flows and with Northwestern Energy for power demands out of the downstream facilities at Hauser and Holter Dams.

Upstream node basins that impact the inflow to Canyon Ferry include the depletions from:

1) Clark Canyon Reservoir
2) Gallatin River at Logan
3) Gallatin River at Gallatin Gateway
4) Madison River below Ennis
5) Madison River – Ennis to mouth
6) Ruby River at mouth
7) Big Hole River at mouth
8) Beaverhead River – Clark Canyon to Twin Bridges
9) Jefferson River – Twin Bridges to Boulder
10) Jefferson River – Boulder to Sappington
11) Jefferson River – Sappington to Three Forks
12) Missouri River – Three Forks to Toston
13) Missouri River – Toston to Canyon Ferry

Depletions are calculated using the CONUSE52 computer model. Input parameters, including climatological data and irrigated acres, for the basins above Canyon Ferry Reservoir were updated to year 2002. Using the historic and present level depletions from the CONUSE52 model, the inflow to Canyon Ferry Reservoir was modified to reflect present level conditions.

A Reservoir Operation Model (ROMs) for Canyon Ferry Reservoir was used to model the reservoir operations under present level flow conditions.

Helena Valley Regulating Reservoir

Helena Valley Regulating Reservoir is an integral part of the Helena Valley Irrigation District (HVID). Water is pumped from Canyon Ferry Reservoir through the Helena Valley Pumping Plant that deliveries water to15, 608 acres within the HVID. Also, the City of Helena has a contract to receive up to 5,680 acre-feet of water each year from the reservoir. The reservoir has an active capacity of 10,500 acre-feet of water. It is located along Prickly Pear Creek east of Helena, Montana.

An EXCEL spreadsheet was used to model the effects of the reservoir in supplying irrigation and municipal water to HVID and the City of Helena.

No Action Alternative

Canyon Ferry Reservoir

Under the No Action Alternative, it was assumed that all of the non-project acres, served with a temporary contract for a number of years, would be included in the No Action Plan. Therefore, no adjustments were made in the inflows to Canyon Ferry Reservoir. The present level inflows were used to operate Canyon Ferry Reservoir.

Using the ROMs, a computer run was made using the present level inflows. The input file assumed the City of Helena would use their full contacted municipal supply of 5, 680 acre-feet.

Helena Valley Regulating Reservoir

An EXCEL spreadsheet was used to model the operation of the Helena Valley Regulating Reservoir (HVRR). In the No Action evaluation, it was assumed that all of the non-project acres, served with a temporary contract would be included in the No Action Plan. In addition, the City of Helena was to receive 5,680 acre-feet of municipal water. Several operational constraints were placed on the HVRR to ensure sufficient water was delivered from Canyon Ferry to meet the need of the HVID and the City of Helena.

These operational targets were:

1) By the end of March, April, May and June, the reservoir was filled to elevation 3820.1 feet (10,500 acre-feet)
2) By the end of July, the reservoir was filled to elevation 3815.0 feet (8,044 acre-feet)
3) By the end of August, the reservoir was filled to elevation 3812.0 feet (6,833 acre-feet)
4) By the end of September, the reservoir was filled to elevation 3820.1 feet (10,500 acre-feet)

It was also assumed that the maximum diversion from the Helena Valley Pumping Plant in June would be 21, 421 acre-feet and in July and August the maximum available diversion would be 22,135 acre-feet. If the diversion necessary to fill the reservoir to the desired target elevation was greater than the canal capacity, then the maximum was delivered and the reservoir was drawn down accordingly based upon the demands.

Proposed Action Alternative

Canyon Ferry Reservoir

In the proposed action alternative, there were no adjustments to the inflows due to increases or decreases in project acres. The same number of acres irrigated in the No Action plan was irrigated in the Proposed Alternative. The City of Helena was provided a contract amount of 11,126 acre-feet of municipal water. Modifications were made to the input file to reflect these changes in demand and the model was run. Table__ displays the results of the differences in the reservoir elevations between the alternatives.

Table______ Canyon Ferry Reservoir Average end-of-month Elevation in Feet			
	No Action	Preferred Action	Difference (feet)
January	3787.3	3787.2	0.1
February	3786.4	3786.4	0.0
March	3786.7	3786.6	0.1
April	3780.4	3780.4	0.0
May	3781.4	3781.5	-0.1
June	3794.9	3794.9	0.0
July	3795.8	3795.8	0.0
August	3791.3	3791.2	0.1
September	3788.8	3788.5	0.3
October	3788.2	3788.0	0.2
November	3788.9	3788.8	0.1
December	3788.7	3788.6	0.1

As displayed, the differences in the average end-of-month elevations between the two alternatives are small.

Table_____ displays the effects of the proposed action on the average monthly reservoir releases at Canyon Ferry.

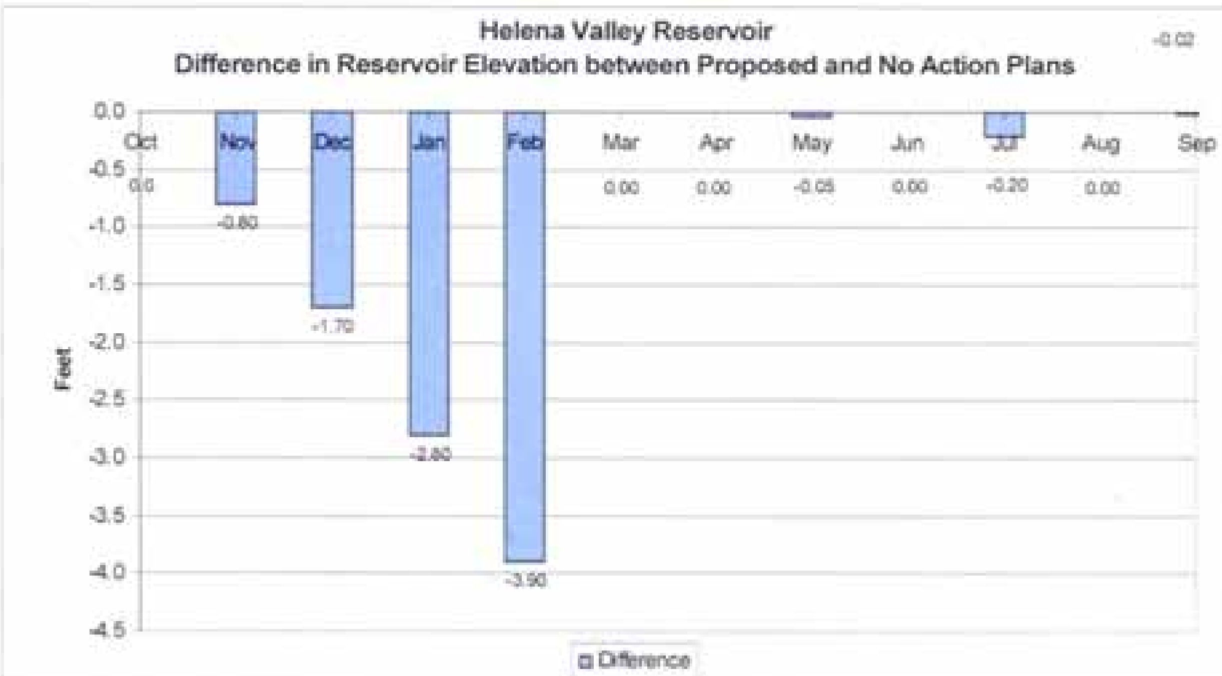
Table______ Canyon Ferry Reservoir Average end-of-month Reservoir Release in Acre-Feet			
	No Action	Preferred Action	Difference in AF
January	252,900	250,900	2,000
February	226,600	224,400	2,200
March	248,300	252,900	-4,600
April	526,100	535,400	7,00
May	564,900	562,100	2,800
June	541,200	542,400	-800
July	344,400	344,700	-300
August	286,400	286,600	-200
September	267,700	272,800	-5,100
October	240,500	238,700	1,800
November	232,900	231,100	1,800
December	215,600	215,600	0

The difference in the total releases from Canyon Ferry Reservoir range from 0.1 % to -1.9 %. This difference is relatively small and will not have a significant impact on the total operation of the system.

Helena Valley Regulating Reservoir

Using the EXCEL spreadsheet to evaluate the operation of the HVRR, modifications were made to simulate the Proposed Action Alternative. The demands from the HVRR were adjusted to include 256 acres of non-project lands in the HVID and the City of Helena was provided a contract amount of 11,126 acre-feet of municipal water.

The following chart displays the average differences in end-of-month elevations between the Proposed Action and the No Action Alternative.



INFLOWS TO CANYON FERRY RESERVOIR - NO ACTION AND PROPOSED ACTION

Assumes all Toston ID Irrigated Lands are within the District and is included in the flows

Flows in KAF

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1929	190.65	148.92	281.32	281.99	468.93	1050.62	307.19	121.89	236.50	184.44	203.79	178.56	3654.80
1930	135.95	209.92	235.92	337.10	438.46	566.55	212.19	254.36	152.93	255.14	233.64	150.40	3182.56
1931	149.74	143.59	198.08	274.03	255.10	410.14	131.98	-9.56	130.22	98.67	200.20	100.91	2083.10
1932	136.58	143.41	208.05	232.16	547.54	1102.19	345.16	125.89	92.86	177.35	215.02	122.06	3448.27
1933	165.34	118.52	193.34	220.35	425.32	1206.84	248.95	161.47	117.51	173.69	193.75	174.78	3399.83
1934	168.50	166.13	371.32	441.57	348.37	532.42	193.43	76.50	111.02	85.38	159.77	114.46	2768.86
1935	168.14	123.84	206.90	340.11	421.43	814.52	348.75	77.28	107.03	106.46	174.56	122.93	3011.96
1936	120.44	96.49	210.88	314.93	624.25	868.61	266.83	96.67	120.25	96.02	163.83	141.23	3120.41
1937	104.51	173.69	160.02	271.04	334.62	566.89	390.87	102.71	90.95	101.49	178.96	122.51	2598.25
1938	134.52	147.53	198.73	391.57	593.08	1162.39	557.29	190.05	90.05	225.38	216.86	164.36	4071.80
1939	169.71	111.07	265.92	422.76	675.09	770.38	297.70	48.87	172.07	136.57	183.29	131.29	3384.71
1940	150.16	161.84	226.78	346.85	387.15	489.26	371.75	31.69	224.42	246.47	179.86	149.00	2965.22
1941	141.66	157.11	251.04	311.12	321.79	751.95	354.62	253.32	332.18	273.41	260.90	229.42	3638.52
1942	174.35	181.42	307.62	609.23	782.08	1353.67	456.52	156.59	223.03	181.40	224.41	217.86	4868.18
1943	181.08	266.21	291.78	639.63	732.33	1543.13	485.33	192.89	220.37	193.90	247.74	219.04	5213.42
1944	226.53	201.25	223.24	318.44	386.07	1362.51	594.60	77.78	203.43	191.99	223.83	183.69	4193.34
1945	233.41	204.62	193.56	264.83	422.29	1047.57	283.97	-6.02	229.67	188.35	244.68	195.27	3502.19
1946	214.69	207.48	269.75	369.66	596.10	713.49	412.14	35.93	299.80	241.93	220.75	265.05	3846.76
1947	223.81	207.48	362.99	482.91	911.12	1313.93	348.20	31.76	306.74	303.89	273.25	267.76	5033.84
1948	246.04	221.44	309.55	467.40	1099.07	1615.13	500.37	125.14	178.52	233.50	258.92	222.22	5477.31
1949	189.76	188.88	291.05	478.94	771.39	785.54	246.51	-14.35	251.68	238.74	241.22	198.35	3867.71
1950	181.42	204.88	247.31	303.91	382.04	1098.06	475.27	128.64	265.70	268.26	278.25	255.22	4088.96
1951	204.24	217.94	252.66	417.81	790.81	826.91	282.79	161.87	223.21	276.15	256.23	191.86	4102.48
1952	189.29	230.44	273.00	478.51	1101.27	1034.28	307.22	76.95	163.98	167.34	222.89	242.24	4487.41
1953	252.46	196.85	82.00	299.54	382.58	1166.28	398.78	178.13	176.96	169.76	250.87	208.75	3762.95
1954	200.94	232.00	237.20	282.52	431.44	573.70	357.97	146.50	186.38	152.04	233.37	182.30	3216.36
1955	168.36	140.02	189.59	267.24	469.23	772.98	406.43	153.77	134.47	148.24	209.76	226.63	3286.73
1956	202.90	161.11	299.05	442.77	909.33	1066.87	253.73	132.33	169.90	149.07	226.96	188.93	4202.94
1957	128.19	180.54	240.92	268.47	727.11	1021.77	334.07	121.17	197.72	203.06	247.09	218.47	3888.57
1958	189.68	193.47	220.49	315.25	784.64	705.65	302.87	135.07	167.07	179.89	229.13	226.32	3649.53
1959	177.98	156.53	238.25	299.01	397.75	1108.79	427.82	65.48	146.35	365.14	397.28	348.12	4128.48
1960	221.76	245.32	332.05	455.11	556.49	823.87	214.63	101.22	168.79	152.65	229.48	196.39	3697.76
1961	175.88	194.68	200.98	176.99	263.88	753.57	158.93	105.81	133.73	202.49	252.62	168.13	2787.70
1962	159.78	193.43	234.30	459.46	602.25	1055.02	316.28	166.58	196.33	237.61	280.74	230.18	4131.95

1963	159.67	293.03	258.10	290.67	581.53	972.77	399.57	118.43	215.08	187.67	256.72	197.74	3930.98
1964	194.27	194.72	220.09	294.82	644.16	1362.37	604.26	138.01	233.09	198.71	269.78	234.18	4588.44
1965	263.02	214.87	227.22	459.10	786.03	1461.67	726.79	231.81	310.49	351.41	340.64	262.93	5635.98
1966	233.13	212.88	258.87	337.55	367.12	431.15	212.33	68.92	125.24	155.50	225.90	204.04	2832.63
1967	204.46	171.28	225.32	257.74	649.17	1476.21	626.70	127.05	177.12	254.20	286.01	204.51	4659.77
1968	211.82	286.97	314.69	328.01	549.58	1197.62	453.51	189.02	270.14	321.00	339.48	229.68	4691.53
1969	223.80	231.38	322.13	646.99	1005.45	769.34	590.66	262.25	182.48	261.49	317.91	234.83	5048.69
1970	228.67	219.11	248.09	284.85	825.53	1493.60	523.44	137.12	242.45	287.15	304.18	245.27	5039.46
1971	246.96	277.43	257.83	383.50	891.72	1366.53	588.95	139.94	251.39	308.55	329.31	222.13	5264.23
1972	241.93	257.73	359.01	338.68	678.31	1318.32	338.74	142.14	306.05	298.46	325.77	221.24	4826.39
1973	229.21	210.29	265.22	319.97	505.94	598.53	229.68	60.15	204.94	252.51	313.49	251.90	3441.80
1974	227.02	215.31	275.34	387.70	547.35	1437.46	352.73	112.83	161.65	229.02	280.70	235.26	4462.37
1975	208.32	186.13	256.52	273.10	698.63	1450.44	1060.47	345.04	243.63	347.48	374.86	349.29	5793.91
1976	290.11	255.59	294.03	516.96	1290.23	1132.44	487.50	237.30	326.98	338.46	309.85	256.16	5735.60
1977	209.45	220.46	237.45	343.93	233.23	611.26	180.39	97.64	166.00	266.40	237.24	225.06	3028.50
1978	217.63	205.99	312.91	446.25	648.51	1130.79	582.85	197.37	274.31	276.03	240.70	212.10	4745.44
1979	178.02	196.32	309.36	365.23	723.04	779.13	234.52	167.08	197.49	180.36	232.50	215.97	3779.01
1980	165.58	216.65	246.72	378.22	808.30	1137.39	426.59	126.45	259.91	266.91	286.67	257.62	4577.02
1981	234.63	201.17	246.27	327.16	917.57	1314.81	378.00	162.33	144.91	261.02	270.29	239.96	4698.12
1982	184.21	238.70	271.96	362.60	836.69	1391.44	813.97	239.28	248.58	355.75	313.92	259.51	5516.62
1983	284.31	223.90	281.82	332.49	579.41	1112.02	714.17	291.80	283.83	377.66	389.20	256.05	5126.65
1984	312.79	273.12	313.35	423.19	982.17	1442.22	693.33	374.57	313.75	355.76	341.65	232.21	6058.09
1985	244.11	204.22	297.53	472.87	535.49	606.40	172.64	125.58	177.54	286.11	208.13	222.22	3552.84
1986	226.23	226.85	308.65	404.55	588.71	1120.38	308.53	166.99	258.61	288.62	286.42	210.30	4394.84
1987	194.26	200.74	241.81	295.35	240.80	506.82	236.11	145.51	184.59	189.33	219.40	173.59	2828.29
1988	167.35	190.37	219.53	319.31	432.63	565.72	142.41	82.31	100.33	155.73	177.68	150.99	2704.33
1989	157.87	110.21	260.93	334.16	528.39	424.74	149.34	189.53	110.25	207.17	228.34	186.32	2887.25
1990	179.56	148.10	204.53	285.67	277.96	540.10	240.04	186.86	155.05	182.87	220.87	146.76	2768.37
1991	148.39	170.09	178.34	192.09	460.54	800.46	300.67	141.55	145.92	192.41	252.85	204.21	3187.51
1992	167.83	170.80	197.04	204.23	219.61	254.14	311.77	152.93	133.44	212.40	226.35	152.28	2402.81
1993	143.98	141.14	269.19	272.73	676.65	809.90	583.02	352.22	286.57	315.15	276.77	233.57	4360.89
1994	230.17	162.77	236.41	308.36	364.55	284.11	177.09	146.80	104.74	177.31	216.97	180.69	2589.97
1995	163.99	222.08	266.96	335.27	612.90	1160.06	681.12	267.78	278.88	318.14	339.52	272.17	4918.86
1996	227.22	275.00	310.30	460.73	787.20	1259.91	347.00	186.17	181.05	248.08	272.82	204.85	4760.32
1997	251.74	237.79	294.86	409.77	1071.62	1586.13	592.08	351.93	273.05	352.92	358.66	268.38	6048.93
1998	258.84	243.54	307.52	396.42	614.06	874.20	743.40	282.00	211.63	279.05	299.48	248.07	4758.20
1999	286.15	257.30	300.93	327.75	529.29	927.19	349.08	192.33	178.93	220.72	249.97	235.97	4055.59
2000	228.68	217.53	230.13	248.08	319.34	381.27	212.20	132.89	111.98	203.36	196.09	177.41	2658.94
2001	188.89	165.53	213.55	196.76	251.47	274.53	216.25	143.80	97.33	136.60	173.11	147.04	2204.86
Average	198.53	198.29	255.43	354.05	597.28	956.15	391.41	150.93	196.59	228.81	254.85	208.45	3990.78

CANYON FERRY RESERVOIR - NO ACTION ALTERNATIVE - TOTAL RELEASES - KAF

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928	266.1	224.3	238.6	377.3	400.6	383.3	274.8	274.8	257.6	253.8	245.6	162.3
1929	285.3	257.6	285.3	507.4	534.9	513.3	265.8	265.4	246.7	211.9	205.1	162.3
1930	229.0	206.8	228.9	355.9	378.4	361.9	265.8	265.4	246.7	201.0	194.5	162.3
1931	214.2	193.5	214.3	243.7	265.4	237.6	265.8	265.4	246.7	161.0	156.8	162.3
1932	161.6	149.6	158.7	398.3	422.2	404.3	265.8	265.4	246.7	167.9	162.5	162.3
1933	169.8	153.3	169.8	524.2	552.3	530.2	265.8	265.4	246.7	205.5	198.9	162.3
1934	220.3	199.0	220.4	349.4	371.7	355.4	265.8	265.4	246.7	161.0	156.8	162.3
1935	161.6	144.0	158.7	342.5	364.6	348.6	265.8	265.4	246.7	161.0	156.8	162.3
1936	161.6	149.6	158.7	458.4	484.3	464.3	265.8	265.4	246.7	161.0	156.8	162.3
1937	161.6	144.0	158.7	243.7	265.4	237.6	265.8	265.4	246.7	161.0	156.8	162.3
1938	161.6	144.0	158.7	602.3	633.0	608.3	443.3	265.4	246.7	211.7	204.8	162.3
1939	228.7	206.5	228.7	529.4	557.6	535.4	265.8	265.4	246.7	161.0	156.8	162.3
1940	161.6	149.6	158.7	313.1	334.2	319.1	265.8	265.4	246.7	201.4	195.0	162.3
1941	214.9	194.1	215.0	370.0	393.0	376.0	306.2	306.2	288.0	285.2	276.0	162.3
1942	327.6	295.9	327.5	818.4	856.3	824.4	342.5	280.1	262.7	259.1	250.7	266.8
1943	266.1	226.9	251.3	874.4	914.2	880.5	371.3	276.8	259.5	255.8	247.5	266.8
1944	266.1	228.9	244.7	594.9	625.4	601.0	480.6	265.4	246.7	225.1	217.9	162.3
1945	246.8	222.9	246.7	485.3	512.2	491.3	265.8	265.4	246.7	217.1	210.1	162.3
1946	235.9	213.1	235.9	467.1	493.3	473.0	298.1	294.8	277.0	273.8	265.0	266.8
1947	276.2	249.4	276.2	806.2	843.7	812.1	298.6	298.6	280.7	277.6	268.7	266.8
1948	281.3	263.1	281.3	962.4	1005.1	968.4	386.4	273.1	256.0	252.2	244.0	266.8
1949	266.1	216.2	238.6	583.4	613.5	589.5	265.8	265.4	246.7	213.0	206.2	162.3
1950	230.5	208.2	230.5	501.6	528.9	507.6	361.3	296.5	278.6	275.5	266.6	266.8
1951	278.4	251.5	278.4	584.5	614.6	590.5	273.4	273.3	256.2	252.4	244.2	266.8
1952	266.1	224.3	238.6	774.4	810.8	780.3	265.8	265.4	246.7	194.6	188.3	162.3
1953	205.6	185.7	205.7	522.8	550.9	528.8	284.8	268.9	251.9	247.9	239.9	266.8
1954	266.1	216.2	238.6	331.2	352.9	337.3	265.8	265.4	246.7	202.1	195.6	162.3
1955	215.8	194.9	215.7	411.1	435.4	417.0	292.4	265.4	246.7	240.9	234.2	266.8
1956	266.1	224.3	238.6	669.5	702.5	675.6	265.8	265.4	246.7	187.5	181.5	162.3
1957	196.2	177.2	196.1	578.5	608.5	584.5	265.8	265.4	246.7	240.9	234.2	266.8
1958	266.1	216.2	238.6	473.2	499.7	479.2	265.8	265.4	246.7	211.7	204.9	162.3
1959	228.8	206.6	228.8	508.7	536.3	514.7	325.7	325.8	306.9	304.7	294.9	266.8
1960	317.7	297.2	317.7	518.6	546.5	524.5	265.8	265.4	246.7	181.5	175.6	162.3
1961	188.1	169.9	188.1	307.2	328.1	313.3	265.8	265.4	246.7	177.2	171.4	162.3
1962	182.3	164.6	182.3	611.3	642.3	617.2	280.4	280.4	263.0	259.3	251.0	266.8
1963	266.1	227.5	251.9	521.7	549.7	527.7	285.6	265.4	246.7	236.2	228.5	162.3
1964	261.3	244.5	261.3	672.2	705.3	678.2	490.3	284.7	267.2	263.8	255.2	266.8
1965	266.1	235.7	260.9	805.9	843.3	811.9	612.8	338.7	319.5	317.7	307.5	266.8

1966	335.2	302.8	335.2	287.9	308.1	293.9	265.8	265.4	246.7	174.4	168.8	162.3
1967	178.5	161.3	178.5	699.2	733.1	705.2	512.7	294.3	276.5	273.3	264.5	266.8
1968	275.5	257.7	275.5	597.6	628.1	603.6	339.5	329.1	310.2	308.1	298.2	266.8
1969	322.3	291.1	322.3	711.8	746.2	717.8	476.7	307.1	288.9	286.2	276.9	266.8
1970	292.8	264.5	292.8	772.0	808.4	778.0	409.4	312.7	294.3	291.7	282.3	266.8
1971	300.4	271.3	300.3	784.4	821.2	790.4	475.0	325.7	306.9	304.7	294.9	266.8
1972	317.6	297.2	317.6	683.4	716.8	689.4	302.8	302.8	284.7	281.8	272.7	266.8
1973	287.0	259.2	286.9	383.0	406.5	389.0	268.2	268.2	251.2	247.2	239.2	266.8
1974	266.1	216.2	238.6	688.1	721.6	694.1	267.3	267.3	250.4	246.3	238.4	266.8
1975	266.1	216.2	238.6	703.4	737.4	709.4	946.5	375.2	354.8	354.2	342.8	266.8
1976	384.1	359.3	384.0	882.5	922.6	888.6	373.5	330.3	311.3	309.3	299.3	266.8
1977	324.0	292.6	324.0	305.2	326.1	311.2	265.8	265.4	246.7	228.3	220.9	162.3
1978	251.0	226.7	250.9	647.2	679.4	653.1	468.8	298.2	280.2	277.1	268.2	266.8
1979	280.7	253.6	280.7	529.0	557.3	535.1	265.8	265.4	246.7	218.0	211.0	162.3
1980	237.0	221.7	236.9	679.6	712.8	685.6	312.6	297.6	279.7	276.6	267.7	266.8
1981	280.0	252.9	279.9	757.3	793.2	763.4	281.8	281.8	264.4	260.8	252.4	266.8
1982	266.1	230.2	254.8	767.6	803.8	773.6	700.0	339.3	320.1	318.3	308.1	266.8
1983	336.1	303.5	336.1	580.7	610.6	586.7	600.2	375.0	354.5	354.0	342.5	266.8
1984	383.7	358.9	383.6	852.3	891.3	858.3	579.3	361.9	339.0	337.9	327.0	266.8
1985	362.4	327.4	362.4	445.8	471.3	451.8	265.8	265.4	246.7	235.8	228.2	162.3
1986	261.2	235.9	261.2	610.3	641.2	616.3	282.3	282.3	264.9	261.4	252.9	266.8
1987	266.1	231.2	256.0	257.3	276.5	263.3	265.8	265.4	246.7	195.8	189.5	162.3
1988	207.3	193.9	207.2	347.8	370.1	353.8	265.8	265.4	246.7	161.0	156.8	162.3
1989	161.6	144.0	158.7	280.3	300.2	286.3	265.8	265.4	246.7	176.1	170.4	162.3
1990	180.8	163.3	180.9	277.3	297.2	283.4	265.8	265.4	246.7	180.4	174.6	162.3
1991	186.7	168.7	186.7	392.5	416.2	398.5	265.8	265.4	246.7	203.8	197.2	162.3
1992	218.0	203.9	217.9	243.7	265.4	237.6	265.8	265.4	246.7	161.0	156.8	162.3
1993	161.6	144.0	158.7	466.0	492.2	472.0	469.0	339.5	304.0	301.7	292.0	242.2
1994	322.2	291.0	322.2	243.7	265.4	237.6	265.8	265.4	246.7	179.2	173.4	162.3
1995	185.1	167.1	185.1	608.5	639.4	614.5	567.1	348.4	328.9	327.4	316.9	266.8
1996	348.1	325.7	348.1	740.2	775.5	746.2	290.1	290.1	272.4	269.1	260.4	266.8
1997	269.8	243.7	269.8	924.8	966.2	930.8	478.1	365.8	345.7	344.8	333.7	266.8
1998	371.7	335.8	371.7	534.8	563.2	540.8	629.4	333.9	314.8	312.9	302.8	266.8
1999	328.8	297.0	328.9	501.6	529.0	507.7	275.4	275.4	258.2	254.4	246.2	266.8
2000	266.1	226.4	242.1	243.7	265.4	237.6	265.8	265.4	246.7	168.4	163.0	162.3
2001	170.6	154.0	170.6	243.7	265.4	237.6	265.8	265.4	246.7	240.9	234.2	266.8
AVE	252.9	226.6	248.3	536.1	564.9	541.2	344.4	286.4	267.7	240.5	232.9	215.6

CANYON FERRY RESERVOIR- PREFERRED ALTERNATIVE- TOTAL RELEASES - KAF

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928	266.1	224.3	245.6	375.0	396.1	383.1	274.1	274.1	261.9	252.1	244.0	162.3
1929	283.0	255.6	290.0	507.4	532.8	515.4	266.8	266.4	252.7	209.3	202.6	162.3
1930	225.5	203.7	232.6	355.9	376.4	363.9	266.8	266.4	252.7	198.4	192.0	162.3
1931	210.8	190.4	217.9	245.7	265.4	241.6	266.8	266.4	252.7	161.0	156.8	162.3
1932	161.6	149.6	165.7	391.5	413.1	399.4	266.8	266.4	252.7	165.3	160.0	162.3
1933	166.4	150.3	173.3	524.2	550.3	532.2	266.8	266.4	252.7	202.9	196.4	162.3
1934	216.9	196.0	223.9	349.4	369.7	357.4	266.8	266.4	252.7	161.0	156.8	162.3
1935	161.6	144.0	165.7	337.6	357.5	345.6	266.8	266.4	252.7	161.0	156.8	162.3
1936	161.6	149.6	165.7	453.4	477.1	461.5	266.8	266.4	252.7	161.0	156.8	162.3
1937	161.6	144.0	165.7	245.7	265.4	241.6	266.8	266.4	252.7	161.0	156.8	162.3
1938	161.6	144.0	165.7	590.6	618.9	598.6	443.3	266.4	252.7	209.3	202.5	162.3
1939	225.5	203.6	232.5	529.4	555.6	537.4	266.8	266.4	252.7	161.0	156.8	162.3
1940	161.6	149.6	165.7	308.2	327.0	316.2	266.8	266.4	252.7	198.9	192.5	162.3
1941	211.5	191.0	218.5	370.0	391.0	378.0	305.5	305.5	292.4	283.5	274.4	162.3
1942	325.3	293.8	332.2	818.4	854.3	826.4	342.5	279.3	267.0	257.3	249.0	266.8
1943	266.1	223.6	254.6	874.5	912.2	882.4	371.3	276.0	263.8	254.0	245.8	266.8
1944	266.1	225.5	248.1	595.0	623.3	603.0	480.6	266.4	252.7	222.7	215.6	162.3
1945	243.6	220.0	250.5	485.4	510.1	493.3	266.8	266.4	252.7	214.5	207.6	162.3
1946	232.5	210.0	239.5	467.1	491.2	475.1	298.1	294.0	281.2	272.0	263.2	266.8
1947	273.8	247.3	280.9	806.2	841.6	814.2	297.9	297.9	285.0	275.9	267.0	266.8
1948	279.1	261.0	286.1	962.4	1003.1	970.4	386.4	272.4	260.3	250.4	242.3	266.8
1949	266.1	216.2	245.6	581.1	609.1	589.1	266.8	266.4	252.7	210.5	203.7	162.3
1950	227.1	205.1	234.0	501.6	526.9	509.6	361.3	295.7	282.8	273.7	264.9	266.8
1951	276.0	249.3	283.1	584.5	612.6	592.5	272.7	272.7	260.6	250.6	242.6	266.8
1952	266.1	224.3	245.6	772.2	806.5	780.1	266.8	266.4	252.7	192.0	185.8	162.3
1953	202.2	182.7	209.2	522.8	548.8	530.9	284.8	268.1	256.1	246.1	238.2	266.8
1954	266.1	216.2	245.6	329.0	348.5	337.0	266.8	266.4	252.7	199.5	193.1	162.3
1955	212.3	191.8	219.4	411.1	433.3	419.1	292.4	266.4	252.7	240.9	234.2	266.8
1956	266.1	224.3	245.6	665.0	695.7	672.9	266.8	266.4	252.7	184.9	179.0	162.3
1957	192.8	174.1	199.7	578.5	606.4	586.6	266.8	266.4	252.7	240.9	234.2	266.8
1958	266.1	216.2	245.6	468.4	492.5	476.4	266.8	266.4	252.7	209.2	202.4	162.3
1959	225.3	203.5	232.4	508.7	534.3	516.7	325.1	325.1	311.3	303.0	293.3	266.8
1960	315.4	295.0	322.4	518.6	544.4	526.6	266.8	266.4	252.7	178.9	173.2	162.3
1961	184.7	166.8	191.6	307.3	326.1	315.2	266.8	266.4	252.7	174.6	169.0	162.3
1962	178.8	161.5	185.9	611.3	640.2	619.3	279.7	279.7	267.3	257.7	249.3	266.8
1963	266.1	224.4	255.4	521.7	547.7	529.7	285.6	266.4	252.7	233.8	226.2	162.3
1964	258.2	241.5	265.1	672.2	703.2	680.3	490.3	284.0	271.5	261.9	253.5	266.8
1965	266.1	232.4	264.2	805.9	841.3	813.9	612.8	337.9	323.7	315.9	305.7	266.8

1966	332.9	300.6	339.9	287.9	306.1	295.9	266.8	266.4	252.7	171.8	166.3	162.3
1967	175.1	158.2	182.1	699.2	731.1	707.2	512.7	293.5	280.8	271.5	262.8	266.8
1968	273.1	255.5	280.1	597.6	626.1	605.6	339.5	328.3	314.4	306.3	296.4	266.8
1969	320.0	289.0	326.9	711.8	744.1	719.9	476.7	306.4	293.2	284.3	275.2	266.8
1970	290.4	262.3	297.4	772.0	806.3	780.0	409.4	311.9	298.6	290.0	280.6	266.8
1971	297.9	269.1	304.9	784.4	819.2	792.4	475.0	324.9	311.2	302.9	293.2	266.8
1972	315.2	294.9	322.3	683.4	714.8	691.4	302.1	302.1	289.1	280.1	271.1	266.8
1973	284.6	257.1	291.7	383.1	404.4	391.0	267.5	267.5	255.6	245.5	237.5	266.8
1974	266.1	216.2	245.6	685.9	717.4	693.9	266.8	266.6	254.7	244.6	236.7	266.8
1975	266.1	216.2	245.6	701.2	733.1	709.2	946.5	374.5	359.1	352.5	341.1	266.8
1976	381.6	357.0	388.6	882.6	920.5	890.6	373.5	329.5	315.6	307.5	297.6	266.8
1977	321.6	290.4	328.6	305.3	324.0	313.2	266.8	266.4	252.7	225.7	218.4	162.3
1978	247.6	223.6	254.5	647.2	677.3	655.2	468.8	297.4	284.5	275.4	266.5	266.8
1979	278.3	251.3	285.3	529.1	555.3	537.0	266.8	266.4	252.7	215.5	208.5	162.3
1980	233.6	218.6	240.6	679.6	710.8	687.6	312.6	296.8	284.0	274.8	265.9	266.8
1981	277.6	250.7	284.6	757.4	791.2	765.3	281.1	281.1	268.7	259.1	250.7	266.8
1982	266.1	227.1	258.4	767.6	801.8	775.6	700.0	338.5	324.3	316.6	306.3	266.8
1983	333.7	301.4	340.7	580.7	608.6	588.7	600.2	374.2	358.8	352.2	340.8	266.8
1984	381.3	356.7	388.2	852.3	889.3	860.3	579.3	361.9	343.2	336.0	325.2	266.8
1985	359.8	325.0	366.9	445.8	469.3	453.8	266.8	266.4	252.7	233.3	225.8	162.3
1986	257.7	232.8	264.7	610.3	639.2	618.3	281.6	281.6	269.3	259.7	251.3	266.8
1987	266.1	228.0	259.5	257.3	274.5	265.3	266.8	266.4	252.7	193.3	187.0	162.3
1988	203.9	190.7	210.8	347.8	368.0	355.9	266.8	266.4	252.7	161.0	156.8	162.3
1989	161.6	144.0	165.7	275.3	293.0	283.2	266.8	266.4	252.7	173.5	167.9	162.3
1990	177.4	160.3	184.4	277.4	295.2	285.3	266.8	266.4	252.7	177.9	172.2	162.3
1991	183.2	165.5	190.3	392.5	414.2	400.5	266.8	266.4	252.7	201.3	194.8	162.3
1992	214.5	200.7	221.5	245.7	265.4	241.6	266.8	266.4	252.7	161.0	156.8	162.3
1993	161.6	144.0	165.7	459.2	483.1	467.2	469.0	339.5	308.1	299.8	290.1	242.2
1994	319.7	288.7	326.7	245.7	265.4	241.6	266.8	266.4	252.7	175.6	170.0	162.3
1995	180.2	162.8	187.3	608.5	637.4	616.5	567.1	347.7	333.2	325.7	315.1	266.8
1996	345.7	323.4	352.7	740.2	773.5	748.2	289.4	289.4	276.7	267.4	258.7	266.8
1997	267.6	241.7	274.5	924.8	964.2	932.8	478.1	365.0	350.0	343.0	332.0	266.8
1998	369.3	333.6	376.3	534.8	561.2	542.8	629.4	333.1	319.1	311.1	301.1	266.8
1999	326.4	294.8	333.4	501.7	526.9	509.7	274.7	274.7	262.6	252.7	244.6	266.8
2000	266.1	224.3	245.6	245.7	265.4	241.6	266.8	266.4	252.7	164.7	159.4	162.3
2001	165.5	149.5	172.6	245.7	265.4	241.6	266.8	266.4	252.7	240.9	234.2	266.8
AVE	250.9	224.4	252.9	535.4	562.1	542.4	344.7	286.6	272.8	238.7	231.1	215.6

CANYON FERRY RESERVOIR - END-OF-MONTH ELEVATIONS - NO ACTION ALTERNATIVE - FEET

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928	3776.5	3776.0	3776.7	3775.0	3781.0	3795.2	3795.8	3791.5	3789.6	3790.0	3791.4	3794.0
1929	3791.1	3787.7	3787.6	3780.1	3777.8	3795.2	3796.0	3791.2	3790.6	3789.5	3789.5	3790.1
1930	3787.2	3787.3	3787.6	3786.9	3788.8	3795.2	3793.1	3792.4	3789.2	3790.7	3791.9	3791.6
1931	3789.6	3788.0	3787.6	3788.5	3788.2	3793.5	3788.9	3780.2	3775.7	3773.1	3774.8	3772.5
1932	3771.5	3771.3	3773.3	3766.4	3771.6	3795.2	3797.2	3792.5	3787.4	3787.5	3789.2	3788.0
1933	3787.9	3786.8	3787.6	3777.3	3772.5	3795.2	3794.3	3790.6	3786.3	3785.0	3784.9	3785.3
1934	3783.7	3782.6	3787.6	3790.5	3789.7	3795.2	3792.5	3786.1	3781.4	3778.6	3778.7	3777.1
1935	3777.3	3776.6	3778.4	3778.3	3780.3	3795.2	3797.3	3791.1	3786.4	3784.4	3785.0	3783.8
1936	3782.5	3780.7	3782.5	3777.5	3782.4	3795.2	3794.8	3789.1	3784.8	3782.5	3782.7	3782.1
1937	3780.2	3781.2	3781.3	3782.2	3784.5	3794.8	3798.2	3792.9	3787.7	3785.6	3786.3	3785.1
1938	3784.2	3784.4	3785.7	3778.6	3777.1	3795.2	3798.2	3795.6	3790.4	3790.7	3791.1	3791.2
1939	3789.4	3786.3	3787.6	3784.1	3787.9	3795.2	3795.8	3788.6	3786.0	3785.0	3785.8	3784.9
1940	3784.5	3785.0	3787.2	3788.3	3789.9	3795.2	3798.0	3790.4	3789.4	3790.6	3790.2	3789.8
1941	3787.5	3786.4	3787.6	3785.7	3783.3	3795.2	3796.3	3794.2	3795.4	3794.8	3794.3	3796.4
1942	3791.8	3788.2	3787.6	3780.7	3778.0	3795.2	3798.2	3794.1	3792.6	3789.9	3789.1	3787.6
1943	3784.9	3786.2	3787.6	3779.8	3773.0	3795.2	3798.2	3795.3	3793.8	3791.7	3791.7	3790.3
1944	3789.1	3788.2	3787.6	3778.3	3769.0	3795.2	3798.2	3792.1	3790.5	3789.2	3789.4	3790.1
1945	3789.8	3789.2	3787.6	3780.3	3777.1	3795.2	3795.3	3786.9	3786.1	3785.0	3786.1	3787.2
1946	3786.6	3786.4	3787.6	3784.4	3787.7	3795.2	3798.2	3789.9	3790.3	3789.1	3787.7	3787.7
1947	3786.1	3784.7	3787.6	3776.6	3779.0	3795.2	3796.3	3787.6	3788.1	3788.8	3788.9	3789.0
1948	3787.9	3786.6	3787.6	3769.9	3773.6	3795.2	3798.2	3793.3	3790.7	3789.8	3790.3	3789.0
1949	3786.6	3785.7	3787.5	3784.1	3789.1	3795.2	3794.2	3785.7	3785.6	3786.2	3787.4	3788.6
1950	3787.1	3787.0	3787.6	3781.1	3775.8	3795.2	3798.2	3792.7	3792.1	3791.6	3792.0	3791.7
1951	3789.4	3788.3	3787.6	3782.1	3787.8	3795.2	3795.1	3791.2	3789.9	3790.5	3790.8	3788.5
1952	3786.1	3786.3	3787.5	3777.5	3787.3	3795.2	3796.0	3789.8	3786.9	3785.8	3786.9	3789.5
1953	3791.1	3791.4	3787.6	3780.2	3774.0	3795.2	3798.2	3795.1	3792.5	3789.9	3790.2	3788.4
1954	3786.4	3786.9	3786.9	3785.3	3787.8	3795.2	3797.6	3793.6	3791.4	3789.6	3790.8	3791.5
1955	3790.1	3788.4	3787.6	3782.9	3783.9	3795.2	3798.2	3794.4	3790.7	3787.5	3786.8	3785.5
1956	3783.5	3781.4	3783.5	3775.5	3782.8	3795.2	3794.4	3789.8	3787.2	3785.7	3787.2	3788.1
1957	3786.0	3786.1	3787.6	3777.1	3781.2	3795.2	3796.9	3792.0	3790.2	3788.8	3789.2	3787.8
1958	3785.3	3784.6	3784.1	3778.7	3788.1	3795.2	3795.9	3791.5	3788.7	3787.5	3788.3	3790.4
1959	3788.8	3787.2	3787.6	3780.7	3775.7	3795.2	3797.9	3789.4	3784.0	3785.8	3789.1	3791.7
1960	3788.7	3787.1	3787.6	3785.5	3785.8	3795.2	3793.2	3787.6	3784.9	3783.7	3785.5	3786.6
1961	3786.3	3787.1	3787.6	3783.3	3781.1	3795.2	3791.4	3786.0	3782.0	3782.7	3785.3	3785.6
1962	3784.9	3785.9	3787.6	3782.6	3781.2	3795.2	3795.9	3792.0	3789.6	3788.7	3789.7	3788.6
1963	3785.2	3787.3	3787.6	3779.9	3781.0	3795.2	3798.2	3793.4	3792.1	3790.4	3791.3	3792.4
1964	3790.4	3788.8	3787.6	3774.6	3772.2	3795.2	3798.2	3793.4	3792.1	3789.8	3790.3	3789.3
1965	3789.2	3788.6	3787.6	3775.8	3773.5	3795.2	3798.2	3794.6	3794.1	3794.9	3795.9	3795.9

1966	3792.7	3790.0	3787.6	3789.1	3791.0	3795.2	3793.1	3786.5	3782.3	3781.4	3783.4	3784.8
1967	3785.7	3786.0	3787.6	3772.1	3768.6	3795.2	3798.2	3792.7	3789.4	3788.5	3789.2	3787.3
1968	3785.3	3786.3	3787.6	3778.6	3775.7	3795.2	3798.2	3793.6	3792.1	3792.3	3793.6	3792.5
1969	3789.4	3787.5	3787.6	3785.5	3793.6	3795.2	3798.2	3796.5	3793.0	3792.0	3793.3	3792.3
1970	3790.4	3789.0	3787.6	3770.2	3770.9	3795.2	3798.2	3792.5	3790.6	3790.2	3790.9	3790.3
1971	3788.7	3788.9	3787.6	3773.7	3776.3	3795.2	3798.2	3792.1	3790.2	3790.1	3791.2	3789.8
1972	3787.4	3786.2	3787.6	3775.8	3774.3	3795.2	3795.9	3790.5	3790.9	3791.2	3792.9	3791.5
1973	3789.7	3788.2	3787.6	3785.5	3788.7	3795.2	3793.6	3786.6	3784.9	3784.8	3787.2	3786.8
1974	3785.6	3785.6	3786.8	3776.6	3769.7	3795.2	3797.4	3792.2	3789.2	3788.4	3789.8	3788.8
1975	3787.1	3786.1	3786.7	3771.5	3769.8	3795.2	3798.2	3796.9	3793.3	3792.9	3793.9	3796.5
1976	3793.6	3790.4	3787.6	3775.0	3787.6	3795.2	3798.2	3795.0	3795.3	3795.9	3796.3	3796.0
1977	3792.5	3790.3	3787.6	3788.8	3785.8	3795.2	3792.1	3786.4	3783.5	3784.6	3785.1	3787.2
1978	3786.2	3785.5	3787.6	3781.0	3779.9	3795.2	3798.2	3794.8	3794.4	3794.1	3793.3	3791.6
1979	3788.4	3786.6	3787.6	3782.2	3787.6	3795.2	3793.8	3790.3	3788.5	3787.1	3787.8	3789.6
1980	3787.3	3787.2	3787.6	3777.4	3780.8	3795.2	3798.2	3792.6	3791.7	3791.2	3791.8	3791.6
1981	3790.2	3788.6	3787.6	3772.5	3777.2	3795.2	3797.7	3793.7	3789.7	3789.5	3790.0	3789.2
1982	3786.7	3787.0	3787.6	3773.5	3774.8	3795.2	3798.2	3794.8	3792.3	3793.3	3793.5	3793.3
1983	3791.7	3789.3	3787.6	3779.3	3778.2	3795.2	3798.2	3795.3	3792.9	3793.4	3794.9	3794.6
1984	3792.4	3789.8	3787.6	3772.6	3776.0	3795.2	3798.2	3798.2	3797.2	3797.6	3798.0	3797.0
1985	3793.4	3789.6	3787.6	3788.4	3790.4	3795.2	3791.9	3787.1	3784.6	3786.0	3785.4	3787.3
1986	3786.3	3786.0	3787.6	3780.8	3778.9	3795.2	3795.6	3791.6	3791.2	3791.8	3792.9	3791.1
1987	3788.9	3788.0	3787.6	3788.8	3787.6	3795.2	3793.9	3789.7	3787.5	3787.1	3788.0	3788.4
1988	3787.2	3787.1	3787.6	3786.6	3788.6	3795.2	3790.9	3784.7	3779.5	3779.1	3779.9	3779.5
1989	3779.5	3778.3	3781.9	3783.6	3790.9	3795.2	3791.1	3788.4	3783.7	3784.5	3786.4	3787.2
1990	3787.2	3786.8	3787.6	3787.8	3787.2	3795.2	3794.0	3791.1	3788.0	3787.8	3789.3	3788.9
1991	3787.7	3787.8	3787.6	3781.0	3782.4	3795.2	3795.8	3791.6	3788.2	3787.6	3789.4	3790.8
1992	3789.2	3788.2	3787.6	3786.3	3784.8	3785.2	3786.3	3782.2	3778.1	3779.7	3782.1	3781.8
1993	3781.3	3781.2	3784.9	3778.3	3784.5	3795.2	3798.2	3798.2	3797.5	3797.7	3797.2	3797.0
1994	3794.2	3790.3	3787.6	3789.6	3792.7	3794.1	3790.9	3786.7	3781.8	3781.6	3783.0	3783.7
1995	3783.1	3784.9	3787.6	3778.5	3777.5	3795.2	3798.2	3795.4	3793.6	3793.1	3793.8	3794.0
1996	3790.3	3788.7	3787.6	3778.2	3778.6	3795.2	3796.5	3792.9	3789.8	3788.9	3789.3	3787.4
1997	3786.9	3786.7	3787.6	3769.1	3773.3	3795.2	3798.2	3797.4	3795.0	3795.0	3795.8	3795.9
1998	3792.4	3789.6	3787.6	3783.1	3784.7	3795.2	3798.2	3796.3	3792.9	3791.6	3791.5	3790.9
1999	3789.7	3788.4	3787.6	3781.9	3781.8	3795.2	3797.0	3794.1	3791.4	3790.1	3790.2	3789.3
2000	3788.2	3787.9	3787.6	3787.7	3789.4	3793.8	3791.7	3787.2	3782.5	3783.5	3784.6	3785.1
2001	3785.7	3786.1	3787.6	3786.0	3785.6	3786.7	3784.7	3780.2	3774.6	3770.2	3767.6	3762.3
AVE	3787.3	3786.4	3786.7	3780.4	3781.4	3794.9	3795.8	3791.3	3788.8	3788.2	3788.9	3788.7

CANYON FERRY RESERVOIR - END-OF-MONTH ELEVATIONS - PREFERRED ALTERNATIVE - FEET

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928	3776.5	3776.0	3776.5	3774.8	3781.0	3795.2	3795.8	3791.6	3789.5	3790.0	3791.4	3794.0
1929	3791.2	3787.8	3787.6	3780.1	3777.8	3795.2	3796.0	3791.1	3790.4	3789.4	3789.4	3790.0
1930	3787.2	3787.4	3787.6	3786.9	3788.9	3795.2	3793.1	3792.3	3788.9	3790.5	3791.8	3791.5
1931	3789.6	3788.2	3787.6	3788.5	3788.1	3793.3	3788.7	3779.9	3775.2	3772.6	3774.3	3771.9
1932	3770.9	3770.7	3772.5	3765.8	3771.4	3795.2	3797.2	3792.5	3787.2	3787.3	3789.1	3787.9
1933	3787.9	3786.9	3787.6	3777.3	3772.5	3795.2	3794.2	3790.6	3786.0	3784.8	3784.8	3785.2
1934	3783.7	3782.7	3787.6	3790.5	3789.8	3795.2	3792.5	3786.1	3781.2	3778.3	3778.5	3776.8
1935	3777.1	3776.3	3777.9	3778.0	3780.2	3795.2	3797.3	3791.0	3786.2	3784.2	3784.8	3783.5
1936	3782.2	3780.5	3782.0	3777.2	3782.3	3795.2	3794.8	3789.1	3784.6	3782.2	3782.5	3781.8
1937	3779.9	3781.0	3780.8	3781.6	3783.9	3794.2	3797.6	3792.2	3786.8	3784.6	3785.4	3784.1
1938	3783.3	3783.4	3784.6	3777.8	3776.8	3795.2	3798.2	3795.5	3790.2	3790.5	3791.0	3791.1
1939	3789.4	3786.5	3787.6	3784.1	3787.9	3795.2	3795.7	3788.5	3785.7	3784.7	3785.6	3784.6
1940	3784.3	3784.7	3786.7	3788.0	3789.8	3795.2	3798.0	3790.3	3789.2	3790.5	3790.1	3789.7
1941	3787.5	3786.5	3787.6	3785.7	3783.4	3795.2	3796.3	3794.3	3795.3	3794.7	3794.3	3796.5
1942	3791.8	3788.3	3787.6	3780.7	3778.1	3795.2	3798.2	3794.1	3792.5	3789.9	3789.1	3787.6
1943	3784.9	3786.3	3787.6	3779.8	3773.1	3795.2	3798.2	3795.3	3793.7	3791.7	3791.7	3790.3
1944	3789.1	3788.3	3787.6	3778.3	3769.1	3795.2	3798.2	3792.1	3790.3	3789.1	3789.3	3790.1
1945	3789.8	3789.3	3787.6	3780.3	3777.1	3795.2	3795.3	3786.9	3785.9	3784.8	3786.0	3787.1
1946	3786.6	3786.6	3787.6	3784.4	3787.8	3795.2	3798.2	3789.9	3790.2	3789.0	3787.7	3787.7
1947	3786.1	3784.9	3787.6	3776.6	3779.1	3795.2	3796.3	3787.6	3788.0	3788.7	3788.9	3789.0
1948	3788.0	3786.8	3787.6	3769.9	3773.7	3795.2	3798.2	3793.3	3790.5	3789.8	3790.3	3789.0
1949	3786.6	3785.7	3787.2	3783.9	3789.1	3795.2	3794.1	3785.6	3785.4	3786.1	3787.3	3788.5
1950	3787.1	3787.1	3787.6	3781.1	3775.9	3795.2	3798.2	3792.7	3791.9	3791.6	3792.0	3791.7
1951	3789.5	3788.5	3787.6	3782.1	3787.9	3795.2	3795.1	3791.2	3789.8	3790.4	3790.9	3788.5
1952	3786.1	3786.3	3787.3	3777.4	3787.2	3795.2	3796.0	3789.7	3786.6	3785.6	3786.9	3789.4
1953	3791.1	3791.6	3787.6	3780.2	3774.1	3795.2	3798.2	3795.1	3792.4	3789.8	3790.2	3788.4
1954	3786.4	3786.9	3786.7	3785.2	3787.8	3795.2	3797.6	3793.5	3791.2	3789.5	3790.7	3791.4
1955	3790.1	3788.5	3787.6	3782.9	3784.0	3795.2	3798.2	3794.4	3790.5	3787.3	3786.6	3785.3
1956	3783.3	3781.2	3783.0	3775.2	3782.7	3795.2	3794.4	3789.8	3786.9	3785.5	3787.1	3788.0
1957	3786.0	3786.2	3787.6	3777.1	3781.3	3795.2	3796.8	3792.0	3790.0	3788.6	3789.0	3787.5
1958	3785.1	3784.4	3783.6	3778.4	3788.0	3795.2	3795.9	3791.4	3788.5	3787.3	3788.2	3790.3
1959	3788.8	3787.3	3787.6	3780.7	3775.7	3795.2	3797.9	3789.5	3783.9	3785.7	3789.1	3791.7
1960	3788.8	3787.2	3787.6	3785.5	3785.9	3795.2	3793.2	3787.6	3784.6	3783.5	3785.4	3786.5
1961	3786.3	3787.2	3787.6	3783.3	3781.2	3795.2	3791.4	3785.9	3781.8	3782.5	3785.2	3785.5
1962	3784.9	3786.0	3787.6	3782.6	3781.3	3795.2	3795.9	3792.0	3789.5	3788.7	3789.7	3788.6
1963	3785.2	3787.4	3787.6	3779.9	3781.1	3795.2	3798.2	3793.3	3791.9	3790.2	3791.2	3792.4
1964	3790.4	3789.0	3787.6	3774.6	3772.2	3795.2	3798.2	3793.4	3791.9	3789.7	3790.3	3789.3
1965	3789.2	3788.7	3787.6	3775.8	3773.6	3795.2	3798.2	3794.6	3794.0	3794.8	3795.9	3795.9

1966	3792.8	3790.1	3787.6	3789.1	3791.0	3795.2	3793.1	3786.4	3782.0	3781.3	3783.3	3784.7
1967	3785.7	3786.1	3787.6	3772.1	3768.7	3795.2	3798.2	3792.8	3789.2	3788.5	3789.2	3787.3
1968	3785.4	3786.4	3787.6	3778.6	3775.7	3795.2	3798.2	3793.6	3792.0	3792.2	3793.6	3792.5
1969	3789.5	3787.7	3787.6	3785.5	3793.7	3795.2	3798.2	3796.5	3792.9	3791.9	3793.3	3792.3
1970	3790.4	3789.1	3787.6	3770.2	3771.0	3795.2	3798.2	3792.5	3790.5	3790.2	3790.9	3790.3
1971	3788.7	3789.0	3787.6	3773.7	3776.4	3795.2	3798.2	3792.2	3790.0	3790.0	3791.2	3789.8
1972	3787.5	3786.3	3787.6	3775.8	3774.4	3795.2	3795.9	3790.5	3790.8	3791.2	3792.9	3791.5
1973	3789.8	3788.4	3787.6	3785.5	3788.7	3795.2	3793.6	3786.7	3784.8	3784.8	3787.3	3786.8
1974	3785.6	3785.6	3786.6	3776.5	3769.7	3795.2	3797.4	3792.3	3789.1	3788.4	3789.8	3788.9
1975	3787.1	3786.1	3786.5	3771.3	3769.8	3795.2	3798.2	3797.0	3793.2	3792.8	3793.9	3796.4
1976	3793.7	3790.5	3787.6	3775.0	3787.6	3795.2	3798.2	3795.0	3795.2	3795.9	3796.3	3796.0
1977	3792.6	3790.4	3787.6	3788.8	3785.8	3795.2	3792.1	3786.3	3783.3	3784.4	3785.0	3787.1
1978	3786.2	3785.6	3787.6	3781.0	3779.9	3795.2	3798.2	3794.8	3794.2	3794.0	3793.3	3791.6
1979	3788.5	3786.8	3787.6	3782.2	3787.6	3795.2	3793.8	3790.3	3788.3	3786.9	3787.7	3789.5
1980	3787.4	3787.3	3787.6	3777.4	3780.8	3795.2	3798.2	3792.6	3791.6	3791.2	3791.8	3791.6
1981	3790.3	3788.7	3787.6	3772.5	3777.3	3795.2	3797.7	3793.7	3789.6	3789.4	3790.1	3789.3
1982	3786.7	3787.1	3787.6	3773.5	3774.8	3795.2	3798.2	3794.8	3792.2	3793.2	3793.5	3793.3
1983	3791.8	3789.4	3787.6	3779.3	3778.3	3795.2	3798.2	3795.3	3792.8	3793.4	3794.9	3794.6
1984	3792.5	3789.9	3787.6	3772.6	3776.1	3795.2	3798.2	3798.2	3797.1	3797.5	3798.0	3797.0
1985	3793.5	3789.7	3787.6	3788.4	3790.5	3795.2	3791.8	3787.0	3784.3	3785.8	3785.3	3787.2
1986	3786.3	3786.1	3787.6	3780.8	3779.0	3795.2	3795.6	3791.7	3791.1	3791.8	3792.9	3791.2
1987	3788.9	3788.1	3787.6	3788.8	3787.7	3795.2	3793.8	3789.6	3787.2	3786.9	3787.9	3788.3
1988	3787.2	3787.2	3787.6	3786.6	3788.7	3795.2	3790.9	3784.6	3779.3	3778.9	3779.6	3779.3
1989	3779.2	3778.0	3781.4	3783.3	3790.8	3795.2	3791.1	3788.3	3783.4	3784.3	3786.3	3787.1
1990	3787.2	3786.9	3787.6	3787.8	3787.2	3795.2	3793.9	3791.1	3787.7	3787.7	3789.2	3788.8
1991	3787.7	3787.9	3787.6	3781.0	3782.5	3795.2	3795.8	3791.6	3787.9	3787.4	3789.3	3790.7
1992	3789.2	3788.3	3787.6	3786.2	3784.7	3785.0	3786.1	3782.0	3777.6	3779.2	3781.6	3781.3
1993	3780.8	3780.7	3784.2	3777.8	3784.4	3795.2	3798.2	3798.2	3797.3	3797.6	3797.2	3797.0
1994	3794.3	3790.4	3787.6	3789.5	3792.6	3793.9	3790.7	3786.5	3781.4	3781.2	3782.8	3783.5
1995	3783.0	3785.0	3787.6	3778.5	3777.5	3795.2	3798.2	3795.4	3793.5	3793.0	3793.8	3794.0
1996	3790.4	3788.9	3787.6	3778.2	3778.7	3795.2	3796.5	3793.0	3789.7	3788.9	3789.4	3787.4
1997	3787.0	3786.9	3787.6	3769.1	3773.4	3795.2	3798.2	3797.5	3794.9	3795.0	3795.8	3795.9
1998	3792.5	3789.7	3787.6	3783.1	3784.8	3795.2	3798.2	3796.3	3792.7	3791.5	3791.5	3790.9
1999	3789.7	3788.6	3787.6	3781.9	3781.9	3795.2	3797.1	3794.1	3791.3	3790.1	3790.2	3789.3
2000	3788.2	3788.0	3787.5	3787.6	3789.3	3793.6	3791.5	3786.9	3782.0	3783.1	3784.3	3784.9
2001	3785.7	3786.2	3787.6	3786.0	3785.5	3786.5	3784.4	3780.0	3774.0	3769.6	3767.0	3761.6
AVE	3787.2	3786.4	3786.6	3780.4	3781.5	3794.9	3795.8	3791.2	3788.5	3788.0	3788.8	3788.6

Helena Valley Regulating Reservoir

No Action Alternative

Assuming the full Helena Valley Irrigation District Demands are met

Use City of Helena Present Contract amount of 5600 Acre-feet per year

		Extra Pump to HVR from CF	Pumped from CF	Total Pumped from CF for No Action	Computed Inflow to HVR	Losses	Extra Canal Losses	Add'l Inflow to HVR for Target Elevations	Canal Release	Helena Munic Present	Helena Additional Demand 2044	Helena Total Demand 2044	Evap or Seepage	Historic HVR EOM	Historic HVR Elevation	No Action HVR Operation EOM	No Action HVR Operation Elevation
		AF	AF	AF	AF	%	AF	AF	AF	AF	AF	AF	AF	AF	ELEV	AF	ELEV
Column #		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Year	Month													6141	3810.0	10500	3820.1
1982	Oct	286	99	385	-413	0.05	14	272	0	459	0	0	0	6461	3810.9	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6114	3810.0	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	5944	3809.5	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5712	3808.8	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5099	3806.8	7443	3813.5
	Mar	4058	0	4058	-257	0.1	369	3689	0	375	0	0	0	4842	3806.0	10500	3820.1
	Apr	-1289	2555	1266	2211	0.13	0	-1289	592	330	0	0	0	6461	3810.9	10500	3820.1
	May	595	10969	11564	9857	0.10	55	540	10140	257	0	0	0	9785	3818.7	10500	3820.1
	Jun	635	16455	17090	14020	0.15	82	553	14036	537	0	0	0	9726	3818.6	10500	3820.1
	Jul	1141	15356	16497	14163	0.08	82	1059	16754	924	0	0	0	6928	3812.2	8044	3815.0
	Aug	-893	17090	16197	14927	0.13	0	-893	14618	627	0	0	0	7024	3812.5	6833	3812.0
	Sep	5569	8463	14032	9484	0.10	506	5063	10236	644	0	0	0	6097	3809.9	10500	3820.1
1983	Oct	741	0	741	-26	0.05	35	706	821	459	0	0	0	4859	3806.0	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	4616	3805.2	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	4278	3804.0	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	3811	3802.2	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	3526	3800.9	7443	3813.5
	Mar	4094	0	4094	-290	0.10	372	3722	0	375	0	0	0	3077	3799.0	10500	3820.1
	Apr	-4580	7772	3192	6700	0.14	0	-4580	1790	330	0	0	0	7865	3814.5	10500	3820.1
	May	446	11536	11982	9975	0.14	53	393	10111	257	0	0	0	7768	3814.3	10500	3820.1
	Jun	408	17070	17478	18380	-0.08	-34	442	18285	537	0	0	0	8496	3816.0	10500	3820.1
	Jul	-2062	12261	10199	12039	0.02	0	-2062	11509	924	0	0	0	8851	3816.8	8044	3815.0
	Aug	1967	14273	16240	13938	0.02	45	1922	16444	627	0	0	0	6094	3809.9	6833	3812.0
	Sep	6791	6083	12874	3401	0.44	2078	4713	3803	644	0	0	0	5692	3808.7	10500	3820.1
1984	Oct	1061	0	1061	-1202		0	1061	0	459	0	0	0	4490	3804.7	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	4745	3805.6	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	4763	3805.7	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	4305	3804.1	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	3927	3802.6	7443	3813.5
	Mar	3990	0	3990	-195	0.10	363	3627	0	375	0	0	0	3732	3801.8	10500	3820.1
	Apr	-4265	5649	1384	5089	0.10	0	-4265	494	330	0	0	0	8327	3815.6	10500	3820.1
	May	271	14531	14802	10433	0.28	60	211	10387	257	0	0	0	8261	3815.5	10500	3820.1
	Jun	1228	16892	18120	13792	0.18	190	1038	14293	537	0	0	0	7386	3813.4	10500	3820.1
	Jul	3831	18371	22202	14386	0.22	683	3148	19066	924	0	0	0	4256	3803.9	8044	3815.0
	Aug	-3171	17804	14633	18925	-0.06	0	-3171	16338	627	0	0	0	6224	3810.3	6833	3812.0
	Sep	2679	11319	13998	11766	-0.04	-110	2789	10244	644	0	0	0	7403	3813.4	10500	3820.1
1985	Oct	195	714	909	-336		0	195	0	459	0	0	0	6974	3812.3	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6459	3811.0	9283	3817.7

	Dec		0	0	-168				0	375	0	0	0	6340	3810.6	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5844	3809.2	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	4877	3806.1	7443	3813.5
	Mar	4433	0	4433	-598	0.10	403	4030	0	375	0	0	0	4504	3804.8	10500	3820.1
	Apr	-4664	6700	2036	6090	0.09	0	-4664	1096	330	0	0	0	9240	3817.6	10500	3820.1
	May	3209	16653	19862	13369	0.20	529	2680	15792	257	0	0	0	6322	3810.6	10500	3820.1
	Jun	1847	18955	20802	16950	0.11	177	1670	18083	537	0	0	0	4582	3805.1	10500	3820.1
	Jul	-3288	20433	17145	15812	0.23	0	-3288	15000	924	0	0	0	4696	3805.5	7100	3812.6
	Aug	-3172	13639	10467	14199	-0.04	0	-3172	10667	627	0	0	0	7768	3814.3	6833	3812.0
	Sep	5657	6757	12414	5526	0.18	872	4785	6000	644	0	0	0	7148	3812.8	10500	3820.1
1986	Oct	186	60	246	-327		0	186	0	459	0	0	0	6580	3811.3	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6378	3810.7	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	5653	3808.6	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5240	3807.3	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	4554	3805.0	7443	3813.5
	Mar	3534	0	3534	219	0.10	321	3213	0	375	0	0	0	4532	3804.9	10500	3820.1
	Apr	-5048	8347	3299	6121	0.27	0	-5048	743	330	0	0	0	9646	3818.4	10500	3820.1
	May	3236	12845	16081	9246	0.28	708	2528	11517	257	0	0	0	7032	3812.5	10500	3820.1
	Jun	794	19589	20383	16866	0.14	97	697	17026	537	0	0	0	6280	3810.4	10500	3820.1
	Jul	-3985	18787	14802	19002	-0.01	0	-3985	16549	924	0	0	0	8104	3815.1	8044	3815.0
	Aug	-855	15404	14549	15707	-0.02	0	-855	15436	627	0	0	0	7789	3814.4	6833	3812.0
	Sep	2120	6896	9016	9775	-0.42	-1520	3640	9104	644	0	0	0	8183	3815.3	10500	3820.1
1987	Oct	407	0	407	-548		0	407	0	459	0	0	0	7516	3813.7	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	7109	3812.7	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6654	3811.5	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5653	3808.6	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5653	3808.6	7443	3813.5
	Mar	3995	0	3995	-200	0.10	363	3632	0	375	0	0	0	5184	3807.1	10500	3820.1
	Apr	-3771	6562	2791	5119	0.22	0	-3771	1018	330	0	0	0	9079	3817.3	10500	3820.1
	May	315	17826	18141	13489	0.24	62	253	13485	257	0	0	0	9607	3818.4	10500	3820.1
	Jun	400	16894	17294	14869	0.12	43	357	14689	537	0	0	0	10284	3819.7	10500	3820.1
	Jul	-1649	17488	15839	17399	0.01	0	-1649	17282	924	0	0	0	9914	3819.0	8044	3815.0
	Aug	-402	12706	12304	15728	-0.24	0	-402	15910	627	0	0	0	9240	3817.6	6833	3812.0
	Sep	10452	10240	20692	9743	0.05	484	9968	16200	644	0	0	0	9442	3818.0	9700	3818.5
1988	Oct	1890	0	1890	-356		0	1890	875	459	0	0	0	8196	3815.3	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	7693	3814.1	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	7508	3813.7	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	6882	3812.1	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	6152	3810.1	7443	3813.5
	Mar	4067	0	4067	-265	0.10	370	3697	0	375	0	0	0	5653	3808.6	10500	3820.1
	Apr	-4122	5550	1428	5412	0.02	0	-4122	960	330	0	0	0	9745	3818.6	10500	3820.1
	May	2733	15900	18633	11506	0.28	592	2141	13390	257	0	0	0	7338	3813.3	10500	3820.1
	Jun	435	18855	19290	17541	0.07	28	407	17411	537	0	0	0	6947	3812.3	10500	3820.1
	Jul	-160	19262	19102	18258	0.05	0	-160	19630	924	0	0	0	4925	3806.2	8044	3815.0
	Aug	-2849	19222	16373	26718	-0.39	0	-2849	24453	627	0	0	0	6519	3811.1	6833	3812.0
	Sep	2284	11807	14091	12381	-0.05	-117	2401	10471	644	0	0	0	8053	3815.0	10500	3820.1
1989	Oct	516	0	516	-657		0	516	0	459	0	0	0	7207	3812.9	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6665	3811.5	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6382	3810.7	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	6155	3810.1	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5818	3809.1	7443	3813.5
	Mar	4435	0	4435	-600	0.10	403	4032	0	375	0	0	0	5026	3806.6	10500	3820.1
	Apr	-4232	5234	1002	4562	0.13	0	-4232	0	330	0	0	0	9413	3818.0	10500	3820.1
	May	1270	10496	11766	8026	0.24	242	1028	8797	257	0	0	0	8402	3815.8	10500	3820.1

	Jun	584	19539	20123	17106	0.12	65	519	17088	537	0	0	0	8117	3815.1	10500	3820.1
	Jul	-2541	20595	18054	21858	-0.06	0	-2541	20849	924	0	0	0	8534	3816.1	8044	3815.0
	Aug	-1190	14030	12840	13346	0.05	0	-1190	12740	627	0	0	0	8599	3816.2	6833	3812.0
	Sep	7256	4021	11277	3549	0.12	762	6494	5732	644	0	0	0	6404	3810.8	10500	3820.1
1990	Oct	-482	344	-138	196	0.43	-145	-337	0	459	0	0	0	6220	3810.3	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	5604	3808.4	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	5302	3807.5	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	4937	3806.3	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	4448	3804.6	7443	3813.5
	Mar	4065	0	4065	-263	0.10	370	3695	0	375	0	0	0	4014	3803.0	10500	3820.1
	Apr	-4117	6148	2031	5431	0.12	0	-4117	984	330	0	0	0	8265	3815.5	10500	3820.1
	May	438	14532	14970	11015	0.24	85	353	11111	257	0	0	0	9539	3818.2	10500	3820.1
	Jun	809	18062	18871	15719	0.13	93	716	15898	537	0	0	0	9617	3818.4	10500	3820.1
	Jul	-384	19680	19296	20139	-0.02	0	-384	21287	924	0	0	0	8130	3815.2	8044	3815.0
	Aug	-4510	14432	9922	14488	0.00	0	-4510	10562	627	0	0	0	8809	3816.7	6833	3812.0
	Sep	9755	5507	15262	2299	0.58	3591	6164	4152	644	0	0	0	6943	3812.2	10500	3820.1
1991	Oct	560	655	1215	-701		0	560	0	459	0	0	0	6242	3810.3	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	5894	3809.3	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	5851	3809.2	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5653	3808.6	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5396	3807.8	7443	3813.5
	Mar	4431	1071	5502	515	0.52	1514	2917	0	375	0	0	0	5911	3809.4	10500	3820.1
	Apr	-2642	8287	5645	3058	0.63	0	-2642	66	330	0	0	0	8883	3816.8	10500	3820.1
	May	392	13460	13852	9600	0.29	87	305	9648	257	0	0	0	9418	3818.0	10500	3820.1
	Jun	622	17388	18010	14258	0.18	95	527	14248	537	0	0	0	10091	3819.3	10500	3820.1
	Jul	596	18251	18847	16397	0.10	55	541	18470	924	0	0	0	8018	3814.9	8044	3815.0
	Aug	-1247	19787	18540	18163	0.08	0	-1247	17500	627	0	0	0	8035	3814.9	6833	3812.0
	Sep	5615	10565	16180	10055	0.05	259	5356	11100	644	0	0	0	6930	3812.2	10500	3820.1
1992	Oct	192	0	192	-324	0.05	9	183	0	459	0	0	0	6520	3811.1	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6261	3810.4	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6149	3810.1	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	6132	3810.0	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5454	3808.0	7443	3813.5
	Mar	4043	0	4043	-243	0.10	368	3675	0	375	0	0	0	5204	3807.2	10500	3820.1
	Apr	-4456	11266	6810	10081	0.11	0	-4456	5295	330	0	0	0	9905	3819.0	10500	3820.1
	May	3353	19192	22545	14692	0.23	637	2716	17651	257	0	0	0	6955	3812.3	10000	3819.1
	Jun	-1742	17453	15711	16011	0.08	0	-1742	13232	537	0	0	0	10440	3820.0	10500	3820.1
	Jul	-1792	18807	17015	16310	0.13	0	-1792	16050	924	0	0	0	10394	3819.9	8044	3815.0
	Aug	481	18339	18820	17447	0.05	22	459	18490	627	0	0	0	9005	3817.1	6833	3812.0
	Sep	6366	10486	16852	9627	0.08	482	5884	11200	644	0	0	0	7444	3813.5	10500	3820.1
1993	Oct	340	0	340	-65	0.05	16	324	400	459	0	0	0	6945	3812.2	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6608	3811.3	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6334	3810.6	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	6067	3809.8	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5835	3809.1	7443	3813.5
	Mar	3949	0	3949	-158	0.10	359	3590	0	375	0	0	0	5678	3808.6	10500	3820.1
	Apr	-3509	8188	4679	3839	0.53	0	-3509	0	330	0	0	0	9556	3818.2	10500	3820.1
	May	862	12944	13806	9028	0.30	200	662	9433	257	0	0	0	9110	3817.3	10500	3820.1
	Jun	-156	16077	15921	15339	0.06	0	-156	14646	537	0	0	0	9772	3818.7	10500	3820.1
	Jul	-1735	11528	9793	12068	-0.05	0	-1735	11865	924	0	0	0	9971	3819.1	8044	3815.0
	Aug	-201	13857	13656	14922	-0.08	0	-201	15305	627	0	0	0	9575	3818.3	6833	3812.0
	Sep	7033	6360	13393	7000	0.01	70	6963	9652	644	0	0	0	6940	3812.2	10500	3820.1
1994	Oct	135	0	135	-270	0.05	6	129	0	459	0	0	0	6627	3811.4	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6437	3810.9	9283	3817.7

	Dec		0	0	-168				0	375	0	0	0	6388	3810.7	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5720	3808.8	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5558	3808.3	7443	3813.5
	Mar	4126	0	4126	-319	0.10	375	3751	0	375	0	0	0	5239	3807.3	10500	3820.1
	Apr	-2709	9259	6550	4915	0.47	0	-2709	1876	330	0	0	0	10170	3819.5	10500	3820.1
	May	258	16832	17090	15584	0.07	18	240	15567	257	0	0	0	10124	3819.4	10500	3820.1
	Jun	1030	17507	18537	15610	0.11	101	929	16002	537	0	0	0	9644	3818.4	10500	3820.1
....	Jul	1756	20929	22685	17926	0.14	220	1536	19538	924	0	0	0	7909	3814.6	9500	3818.1
	Aug	-1885	16356	14471	14619	0.11	0	-1885	14774	627	0	0	0	7614	3813.8	6833	3812.0
	Sep	5651	10526	16177	9198	0.13	633	5018	9905	644	0	0	0	6887	3812.1	10500	3820.1
1995	Oct	11	278	289	0	0.05	1	10	151	459	0	0	0	6583	3811.3	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6307	3810.5	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6064	3809.8	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5590	3808.4	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5314	3807.5	7443	3813.5
	Mar	3900	0	3900	-113	0.10	355	3545	0	375	0	0	0	5289	3807.4	10500	3820.1
	Apr	-3619	7553	3934	6281	0.17	0	-3619	2332	330	0	0	0	9228	3817.6	10500	3820.1
	May	394	10068	10462	9011	0.10	37	357	9111	257	0	0	0	9718	3818.6	10500	3820.1
	Jun	142	17150	17292	15771	0.08	11	131	15365	537	0	0	0	9467	3818.1	10500	3820.1
	Jul	-827	16724	15897	15769	0.06	0	-827	16474	924	0	0	0	8570	3816.1	8044	3815.0
	Aug	-870	20511	19641	18169	0.11	0	-870	17883	627	0	0	0	8788	3816.6	6833	3812.0
	Sep	5848	8576	14424	8579	0.00	-2	5850	10118	644	0	0	0	7196	3812.9	10500	3820.1
1996	Oct	192	0	192	-324	0.05	9	183	0	459	0	0	0	6829	3811.9	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6564	3811.2	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6307	3810.5	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	6149	3810.1	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5785	3809.0	7443	3813.5
	Mar	4016	0	4016	-219	0.10	365	3651	0	375	0	0	0	5571	3808.3	10500	3820.1
	Apr	-3805	5740	1935	5087	0.11	0	-3805	952	330	0	0	0	9703	3818.5	10500	3820.1
	May	19	8688	8707	9068	-0.04	-1	20	8831	257	0	0	0	9930	3819.0	10500	3820.1
	Jun	1671	19502	21173	17464	0.10	158	1513	18440	537	0	0	0	9001	3817.1	10500	3820.1
	Jul	-1452	20300	18848	17909	0.12	0	-1452	17989	924	0	0	0	8479	3815.9	8044	3815.0
	Aug	-1077	19127	18050	17335	0.09	0	-1077	16842	627	0	0	0	8880	3816.8	6833	3812.0
	Sep	5798	9726	15524	9712	0.00	8	5790	11191	644	0	0	0	7184	3812.9	10500	3820.1
1997	Oct	245	0	245	-374	0.05	12	233	0	459	0	0	0	6822	3811.9	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6627	3811.4	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6301	3810.5	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	6023	3809.7	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5788	3809.0	7443	3813.5
	Mar	3960	0	3960	-168	0.10	360	3600	0	375	0	0	0	5571	3808.3	10500	3820.1
	Apr	-4270	8982	4712	7299	0.19	0	-4270	2699	330	0	0	0	10098	3819.3	10500	3820.1
	May	424	11500	11924	10512	0.09	34	390	10645	257	0	0	0	10282	3819.7	10500	3820.1
	Jun	235	13500	13735	12386	0.08	18	217	12066	537	0	0	0	9895	3818.9	10500	3820.1
	Jul	-1936	18129	16193	16552	0.09	0	-1936	16148	924	0	0	0	9836	3818.8	8044	3815.0
	Aug	2584	13963	16547	12890	0.08	184	2400	15874	627	0	0	0	8461	3815.9	6833	3812.0
	Sep	9206	9544	18750	10145	0.10	837	8369	14203	644	0	0	0	6770	3811.8	10500	3820.1
1998	Oct	396	83	479	-518	0.05	19	377	0	459	0	0	0	6572	3811.2	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6282	3810.4	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	5996	3809.6	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5742	3808.8	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5429	3807.9	7443	3813.5
	Mar	4054	0	4054	-253	0.10	369	3685	0	375	0	0	0	5276	3807.4	10500	3820.1
	Apr	-4356	9055	4699	6686	0.26	0	-4356	2000	330	0	0	0	9951	3819.0	10500	3820.1
	May	423	20010	20433	15636	0.22	76	347	15726	257	0	0	0	10328	3819.8	10500	3820.1

	Jun	737	11709	12446	11960	-0.02	-17	754	12197	537	0	0	0	10103	3819.3	10500	3820.1
	Jul	-282	14220	13938	14898	-0.05	0	-282	16148	924	0	0	0	8665	3816.4	8044	3815.0
	Aug	-1325	19893	18568	20795	-0.05	0	-1325	20054	627	0	0	0	9233	3817.6	6833	3812.0
	Sep	6478	10259	16737	10499	-0.02	-155	6633	12821	644	0	0	0	6818	3811.9	10500	3820.1
1999	Oct	197	93	290	-220	0.05	9	188	109	459	0	0	0	6598	3811.3	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6349	3810.6	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6070	3809.8	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5832	3809.1	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5600	3808.4	7443	3813.5
	Mar	3963	215	4178	-171	0.10	360	3603	0	375	0	0	0	5429	3807.9	10500	3820.1
	Apr	-4070	10155	6085	9895	0.03	0	-4070	5495	330	0	0	0	9826	3818.8	10500	3820.1
	May	807	15971	16778	14873	0.07	52	755	15371	257	0	0	0	9261	3817.6	10500	3820.1
	Jun	-446	17477	17031	15829	0.09	0	-446	14846	537	0	0	0	10216	3819.6	10500	3820.1
	Jul	396	18199	18595	16313	0.10	37	359	18204	924	0	0	0	8036	3814.9	8044	3815.0
	Aug	-886	17810	16924	17107	0.04	0	-886	16805	627	0	0	0	8180	3815.3	6833	3812.0
	Sep	5609	7867	13476	8209	-0.04	-255	5864	9762	644	0	0	0	6557	3811.2	10500	3820.1
2000	Oct	164	0	164	-297	0.05	8	156	0	459	0	0	0	6258	3810.4	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6003	3809.6	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	5736	3808.8	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5684	3808.7	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5648	3808.6	7443	3813.5
	Mar	3761	0	3761	13	0.10	342	3419	0	375	0	0	0	5661	3808.6	10500	3820.1
	Apr	-4184	11170	6986	6508	0.42	0	-4184	1994	330	0	0	0	10170	3819.5	10500	3820.1
	May	240	21689	21929	8375	0.61	91	149	8267	257	0	0	0	10216	3819.6	10500	3820.1
	Jun	360	16351	16711	15056	0.08	26	334	14853	537	0	0	0	10246	3819.6	10500	3820.1
	Jul	369	20242	20611	17866	0.12	39	330	19728	924	0	0	0	7842	3814.5	8044	3815.0
	Aug	-3272	20469	17197	23301	-0.14	0	-3272	20613	627	0	0	0	9871	3818.9	6833	3812.0
	Sep	4971	11549	16520	10788	0.07	307	4664	11141	644	0	0	0	9143	3817.4	10500	3820.1
2001	Oct	438	3428	3866	3598	0.05	21	417	4156	459	0	0	0	8542	3816.1	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	8123	3815.1	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	7720	3814.2	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	7330	3813.2	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	6926	3812.2	7443	3813.5
	Mar	3939	0	3939	-149	0.10	358	3581	0	375	0	0	0	6690	3811.6	10500	3820.1
	Apr	-3238	8154	4916	14930	0.35	0	-3238	11362	330	0	0	0	10231	3819.6	10500	3820.1
	May	421	17524	17945	16598	0.05	21	400	16741	257	0	0	0	9915	3819.0	10500	3820.1
	Jun	95	15344	15439	13910	0.09	8	87	13460	537	0	0	0	9991	3819.1	10500	3820.1
	Jul	-1741	17719	15978	15433	0.13	0	-1741	15224	924	0	0	0	9851	3818.8	8044	3815.0
	Aug	684	15581	16265	14300	0.08	52	632	15516	627	0	0	0	8101	3815.1	6833	3812.0
	Sep	5708	11332	17040	10546	0.07	370	5338	11573	644	0	0	0	6741	3811.7	10500	3820.1
2002	Oct	11	126	137	-151	0.05	1	10	0	459	0	0	0	6568	3811.2	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	6304	3810.5	9283	3817.7
	Dec		0	0	-168				0	375	0	0	0	6040	3809.7	8740	3816.5
	Jan		0	0	-281				0	370	0	0	0	5785	3809.0	8089	3815.1
	Feb		0	0	-316				0	330	0	0	0	5570	3808.3	7443	3813.5
	Mar	3972	0	3972	-179	0.10	361	3611	0	375	0	0	0	5391	3807.8	10500	3820.1
	Apr	-3583	7401	3818	6089	0.18	0	-3583	2176	330	0	0	0	9298	3817.7	10500	3820.1
	May	395	15508	15903	13601	0.12	43	352	13696	257	0	0	0	10107	3819.4	10500	3820.1
	Jun	1302	14210	15512	12821	0.10	116	1186	13470	537	0	0	0	9274	3817.7	10500	3820.1
	Jul	-2365	18521	16156	17249	0.07	0	-2365	16416	924	0	0	0	9835	3818.8	8044	3815.0
	Aug	339	18218	18557	16578	0.09	28	311	17473	627	0	0	0	8609	3816.2	6833	3812.0
	Sep	4975	11035	16010	10486	0.05	236	4739	10914	644	0	0	0	7980	3814.8	10500	3820.1
2003	Oct	498	139	637	-615	0.05	24	474	0	459	0	0	0	7363	3813.3	9900	3818.9
	Nov		0	0	-247				0	370	0	0	0	7079	3812.6	9283	3817.7

Dec		0	0	-168				0	375	0	0	0	6792	3811.8	8740	3816.5
Jan		0	0	-281				0	370	0	0	0	6527	3811.1	8089	3815.1
Feb		0	0	-316				0	330	0	0	0	6383	3810.7	7443	3813.5
Mar	3988	0	3988	-193	0.10	363	3625	0	375	0	0	0	6190	3810.2	10500	3820.1
Apr	-3152	7295	4143	6054	0.17	0	-3152	2572	330	0	0	0	9672	3818.5	10500	3820.1
May	1475	10975	12450	11987	-0.09	-150	1625	13355	257	0	0	0	8549	3816.1	10500	3820.1
Jun	-104	21312	21208	20932	0.02	0	-104	20291	537	0	0	0	8737	3816.5	10500	3820.1
Jul	-108	21367	21259	19378	0.09	0	-108	20802	924	0	0	0	6673	3811.5	8044	3815.0
Aug	-2043	20902	18859	20844	0.00	0	-2043	19385	627	0	0	0	7607	3813.8	6833	3812.0
Sep	8656	7521	16177	6560	0.13	981	7675	9924	644	0	0	0	3950	3802.7	10500	3820.1

Column Explanantions

Column #

1 Extra water to be pumped from CF to fill Helena Valley to target elevations
2 Water pumped through siphon from Canyon Ferry to top of bench
3 Total water pumped from Canyon Ferry to HVR for No Action - Col 1 + Col 2
4 Inflow to Helena Valley Reservoir
5 Computation of losses in canal (Col 2 - Col 3)/ Col 2
6 Extra Canal Lossess due to extra diversion
7 Additional inflow to HVR to meet target end-of-month elevations
8 Canal Releases
9 Helena Municipal Diversion from Helena Valley - based upon 5,800 AF existing contract
10 Additional Demand by City of Helena in year 2044 - in the No Action this value is 0
11 Total 2044 Demand by the city of Helena
12 Evaporation or seepage from the seepage - not calculated
13 Helena Valley Historic End of Month content
14 Helena Valley Historic End of Month elevation
15 Helena Valley End of Month content - PEOM + inflow - canal release- municipal demand - No Action Scenario
16 Helena Valley End of Month elevation - No Action scenario

Helena Valley Regulating Reservoir
Proposed Alternative

Includes 412 acres of additional lands for Helena Valley Irrigation District and City of Helena Municipal Demands for Year 2044

Column #		Extra Pump to HVR from CF AF 1	Pumped from CF AF 2	Total Pumped from CF for Proposed Alt AF 3	Computed Inflow to HVR AF 4	Losses % 5	Extra Canal Losses AF 6	Add'l Inflow to HVR for Target Elevations AF 7	Canal Release AF 8	Helena Munic Present AF 9	Helena Additional Demand 2044 AF 10	Helena Total Demand 2044 AF 11	Evap or Seepage AF 12	Historic HVR EOM AF 13	Historic HVR Elevation ELEV 14	Proposed HVR Operation EOM AF 15	Proposed HVR Operation Elevation ELEV 16
Year	Month													6141	3810.0	10500	3820.1
1982	Oct	757	99	856	-413	0.05	36	721	0	459	449	908	0	6461	3810.9	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6114	3810.0	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	5944	3809.5	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5712	3808.8	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5099	3806.8	5997	3809.6
	Mar	6063	0	6063	-257	0.1	551	5512	0	375	377	752	0	4842	3806.0	10500	3820.1
	Apr	-945	2555	1610	2211	0.13	0	-945	620	330	316	646	0	6461	3810.9	10500	3820.1
	May	1085	10969	12054	9857	0.10	100	985	10340	257	245	502	0	9785	3818.7	10500	3820.1
	Jun	1546	16455	18001	14020	0.15	199	1347	14304	537	526	1063	0	9726	3818.6	10500	3820.1
	Jul	2457	15356	17813	14163	0.08	177	2280	17059	924	916	1840	0	6928	3812.2	8044	3815.0
	Aug	5	17090	17095	14927	0.13	1	4	14900	627	615	1242	0	7024	3812.5	6833	3812.0
	Sep	6438	8463	14901	9484	0.10	585	5853	10388	644	638	1282	0	6097	3809.9	10500	3820.1
1983	Oct	1213	0	1213	-26	0.05	58	1155	821	459	449	908	0	4859	3806.0	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	4616	3805.2	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	4278	3804.0	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	3811	3802.2	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	3526	3800.9	5997	3809.6
	Mar	6100	0	6100	-290	0.10	555	5545	0	375	377	752	0	3077	3799.0	10500	3820.1
	Apr	-4236	7772	3536	6700	0.14	0	-4236	1818	330	316	646	0	7865	3814.5	10500	3820.1
	May	951	11536	12487	9975	0.14	113	838	10311	257	245	502	0	7768	3814.3	10500	3820.1
	Jun	1141	17070	18211	18380	-0.08	-95	1236	18553	537	526	1063	0	8496	3816.0	10500	3820.1
	Jul	-841	12261	11420	12039	0.02	0	-841	11814	924	916	1840	0	8851	3816.8	8044	3815.0
	Aug	2885	14273	17158	13938	0.02	66	2819	16726	627	615	1242	0	6094	3809.9	6833	3812.0
	Sep	7929	6083	14012	3401	0.44	2426	5503	3955	644	638	1282	0	5692	3808.7	10500	3820.1
1984	Oct	1510	0	1510	-1202		0	1510	0	459	449	908	0	4490	3804.7	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	4745	3805.6	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	4763	3805.7	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	4305	3804.1	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	3927	3802.6	5997	3809.6
	Mar	5995	0	5995	-195	0.10	545	5450	0	375	377	752	0	3732	3801.8	10500	3820.1
	Apr	-3921	5649	1728	5089	0.10	0	-3921	522	330	316	646	0	8327	3815.6	10500	3820.1
	May	841	14531	15372	10433	0.28	185	656	10587	257	245	502	0	8261	3815.5	10500	3820.1
	Jun	2168	16892	19060	13792	0.18	336	1832	14561	537	526	1063	0	7386	3813.4	10500	3820.1
**********	Jul	3491	18371	21862	14386	0.22	622	2869	19371	924	916	1840	0	4256	3803.9	6544	3811.2
	Aug	-774	17804	17030	18925	-0.06	0	-774	16620	627	615	1242	0	6224	3810.3	6833	3812.0
	Sep	3438	11319	14757	11766	-0.04	-141	3579	10396	644	638	1282	0	7403	3813.4	10500	3820.1
1985	Oct	644	714	1358	-336		0	644	0	459	449	908	0	6974	3812.3	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6469	3811.0	8919	3816.9

	Dec		0	0	-168				0	375	381	756	0	6340	3810.6	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5844	3809.2	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	4877	3806.1	5997	3809.6
	Mar	6438	0	6438	-598	0.10	585	5853	0	375	377	752	0	4504	3804.8	10500	3820.1
	Apr	-4320	6700	2380	6090	0.09	0	-4320	1124	330	316	646	0	9240	3817.6	10500	3820.1
	May	3741	16653	20394	13369	0.20	616	3125	15992	257	245	502	0	6322	3810.6	10500	3820.1
	Jun	2725	18955	21680	16950	0.11	261	2464	18351	537	526	1063	0	4582	3805.1	10500	3820.1
	Jul	-1123	20433	19310	15812	0.23	0	-1123	15305	924	916	1840	0	4696	3805.5	8044	3815.0
	Aug	-3219	13639	10420	14199	-0.04	0	-3219	10949	627	615	1242	0	7768	3814.3	6833	3812.0
	Sep	6591	6757	13348	5526	0.18	1016	5575	6152	644	638	1282	0	7148	3812.8	10500	3820.1
1986	Oct	635	60	695	-327		0	635	0	459	449	908	0	6580	3811.3	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6378	3810.7	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	5653	3808.6	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5240	3807.3	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	4554	3805.0	5997	3809.6
	Mar	5540	0	5540	219	0.10	504	5036	0	375	377	752	0	4532	3804.9	10500	3820.1
	Apr	-4704	8347	3643	6121	0.27	0	-4704	771	330	316	646	0	9646	3818.4	10500	3820.1
	May	3806	12845	16651	9246	0.28	833	2973	11717	257	245	502	0	7032	3812.5	10500	3820.1
	Jun	1698	19589	21287	16866	0.14	207	1491	17294	537	526	1063	0	6280	3810.4	10500	3820.1
	Jul	-2764	18787	16023	19002	-0.01	0	-2764	16854	924	916	1840	0	8104	3815.1	8044	3815.0
	Aug	41	15404	15445	15707	-0.02	-1	42	15718	627	615	1242	0	7789	3814.4	6833	3812.0
	Sep	2581	6896	9477	9775	-0.42	-1849	4430	9256	644	638	1282	0	8183	3815.3	10500	3820.1
1987	Oct	856	0	856	-548		0	856	0	459	449	908	0	7516	3813.7	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	7109	3812.7	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6654	3811.5	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5653	3808.6	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5653	3808.6	5997	3809.6
	Mar	6001	0	6001	-200	0.10	546	5455	0	375	377	752	0	5184	3807.1	10500	3820.1
	Apr	-3427	6562	3135	5119	0.22	0	-3427	1046	330	316	646	0	9079	3817.3	10500	3820.1
	May	868	17826	18694	13489	0.24	170	698	13685	257	245	502	0	9607	3818.4	10500	3820.1
	Jun	1289	16894	18183	14869	0.12	138	1151	14957	537	526	1063	0	10284	3819.7	10500	3820.1
	Jul	-428	17488	17060	17399	0.01	0	-428	17587	924	916	1840	0	9914	3819.0	8044	3815.0
	Aug	377	12706	13083	15728	-0.24	-118	495	16192	627	615	1242	0	9240	3817.6	6833	3812.0
*********	Sep	11070	10240	21310	9743	0.05	512	10558	16352	644	638	1282	0	9442	3818.0	9500	3818.1
1988	Oct	2539	0	2539	-356		0	2539	875	459	449	908	0	8196	3815.3	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	7693	3814.1	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	7508	3813.7	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	6882	3812.1	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	6152	3810.1	5997	3809.6
	Mar	6072	0	6072	-265	0.10	552	5520	0	375	377	752	0	5653	3808.6	10500	3820.1
	Apr	-3778	5550	1772	5412	0.02	0	-3778	988	330	316	646	0	9745	3818.6	10500	3820.1
	May	3301	15900	19201	11506	0.28	715	2586	13590	257	245	502	0	7338	3813.3	10500	3820.1
	Jun	1285	18855	20140	17541	0.07	84	1201	17679	537	526	1063	0	6947	3812.3	10500	3820.1
	Jul	1116	19262	20378	18258	0.05	55	1061	19935	924	916	1840	0	4925	3806.2	8044	3815.0
	Aug	-1952	19222	17270	26718	-0.39	0	-1952	24735	627	615	1242	0	6519	3811.1	6833	3812.0
	Sep	3036	11807	14843	12381	-0.05	-155	3191	10623	644	638	1282	0	8053	3815.0	10500	3820.1
1989	Oct	965	0	965	-657		0	965	0	459	449	908	0	7207	3812.9	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6665	3811.5	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6382	3810.7	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	6155	3810.1	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5818	3809.1	5997	3809.6
	Mar	6441	0	6441	-600	0.10	586	5855	0	375	377	752	0	5026	3806.6	10500	3820.1
	Apr	-3888	5234	1346	4562	0.13	0	-3888	28	330	316	646	0	9413	3818.0	10500	3820.1
	May	1820	10496	12316	8026	0.24	347	1473	8997	257	245	502	0	8402	3815.8	10500	3820.1

	Jun	1476	19539	21015	17106	0.12	163	1313	17356	537	526	1063	0	8117	3815.1	10500	3820.1
	Jul	-1320	20596	19275	21858	-0.06	0	-1320	21154	924	916	1840	0	8534	3816.1	8044	3815.0
	Aug	-293	14030	13737	13346	0.05	0	-293	13022	627	615	1242	0	8599	3816.2	6833	3812.0
	Sep	6890	4021	10911	3992	0.01	49	6841	5884	644	638	1282	0	6404	3810.8	10500	3820.1
1990	Oct	160	344	504	196	0.43	48	112	0	459	449	908	0	6220	3810.3	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	5604	3808.4	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	5302	3807.5	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	4937	3806.3	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	4448	3804.6	5997	3809.6
	Mar	6070	0	6070	-263	0.10	552	5518	0	375	377	752	0	4014	3803.0	10500	3820.1
	Apr	-3773	6148	2375	5431	0.12	0	-3773	1012	330	316	646	0	8265	3815.5	10500	3820.1
	May	991	14532	15523	11015	0.24	193	798	11311	257	245	502	0	9539	3818.2	10500	3820.1
	Jun	1706	18062	19768	15719	0.13	196	1510	16166	537	526	1063	0	9617	3818.4	10500	3820.1
	Jul	817	19680	20497	20139	-0.02	-20	837	21592	924	916	1840	0	8130	3815.2	8044	3815.0
	Aug	-3613	14432	10819	14488	0.00	0	-3613	10844	627	615	1242	0	8809	3816.7	6833	3812.0
	Sep	11005	5507	16512	2299	0.58	4051	6954	4304	644	638	1282	0	6943	3812.2	10500	3820.1
1991	Oct	1009	655	1664	-701		0	1009	0	459	449	908	0	6242	3810.3	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	5894	3809.3	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	5651	3809.2	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5653	3808.6	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5396	3807.8	5997	3809.6
	Mar	7201	1071	8272	515	0.52	2461	4740	0	375	377	752	0	5911	3809.4	10500	3820.1
	Apr	-2298	8287	5989	3058	0.63	0	-2298	114	330	316	646	0	8883	3816.8	10500	3820.1
	May	965	13460	14425	9600	0.29	215	750	9848	257	245	502	0	9418	3818.0	10500	3820.1
	Jun	1559	17388	18947	14258	0.18	238	1321	14516	537	526	1063	0	10091	3819.3	10500	3820.1
	Jul	1941	18251	20192	16397	0.10	179	1762	18775	924	916	1840	0	8018	3814.9	8044	3815.0
	Aug	-350	19787	19437	18163	0.08	0	-350	17782	627	615	1242	0	8035	3814.9	6833	3812.0
	Sep	6443	10565	17008	10056	0.05	297	6146	11252	644	638	1282	0	6930	3812.2	10500	3820.1
1992	Oct	664	0	664	-324	0.05	32	632	0	459	449	908	0	6520	3811.1	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6261	3810.4	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6149	3810.1	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	6132	3810.0	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5454	3808.0	5997	3809.6
	Mar	6048	0	6048	-243	0.10	550	5498	0	375	377	752	0	5204	3807.2	10500	3820.1
	Apr	-4112	11266	7154	10081	0.11	0	-4112	5323	330	316	646	0	9905	3819.0	10500	3820.1
	May	3285	19192	22477	14692	0.23	624	2661	17851	257	245	502	0	6955	3812.3	9500	3818.1
	Jun	-448	17453	17005	16011	0.08	0	-448	13500	537	526	1063	0	10440	3820.0	10500	3820.1
	Jul	-571	18807	18236	16310	0.13	0	-571	16355	924	916	1840	0	10394	3819.9	8044	3815.0
	Aug	1422	18339	19761	17447	0.05	66	1356	18772	627	615	1242	0	9005	3817.1	6833	3812.0
	Sep	7221	10486	17707	9627	0.08	547	6674	11352	644	638	1282	0	7444	3813.5	10500	3820.1
1993	Oct	812	0	812	-65	0.05	39	773	400	459	449	908	0	6945	3812.2	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6608	3811.3	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6334	3810.6	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	6067	3809.8	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5835	3809.1	5997	3809.6
	Mar	5954	0	5954	-158	0.10	541	5413	0	375	377	752	0	5678	3808.6	10500	3820.1
	Apr	-3165	8188	5023	3839	0.53	0	-3165	28	330	316	646	0	9556	3818.2	10500	3820.1
	May	1442	12944	14386	9028	0.30	335	1107	9633	257	245	502	0	9110	3817.3	10500	3820.1
	Jun	667	16077	16744	15339	0.05	29	638	14914	537	526	1063	0	9772	3818.7	10500	3820.1
	Jul	-514	11528	11014	12068	-0.05	0	-514	12170	924	916	1840	0	9971	3819.1	8044	3815.0
	Aug	643	13857	14500	14922	-0.08	-53	696	15587	627	615	1242	0	9575	3818.3	6833	3812.0
	Sep	7831	6360	14191	7000	0.01	78	7753	9804	644	638	1282	0	6940	3812.2	10500	3820.1
1994	Oct	607	0	607	-270	0.05	29	578	0	459	449	908	0	6627	3811.4	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6437	3810.9	8919	3816.9

	Dec		0	0	-168				0	375	381	756	0	6388	3810.7	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5720	3808.8	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5558	3808.3	5997	3809.6
	Mar	6131	0	6131	-319	0.10	557	5574	0	375	377	752	0	5239	3807.3	10500	3820.1
	Apr	-2365	9259	6894	4915	0.47	0	-2365	1904	330	316	646	0	10170	3819.5	10500	3820.1
	May	736	16832	17568	15584	0.07	51	685	15767	257	245	502	0	10124	3819.4	10500	3820.1
	Jun	1910	17507	19417	15610	0.11	187	1723	16270	537	526	1063	0	9644	3818.4	10500	3820.1
	Jul	1488	20929	22417	17926	0.14	187	1301	19843	924	916	1840	0	7909	3814.6	8044	3815.0
	Aug	518	16356	16874	14619	0.11	50	468	15056	627	615	1242	0	7614	3813.8	6833	3812.0
	Sep	6541	10526	17067	9198	0.13	733	5808	10057	644	638	1282	0	6887	3812.1	10500	3820.1
1995	Oct	482	278	760	0	0.05	23	459	151	459	449	908	0	6583	3811.3	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6307	3810.5	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6064	3809.8	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5590	3808.4	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5314	3807.5	5997	3809.6
	Mar	5905	0	5905	-113	0.10	537	5368	0	375	377	752	0	5289	3807.4	10500	3820.1
	Apr	-3275	7553	4278	6281	0.17	0	-3275	2360	330	316	646	0	9228	3817.6	10500	3820.1
	May	886	10068	10954	9011	0.10	84	802	9311	257	245	502	0	9718	3818.6	10500	3820.1
	Jun	999	17150	18149	15771	0.08	74	925	15633	537	526	1063	0	9467	3818.1	10500	3820.1
	Jul	416	16724	17140	15769	0.06	22	394	16779	924	916	1840	0	8570	3816.1	8044	3815.0
	Aug	30	20511	20541	18169	0.11	3	27	18165	627	615	1242	0	8788	3816.6	6833	3812.0
	Sep	6638	8576	15214	8579	0.00	-2	6640	10270	644	638	1282	0	7196	3812.9	10500	3820.1
1996	Oct	664	0	664	-324	0.05	32	632	0	459	449	908	0	6829	3811.9	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6564	3811.2	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6307	3810.5	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	6149	3810.1	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5785	3809.0	5997	3809.6
	Mar	6021	0	6021	-219	0.10	547	5474	0	375	377	752	0	5571	3808.3	10500	3820.1
	Apr	-3461	5740	2279	5087	0.11	0	-3461	980	330	316	646	0	9703	3818.5	10500	3820.1
	May	470	8688	9158	9068	0.01	5	465	9031	257	245	502	0	9930	3819.0	10500	3820.1
	Jun	2548	19502	22050	17464	0.10	241	2307	18708	537	526	1063	0	9001	3817.1	10500	3820.1
	Jul	-231	20300	20069	17909	0.12	0	-231	18294	924	916	1840	0	8479	3815.9	8044	3815.0
	Aug	-180	19127	18947	17335	0.09	0	-180	17124	627	615	1242	0	8880	3816.8	6833	3812.0
	Sep	6589	9726	16315	9712	0.00	9	6580	11343	644	638	1282	0	7184	3812.9	10500	3820.1
1997	Oct	716	0	716	-374	0.05	34	682	0	459	449	908	0	6822	3811.9	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6627	3811.4	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6301	3810.5	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	6023	3809.7	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5788	3809.0	5997	3809.6
	Mar	5965	0	5965	-168	0.10	542	5423	0	375	377	752	0	5571	3808.3	10500	3820.1
	Apr	-3926	8982	5056	7299	0.19	0	-3926	2727	330	316	646	0	10098	3819.3	10500	3820.1
	May	907	11500	12407	10512	0.09	72	835	10845	257	245	502	0	10282	3819.7	10500	3820.1
	Jun	1094	13500	14594	12386	0.08	83	1011	12334	537	526	1063	0	9895	3818.9	10500	3820.1
	Jul	-715	18129	17414	16552	0.09	0	-715	16453	924	916	1840	0	9836	3818.8	8044	3815.0
	Aug	3550	13963	17513	12890	0.08	253	3297	16156	627	615	1242	0	8461	3815.9	6833	3812.0
	Sep	10075	9544	19619	10145	0.10	916	9159	14355	644	638	1282	0	6770	3811.8	10500	3820.1
1998	Oct	867	83	950	-518	0.05	41	826	0	459	449	908	0	6572	3811.2	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6282	3810.4	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	5996	3809.6	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5742	3808.8	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5429	3807.9	5997	3809.6
	Mar	6059	0	6059	-253	0.10	551	5508	0	375	377	752	0	5276	3807.4	10500	3820.1
	Apr	-4012	9055	5043	6686	0.26	0	-4012	2028	330	316	646	0	9951	3819.0	10500	3820.1
	May	965	20010	20975	15636	0.22	173	792	15926	257	245	502	0	10328	3819.8	10500	3820.1

	Jun	1512	11709	13221	11980	-0.02	-36	1548	12465	537	526	1063	0	10103	3819.3	10500	3820.1
	Jul	894	14220	15114	14898	-0.05	-45	939	16453	924	916	1840	0	8665	3816.4	8044	3815.0
	Aug	-428	19893	19465	20795	-0.05	0	-428	20336	627	615	1242	0	9233	3817.6	6833	3812.0
	Sep	7249	10259	17508	10499	-0.02	-174	7423	12973	644	638	1282	0	6818	3811.9	10500	3820.1
1999	Oct	669	93	762	-220	0.05	32	637	109	459	449	908	0	6598	3811.3	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6349	3810.6	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6070	3809.8	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5832	3809.1	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5600	3808.4	5997	3809.6
	Mar	5969	215	6184	-171	0.10	543	5426	0	375	377	752	0	5429	3807.9	10500	3820.1
	Apr	-3726	10155	6429	9895	0.03	0	-3726	5523	330	316	646	0	9826	3818.8	10500	3820.1
	May	1282	15971	17253	14873	0.07	82	1200	15571	257	245	502	0	9261	3817.6	10500	3820.1
	Jun	381	17477	17858	15829	0.09	33	348	15114	537	526	1063	0	10216	3819.6	10500	3820.1
	Jul	1744	18199	19943	16313	0.10	164	1580	18509	924	916	1840	0	8036	3814.9	8044	3815.0
	Aug	11	17810	17821	17107	0.04	0	11	17087	627	615	1242	0	8180	3815.3	6833	3812.0
	Sep	6365	7867	14232	8209	-0.04	-289	6654	9914	644	638	1282	0	6557	3811.2	10500	3820.1
2000	Oct	635	0	635	-297	0.05	30	605	0	459	449	908	0	6258	3810.4	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6003	3809.6	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	5736	3808.8	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5684	3808.7	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5648	3808.6	5997	3809.6
	Mar	5766	0	5766	13	0.10	524	5242	0	375	377	752	0	5661	3808.6	10500	3820.1
	Apr	-3840	11170	7330	6508	0.42	0	-3840	2022	330	316	646	0	10170	3819.5	10500	3820.1
	May	959	21689	22648	8375	0.61	365	594	8467	257	245	502	0	10216	3819.6	10500	3820.1
	Jun	1217	16351	17568	15056	0.08	89	1128	15121	537	526	1063	0	10246	3819.6	10500	3820.1
	Jul	1733	20242	21975	17866	0.12	182	1551	20033	924	916	1840	0	7842	3814.5	8044	3815.0
	Aug	-2375	20469	18094	23301	-0.14	0	-2375	20895	627	615	1242	0	9871	3818.9	6833	3812.0
	Sep	5813	11549	17362	10788	0.07	359	5454	11293	644	638	1282	0	9143	3817.4	10500	3820.1
2001	Oct	909	3428	4337	3598	0.05	43	866	4156	459	449	908	0	8542	3816.1	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	8123	3815.1	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	7720	3814.2	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	7330	3813.2	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	6926	3812.2	5997	3809.6
	Mar	5944	0	5944	-149	0.10	540	5404	0	375	377	752	0	6690	3811.6	10500	3820.1
	Apr	-2894	8154	5260	14930	0.35	0	-2894	11390	330	316	646	0	10231	3819.6	10500	3820.1
	May	890	17524	18414	16598	0.05	45	845	16941	257	245	502	0	9915	3819.0	10500	3820.1
	Jun	963	15344	16307	13910	0.09	82	881	13728	537	526	1063	0	9991	3819.1	10500	3820.1
	Jul	-520	17719	17199	15433	0.13	0	-520	15529	924	916	1840	0	9851	3818.8	8044	3815.0
	Aug	1655	15581	17236	14300	0.08	126	1529	15798	627	615	1242	0	8101	3815.1	6833	3812.0
	Sep	6553	11332	17885	10546	0.07	425	6128	11725	644	638	1282	0	6741	3811.7	10500	3820.1
2002	Oct	482	126	608	-151	0.05	23	459	0	459	449	908	0	6568	3811.2	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	6304	3810.5	8919	3816.9
	Dec		0	0	-168				0	375	381	756	0	6040	3809.7	7995	3814.8
	Jan		0	0	-281				0	370	375	745	0	5785	3809.0	6969	3812.3
	Feb		0	0	-316				0	330	326	656	0	5570	3808.3	5997	3809.6
	Mar	5977	0	5977	-179	0.10	543	5434	0	375	377	752	0	5391	3807.8	10500	3820.1
	Apr	-3239	7401	4162	6089	0.18	0	-3239	2204	330	316	646	0	9298	3817.7	10500	3820.1
	May	895	15508	16403	13601	0.12	98	797	13896	257	245	502	0	10107	3819.4	10500	3820.1
	Jun	2174	14210	16384	12821	0.10	194	1980	13738	537	526	1063	0	9274	3817.7	10500	3820.1
	Jul	-1144	18521	17377	17249	0.07	0	-1144	16721	924	916	1840	0	9835	3818.8	8044	3815.0
	Aug	1317	18218	19535	16578	0.09	109	1208	17755	627	615	1242	0	8609	3816.2	6833	3812.0
	Sep	5804	11035	16839	10486	0.05	275	5529	11066	644	638	1282	0	7980	3814.8	10500	3820.1
2003	Oct	969	139	1108	-615	0.05	46	923	0	459	449	908	0	7363	3813.3	9900	3818.9
	Nov		0	0	-247				0	370	364	734	0	7079	3812.6	8919	3816.9

Dec		0	0	-168				0	375	381	756	0	6792	3811.8	7995	3814.8
Jan		0	0	-281				0	370	375	745	0	6527	3811.1	6969	3812.3
Feb		0	0	-316				0	330	326	656	0	6383	3810.7	5997	3809.6
Mar	5993	0	5993	-193	0.10	545	5448	0	375	377	752	0	6190	3810.2	10500	3820.1
Apr	-2808	7295	4487	6054	0.17	0	-2808	2600	330	316	646	0	9672	3818.5	10500	3820.1
May	1879	10975	12854	11987	-0.09	-191	2070	13555	257	245	502	0	8549	3816.1	10500	3820.1
Jun	702	21312	22014	20932	0.02	12	690	20559	537	526	1063	0	8737	3816.5	10500	3820.1
Jul	1217	21367	22584	19376	0.09	104	1113	21107	924	916	1840	0	6673	3811.5	8044	3815.0
Aug	-1146	20902	19756	20844	0.00	0	-1146	19667	627	615	1242	0	7607	3813.8	6833	3812.0
Sep	9547	7521	17068	6560	0.13	1082	8465	10076	644	638	1282	0	3950	3802.7	10500	3820.1

Column Explanantions

Column #

1 Extra water to be pumped from CF to fill Helena Valley to target elevations
2 Water pumped through siphon from Canyon Ferry to top of bench
3 Total water pumped from Canyon Ferry to HVR for No Action - Col 1 + Col 2
4 Inflow to Helena Valley Reservoir
5 Computation of losses in canal (Col 2 - Col 3)/ Col 2
6 Extra Canal Lossess due to extra diversion
7 Additional inflow to HVR to meet target end-of-month elevations
8 Canal Releases plus the addition of 412 acres of previous non-irrigated lands
9 Helena Municipal Diversion from Helena Valley - based upon 11,000 AF contract in 2044
10 Additional Demand by City of Helena in year 2044
11 Total 2044 Demand by the city of Helena
12 Evaporation or seepage from the seepage - not calculated
13 Helena Valley Historic End of Month content
14 Helena Valley Historic End of Month elevation
15 Helena Valley End of Month content - PEOM + inflow - canal release- municipal demand - Proposed Scenario
16 Helena Valley End of Month elevation - Proposed scenario

Appendix B

Purpose

A study of water quality of the Helena Valley (Kendy, et al., 1998) supplied information used in Chapters 3 and 4. Data were collected in 1993 and 1995 from 27 wells, 4 suction lysimeters, 13 surface-water sites, bottom sediment sites, and 8 biological sites in valley areas that could be affected by seepage from Helena Valley Canal and from irrigation return flows.

Appendix B includes a map and tables from Kendy, et al. (1998) as follows:

1. Generalized geology and location of the sampling sites in the Helena Valley (fig.1)

2. Physical properties and inorganic constituent concentrations in surface water from Helena Valley (Table 1)

3. Physical properties and inorganic constituent concentrations in soil moisture from clustered suction lysimeter and monitoring wells in Helena Valley (Table 2)

4. Physical properties and inorganic constituent concentrations in groundwater from Helena Valley (Table 3)

5. Inorganic constituent concentrations in bottom sediment from Lake Helena (Table 4)

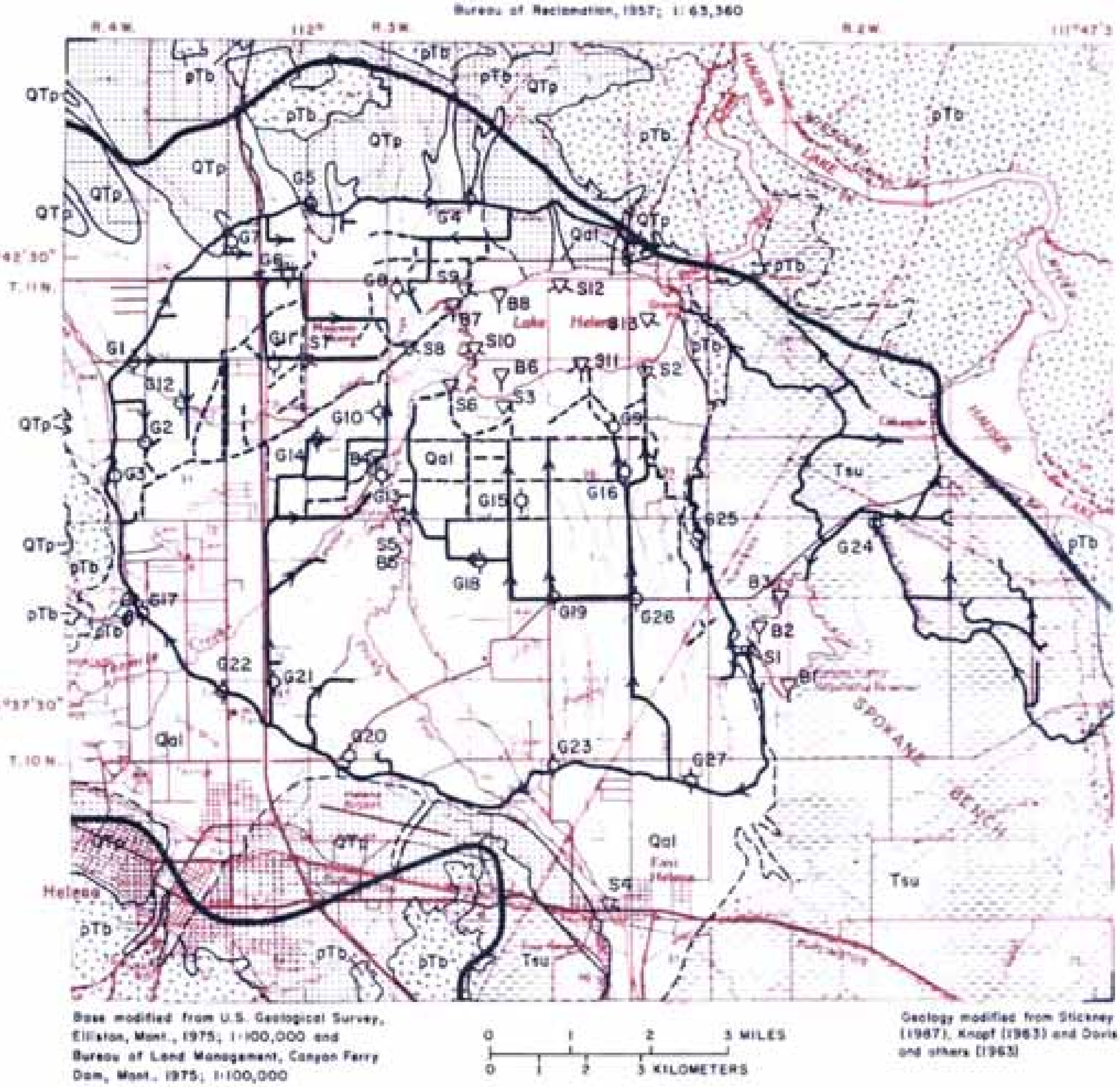
6. Trace element concentrations in aquatic invertebrates from Helena Valley (Table 5)

7. Trace element concentrations in fish from Helena Valley (Table 6)

8. Trace element concentrations in bird livers from the Helena Valley Regulating Reservoir (Table 7)

9. Organochlorine compound concentrations in fish from Helena Valley (Table 8).

Figure 1. Generalized geology and location of surface-water, soil-moisture, ground-water, bottom-sediment, and biological sampling sites, Helena Valley area , Montana.



SOIL-MOISTURE AND GROUND-WATER SAMPLING SITE AND SITE NUMBER

G10 Soil moisture

G5 Ground water

SURFACE-WATER, BOTTOM-SEDIMENT, AND BIOLOGICAL SAMPLING SITE AND SITE NUMBER

S13 Surface water

S11 Bottom sediment

B6 Biota

EXPLANATION FOR FIGURE 1

EXPLANATION

Qal QUATERNARY ALLUVIUM

QTp QUATERNARY-TERTIARY PEDIMENT DEPOSITS

Tsu TERTIARY SEDIMENTS, UNDIFFERENTIATED

pTb PRE-TERTIARY BEDROCK

CONTACT--Dashed where approximately located

IRRIGATION CANAL OR SUPPLY LATERAL--Arrow indicates flow direction

IRRIGATION DRAIN

APPROXIMATE MARGIN OF HELENA VALLEY

Table 1. Physical properties and inorganic-constituent concentrations in surface water from the Helena Valley, Montana

[Site number: Letter preceding number indicates medium type (S, surface water). Constituents are dissolved. Abbreviations: °C, degrees Celsius; E, estimated; inst., instantaneous; FET, fixed-endpoint titration; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter. Symbols: <, less than; --, no data]

Site number (fig. 3)	Date	Discharge, inst., (cubic feet per second)	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Hardness (mg/L as $CaCO_3$)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Sodium (percent)
S1	07-05-95	105	363	8.6	13.5	11.4	140	37	11	21	24
S2	03-27-95	6.3	428	8.1	5.0	--	--	--	--	--	--
	07-06-95	24	398	7.7	12.0	9.4	--	--	--	--	--
S3	03-27-95	9.7	440	8.4	6.0	--	--	--	--	--	--
	07-06-95	22	475	8.6	15.5	15.6	--	--	--	--	--
	07-06-95[1]	--	--	--	--	--	--	--	--	--	--
S4	03-23-95	39	255	8.7	6.0	--	--	--	--	--	--
	07-05-95	207	150	8.0	12.0	10.0	58	17	3.8	5.8	17
S5	03-23-95	--	381	8.4	8.5	--	--	--	--	--	--
	07-05-95	142	238	8.2	16.0	10.0	--	--	--	--	--
S6	03-27-95	52	380	8.3	5.0	--	--	--	--	--	--
	07-06-95	153	245	7.9	14.0	10.4	99	28	7.1	11	19
S7	03-23-95	.31	672	8.7	8.5	--	--	--	--	--	--
	07-05-95	14	399	8.7	--	11.0	160	40	14	23	24
S8	03-27-95	13	519	8.5	8.0	--	--	--	--	--	--
	07-06-95	48	480	8.2	15.0	14.4	200	52	16	25	21
S9	03-27-95	.07	922	8.8	6.0	--	--	--	--	--	--
	07-05-95	E.30	875	7.9	15.5	--	--	--	--	--	--
S10	03-27-95	--	363	9.0	4.5	11.5	140	37	12	20	23
	07-06-95	--	247	7.9	14.0	9.0	96	27	7.0	11	19
S11	07-06-95	--	311	9.0	20.0	11.2	--	--	--	--	--
S12	07-06-95	--	309	8.7	20.0	10.2	--	--	--	--	--
S13	03-27-95	--	363	8.8	3.0	12.2	--	--	--	--	--
	07-06-95	--	295	8.3	17.0	8.3	120	33	8.9	14	20

[1]Quality-control sample. Replicate arsenic analysis.

Table 1. Physical properties and inorganic-constituent concentrations in surface water from the Helena Valley, Montana (Continued)

Site number (fig. 3)	Sodium adsorption ratio	Potassium (mg/L as K)	Alkalinity, lab (FET) (mg/L as $CaCO_3$)	Sulfate (mg/L as SO_4)	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Dissolved solids, calculated (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)
S1	0.8	3.8	134	32	13	1.1	199	<0.01	<0.05
S2	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
S3	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
S4	--	--	--	--	--	--	--	--	--
	.3	1.6	49	20	1.1	.10	79	<.01	<.05
S5	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
S6	--	--	--	--	--	--	--	--	--
	.5	2.3	86	26	5.4	.30	133	.02	.24
S7	--	--	--	--	--	--	--	--	--
	.8	3.4	150	36	13	1.0	223	<.01	.59
S8	--	--	--	--	--	--	--	--	--
	.8	3.4	184	44	14	.80	268	<.01	.51
S9	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--
S10	.7	3.5	123	49	12	.40	208	--	--
	.5	2.3	86	26	5.5	.20	132	.03	.26
S11	--	--	--	--	--	--	--	--	--
S12	--	--	--	--	--	--	--	--	--
S13	--	--	--	--	--	--	--	--	--
	.6	2.7	107	29	7.2	.40	160	.02	.07

Table 1. Physical properties and inorganic-constituent concentrations in surface water from the Helena Valley, Montana (Continued)

Site number (fig. 3)	Ammonia (mg/L as N)	Phosphorus, ortho (mg/L as P)	Arsenic (µg/L as As)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Mercury (µg/L as Hg)	Selenium (µg/L as Se)	Zinc (µg/L as Zn)
S1	0.020	<0.01	31	<1	<1	<1	<1	<0.1	<1	<3
S2	--	--	2	--	--	--	--	--	--	--
	--	--	15	--	--	--	--	--	--	--
S3	--	--	2	--	--	--	--	--	--	--
	--	--	7	--	--	--	--	--	--	--
	--	--	7	--	--	--	--	--	--	--
S4	--	--	7	--	--	--	--	--	--	--
	.020	<.01	5	<1	<1	3	1	<.1	<1	40
S5	--	--	8	--	--	--	--	--	--	--
	--	--	8	--	--	--	--	--	--	--
S6	--	--	8	--	--	--	--	--	--	--
	.080	.03	12	<1	<1	3	1	<.1	<1	20
S7	--	--	2	--	--	--	--	--	--	--
	.020	<.01	25	<1	<1	1	<1	<.1	<1	<3
S8	--	--	3	--	--	--	--	--	--	--
	.020	<.01	17	<1	<1	<1	<1	.2	<1	<3
S9	--	--	17	--	--	--	--	--	--	--
	--	--	11	--	--	--	--	--	--	--
S10	--	--	6	<1	<1	2	<1	<.1	<1	<3
	.11	.03	12	<1	<1	3	<1	<.1	<1	9
S11	--	--	15	--	--	--	--	--	--	--
S12	--	--	15	--	--	--	--	--	--	--
S13	--	--	5	--	--	--	--	--	--	--
	.060	.06	17	<1	<1	2	<1	<.1	<1	<3

Table 2. Physical properties and inorganic-constituent concentrations in soil moisture and ground water from clustered suction-lysimeter and monitoring-well sites in the Helena Valley, Montana

[Site number: Letter preceding number indicates medium type (G, ground water and soil moisture). Constituents are dissolved. Sampling equipment: L, suction lysimeter; W, test well. Sample type: CF, capillary fringe; GW, ground water; GW-R, ground-water field replicate; SM, soil moisture. Abbreviations: ft, feet; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; lab, laboratory. Symbols: --, no data; <, less than]

Site number (fig. 3)	Sampling equipment	Depth of sampled interval (ft below land surface)	Date[1]	Depth to ground water (ft below land surface)	Sample type[2]	Specific conductance, lab (µS/cm)	pH, lab (standard units)	Hardness (mg/L as $CaCO_3$)	Calcium (mg/L as Ca)
				Sprinkler-irrigated site					
G10	L	1.8 - 2.0	08-04-95	5.00	SM	--	--	--	--
	L	4.1 - 4.3	07-31-95	4.94	SM	3,170	8.1	810	230
			08-04-95	5.00	SM	2,290	7.8	690	200
	W	5.0 - 6.5	08-07-95	4.85	GW	[3]630	[3]7.6	260	80
				Flood-irrigated site					
G13	L	2.3 - 2.5	07-31-95	2.37	GW	1,450	7.7	600	170
			08-04-95	3.00	CF	1,300	7.7	570	160
	L	4.4 - 4.6	07-31-95	2.37	GW	1,200	7.5	600	170
			08-04-95	3.00	GW	1,180	7.9	590	170
			08-04-95	3.00	GW-R	1,190	7.7	620	180
	W	6.2 - 8.3	08-07-95	--	GW	[3]755	[3]7.0	330	97

[1]Irrigation dates: 07-21-95 to 07-28-95, 08-04-95 (sprinkler-irrigated site); 07-30-95 (flood-irrigated site).
[2]Owing to fluctuating water tables, lysimeters could produce different types of samples on different dates.
[3]Parameter measured in the field.

Table 2. Physical properties and inorganic-constituent concentrations in soil moisture and ground water from clustered suction-lysimeter and monitoring-well sites in the Helena Valley, Montana (Continued)

Site number (fig. 3)	Date[1]	Magnesium (mg/L as Mg)	Sodium (mg/L as Na)	Sodium (percent)	Sodium adsorption ratio	Potassium (mg/L as K)	Alkalinity, whole (mg/L as $CaCO_3$)	Sulfate (mg/L as SO_4)	Chloride (mg/L as Cl)	Fluoride (mg/L as F)
Sprinkler-irrigated site										
G10	08-04-95	--	--	--	--	--	--	--	--	--
	07-31-95	57	480	56	7.0	17	319	1,400	52	1.0
	08-04-95	47	290	47	5.0	16	295	900	68	.80
	08-07-95	15	19	13	.5	11	[3]223	110	25	.60
Flood-irrigated site										
G13	07-31-95	42	100	26	2.0	5.1	432	170	33	1.4
	08-04-95	41	97	27	2.0	4.2	357	180	38	1.4
	07-31-95	42	53	16	.9	2.0	476	69	25	1.0
	08-04-95	41	56	17	1.0	1.6	241	86	28	1.0
	08-04-95	42	57	17	1.0	1.6	356	86	27	1.0
	08-07-95	21	27	15	.6	4.7	[3]350	36	17	.70

Table 2. Physical properties and inorganic-constituent concentrations in soil moisture and ground water from clustered suction-lysimeter and monitoring-well sites in the Helena Valley, Montana (Continued)

Site number (fig. 3)	Date[1]	Silica (mg/L as SiO_2)	Dissolved solids, calculated (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Ammonia (mg/L as N)	Phosphorus, ortho (mg/L as P)	Arsenic (µg/L as As)	Iron (µg/L as Fe)	Manganese (µg/L as Mn)
					Sprinkler-irrigated site					
G10	08-04-95	--	--	--	--	--	--	22	--	--
	07-31-95	72	2,530	<0.01	5.4	0.27	0.37	12	<9	<3
	08-04-95	75	1,790	<.01	2.9	.04	.17	9	<9	<3
	08-07-95	--	395	<.01	.11	.07	.03	16	--	--
					Flood-irrigated site					
G13	07-31-95	45	910	<.01	19	.02	.04	14	<3	1
	08-04-95	48	899	<.01	27	.02	.04	12	<3	2
	07-31-95	54	709	<.01	1.2	.07	.18	10	670	750
	08-04-95	53	589	.01	1.4	.08	.17	7	160	810
	08-04-95	54	670	.01	1.4	.08	.16	7	160	820
	08-07-95	--	415	<.01	.36	.35	<.01	6	--	--

Table 3. Physical properties and inorganic-constituent concentrations in ground water from the Helena Valley, Montana

[Site number: Letter preceding number indicates medium type (G, ground water). Constituents are dissolved. Analyzing agency: MBMG, Montana Bureau of Mines and Geology; USGS, U.S. Geological Survey. Abbreviations: °C, degrees Celsius; IT, incremental titration; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter. Symbols: --, no data; <, less than]

Site number (fig. 3)	Location number	Date	Specific conductance, field (µS/cm)	pH, field (standard units)	Temperature, water (°C)	Oxygen, field (mg/L)	Hardness (mg/L as $CaCO_3$)	Calcium (mg/L as Ca)	Magnesium (mg/L as Mg)
G1	11N04W25AABA01	08-09-95	385	7.7	14.5	7.7	150	39	13
G2	11N04W25DDDD01	08-07-95	403	7.5	--	--	170	41	16
G3	11N04W36ACCA01	08-09-95	400	7.8	14.0	--	200	44	21
G4	11N03W14BBBB01	08-08-95	422	7.9	13.0	8.3	120	28	12
G5	11N03W16BBBB01	08-08-95	722	7.7	11.0	8.2	260	74	18
G6	11N03W17DDCC01	06-30-93	525	7.6	10.5	8.3	--	--	--
G7	11N03W18ADDD01	08-09-95	409	7.7	15.0	8.4	170	45	14
G8	11N03W22BBCB02	07-08-93	1,790	7.3	10.0	.9	550	120	59
G9	11N03W25DDBD01	06-29-93	433	6.8	10.0	2.9	--	--	--
G10	11N03W28DAAD01	08-07-95	630	7.6	11.0	2.0	260	80	15
G11	11N03W29ABBA01	06-28-93	615	7.6	10.0	4.3	--	--	--
G12	11N03W30DBCA01	06-28-93	688	7.3	9.5	6.9	--	--	--
G13	11N03W33ADDB01	08-07-95	755	7.0	12.0	3.1	330	97	21
G14	11N03W33BBAA02	07-08-93	504	7.0	8.0	1.4	210	61	15
G15	11N03W35DACC01	07-08-93	463	7.1	8.5	3.9	190	56	13
G16	11N02W31BCCB01	06-29-93	405	6.8	11.0	3.4	160	46	10
	Replicate[1]	06-29-93	413	7.0	--	--	150	44	10
G17	10N04W12AACD01	09-29-89	600	6.9	9.0	5.2	320	89	23
		08-10-95	671	7.3	9.0	6.6	--	--	--
G18	10N03W02BCDD01	06-30-93	394	7.1	10.0	2.8	170	51	11
G19	10N03W02DDDD03	08-14-90	480	7.1	12.0	--	210	62	14
		08-07-95	426	7.3	10.0	6.4	--	--	--
G20	10N03W16DCCC02	08-13-90	425	8.0	13.0	--	150	29	18
		08-08-95	387	8.0	13.0	6.7	--	--	--
G21	10N03W17ABBB01	08-07-95	508	6.5	12.5	--	210	70	9.7
G22	10N03W18AADA01	08-09-95	400	7.7	13.5	--	190	54	13
G23	10N03W24BBBC01	08-09-95	308	7.4	11.0	8.6	120	35	8.5
	Replicate[1]	08-09-95	307	7.3	--	--	120	36	8.4
G24	10N02W03BBAB01	08-08-95	398	7.9	11.5	7.8	110	34	6.0
G25	10N02W06AADC01	08-08-95	390	7.7	13.0	7.6	140	44	8.3
G26	10N02W07BBBB01	08-17-90	390	6.6	17.0	--	150	41	12
		08-07-95	328	7.5	14.0	3.9	--	--	--
G27	10N02W19ADBB01	08-10-95	404	7.5	13.5	6.8	160	48	9.7
--	Field blank[1]	08-10-95	2	7.6	--	--	--	.2	<.01

[1]Quality-control sample. Specific conductance, pH, and alkalinity were measured in the laboratory.
[2]Filtered sample.

Table 3. Physical properties and inorganic-constituent concentrations in ground water from the Helena Valley, Montana (Continued)

Site number (fig. 3)	Location number	Sodium (mg/L as Na)	Sodium (percent)	Sodium adsorption ratio	Potassium (mg/L as K)	Bicarbonate, field (IT) (mg/L as HCO_3)	Carbonate, field (IT) (mg/L as CO_3)	Alkalinity, field (IT) (mg/L as $CaCO_3$)	Sulfate (mg/L as SO_4)
G1	11N04W25AABA01	20	22	0.7	3.4	157	0	129	33
G2	11N04W25DDDD01	20	20	.7	1.7	220	0	180	34
G3	11N04W36ACCA01	23	20	.7	1.6	187	0	153	85
G4	11N03W14BBBB01	47	45	2	2.7	186	0	153	91
G5	11N03W16BBBB01	47	28	1	2.9	186	0	153	120
G6	11N03W17DDCC01	--	45	--	--	224	0	184	--
G7	11N03W18ADDD01	22	22	.7	1.3	185	0	151	35
G8	11N03W22BBCB02	210	45	4	1.8	405	0	332	550
G9	11N03W25DDBD01	--	--	--	--	161	0	132	--
G10	11N03W28DAAD01	19	13	.5	11	272	0	223	110
G11	11N03W29ABBA01	--	--	--	--	293	0	240	--
G12	11N03W30DBCA01	--	--	--	--	309	0	253	--
G13	11N03W33ADDB01	27	15	.6	4.7	427	0	350	36
G14	11N03W33BBAA02	21	17	.6	2.9	205	0	168	71
G15	11N03W35DACC01	17	16	.6	3.2	202	0	165	51
G16	11N02W31BCCB01	19	21	.7	3.4	165	0	135	49
	Replicate[1]	19	21	.7	3.3	165	0	135	49
G17	10N04W12AACD01	18	11	.4	2.8	344	0	282	65
		--	--	--	--	--	--	--	--
G18	10N03W02BCDD01	13	14	.4	2.8	179	0	147	43
G19	10N03W02DDDD03	14	12	.4	3.5	197	0	162	78
		--	--	--	--	--	--	--	--
G20	10N03W16DCCC02	29	30	1	3.6	198	0	162	44
		--	--	--	--	--	--	--	--
G21	10N03W17ABBB01	27	21	.8	2.9	--	--	--	37
G22	10N03W18AADA01	22	20	.7	3.1	[2]212	[2]0	[2]174	77
G23	10N03W24BBBC01	14	19	.6	3.0	126	0	103	32
	Replicate[1]	15	20	.6	2.7	--	--	107	58
G24	10N02W03BBAB01	37	40	2	8.6	121	0	--	34
G25	10N02W06AADC01	26	27	.9	8.8	174	0	143	79
G26	10N02W07BBBB01	22	24	.8	3.8	173	0	142	37
		--	--	--	--	167	0	137	--
G27	10N02W19ADBB01	22	23	.8	3.0	187	0	153	36
--	Field blank[1]	<.2	--	--	<.1	--	--	1	<.10

Table 3. Physical properties and inorganic-constituent concentrations in ground water from the Helena Valley, Montana (Continued)

Site number (fig. 3)	Location number	Chloride (mg/L as Cl)	Fluoride (mg/L as F)	Dissolved solids, calculated (mg/L)	Nitrite (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Ammonia (mg/L as N)	Phosphorus, ortho (mg/L as P)
G1	11N04W25AABA01	12	1.1	199	<0.01	0.13	<0.015	0.02
G2	11N04W25DDDD01	12	.90	239	<.01	.87	<.015	<.01
G3	11N04W36ACCA01	9.0	1.0	283	<.01	1.4	<.015	.01
G4	11N03W14BBBB01	8.5	.50	283	<.01	.35	<.015	.01
G5	11N03W16BBBB01	52	.40	414	<.01	1.8	<.015	.01
G6	11N03W17DDCC01	13	--	--	--	--	--	--
G7	11N03W18ADDD01	6.5	.90	216	<.01	.07	<.015	<.01
G8	11N03W22BBCB02	71	.50	1,240	<.1	.87	--	<.1
G9	11N03W25DDBD01	11	--	--	--	--	--	--
G10	11N03W28DAAD01	25	.60	395	<.01	.11	.07	.03
G11	11N03W29ABBA01	13	--	--	--	--	--	--
G12	11N03W30DBCA01	11	--	--	--	--	--	--
G13	11N03W33ADDB01	17	.70	415	<.01	.36	.35	<.01
G14	11N03W33BBAA02	14	.35	311	<.1	--	--	<.1
G15	11N03W35DACC01	10	.22	281	<.1	--	--	<.1
G16	11N02W31BCCB01	12	.35	246	--	--	--	<.1
	Replicate[1]	12	.35	244	--	--	--	.15
G17	10N04W12AACD01	12	.44	410	--	--	--	<.1
		--	--	--	--	--	--	--
G18	10N03W02BCDD01	6.4	.26	246	<.1	--	--	<.1
G19	10N03W02DDDD03	9.6	.25	303	--	--	--	--
		--	--	--	--	--	--	--
G20	10N03W16DCCC02	15	.95	263	--	--	--	--
		--	--	--	--	--	--	--
G21	10N03W17ABBB01	41	.20	312	.03	.39	.14	<.01
G22	10N03W18AADA01	9.1	1.0	284	<.01	.14	.04	<.01
G23	10N03W24BBBC01	6.4	.60	161	<.01	<.05	<.015	.01
	Replicate[1]	11	.40	196	<.01	.05	<.015	<.01
G24	10N02W03BBAB01	12	1.0	192	--	--	--	--
G25	10N02W06AADC01	10	.80	264	<.01	.23	<.015	.02
G26	10N02W07BBBB01	12	1.1	237	--	--	--	--
		--	--	--	--	--	--	--
G27	10N02W19ADBB01	12	.70	225	<.01	.30	<.015	.05
--	Field blank[1]	<.10	<.10	--	<.01	<.05	<.015	<.01

Table 3. Physical properties and inorganic-constituent concentrations in ground water from the Helena Valley, Montana (Continued)

Site number (fig. 3)	Location number	Arsenic (µg/L as As)	Cadmium (µg/L as Cd)	Chromium (µg/L as Cr)	Copper (µg/L as Cu)	Lead (µg/L as Pb)	Mercury (µg/L as Hg)	Selenium (µg/L as Se)	Zinc (µg/L as Zn)	Analyzing agency
G1	11N04W25AABA01	3	<1	<1	<1	<1	<0.1	<1	5	USGS
G2	11N04W25DDDD01	<1	<1	<1	<1	<1	<.1	<2	--	USGS
G3	11N04W36ACCA01	6	<1	<1	<1	<1	<.1	<1	3	USGS
G4	11N03W14BBBB01	3	<1	<1	<1	<1	<.1	<1	<3	USGS
G5	11N03W16BBBB01	2	<1	<1	3	<1	.1	1	12	USGS
G6	11N03W17DDCC01	2	--	--	--	--	--	--	--	MBMG
G7	11N03W18ADDD01	2	<1	<1	<1	<1	<.1	<1	7	USGS
G8	11N03W22BBCB02	4	<2	<2	<2	<3	--	3	<2	MBMG
G9	11N03W25DDBD01	1	--	--	--	--	--	--	--	MBMG
G10	11N03W28DAAD01	16	<1	1	2	<1	<.1	<1	<3	USGS
G11	11N03W29ABBA01	2	--	--	--	--	--	--	--	MBMG
G12	11N03W30DBCA01	3	--	--	--	--	--	--	--	MBMG
G13	11N03W33ADDB01	6	<1	1	<1	<1	<.1	<1	7	USGS
G14	11N03W33BBAA02	1	<2	<2	<2	<3	--	<1	<2	MBMG
G15	11N03W35DACC01	1	<2	<2	<2	<3	--	<1	<2	MBMG
G16	11N02W31BCCB01	<1	<2	<2	<2	<3	--	<1	15	MBMG
	Replicate[1]	1	2	2	2	3	--	1	18	MBMG
G17	10N04W12AACD01	--	<5	<5	<4	--	--	--	11	USGS
		3	--	--	--	--	--	--	--	
G18	10N03W02BCDD01	1	<2	<2	<2	<3	--	<1	29	MBMG
G19	10N03W02DDDD03	--	<5	<5	<4	--	--	--	<6	USGS
		1	--	--	--	--	--	--	--	
G20	10N03W16DCCC02	--	<5	<5	<4	--	--	--	<6	USGS
		5	--	--	--	--	--	--	--	
G21	10N03W17ABBB01	<1	<1	<1	2	<1	<.1	<1	--	USGS
G22	10N03W18AADA01	<1	<1	<1	--	<1	<.1	<1	5	USGS
G23	10N03W24BBBC01	1	<1	<1	<1	<1	<.1	<1	<3	USGS
	Replicate[1]	1	<1	<1	<1	<1	--	<1	<3	USGS
G24	10N02W03BBAB01	22	<1	<1	<1	<1	--	<1	5	USGS
G25	10N02W06AADC01	17	<1	<1	<1	<1	<.1	<1	55	USGS
G26	10N02W07BBBB01	--	<5	<5	<4	--	--	--	<6	USGS
		2	--	--	--	--	--	--	--	
G27	10N02W19ADBB01	1	<1	<1	<1	<1	<.1	<1	20	USGS
--	Field blank[1]	<1	<1	<1	<1	<1	<.1	<1	<3	USGS

Table 4. Inorganic-constituent concentrations in bottom sediment from Lake Helena, Montana

[Samples collected July 6, 1995. Analyses by the U.S. Geological Survey. Analyses conducted on sediment fraction finer than 0.063 millimeter diameter. All concentrations are total. Abbreviations: µg/g, microgram per gram of dry sample weight; percent, percent of dry sample weight. Symbol: <, less than; --, no data]

Inorganic constituent	Site S10, Lake Helena (west)	Site S11, Lake Helena (south)	Site S12, Lake Helena (north)	Helena Valley soil, geometric mean[1]
MAJOR IONS				
Calcium (percent)	4.0	6.7	4.1	--
Magnesium (percent)	1.4	1.4	1.5	--
Phosphorus (percent)	.14	.19	.14	--
Potassium (percent)	1.9	1.9	1.9	--
Sodium (percent)	1.2	1.5	1.2	--
TRACE ELEMENTS				
Aluminum (percent)	6.2	6.4	6.3	12
Arsenic (µg/g)	46	18	34	[2]42
Barium (µg/g)	600	580	600	132
Berylliu (µg/g)	2	2	2	.9
Cadmium (µg/g)	4	<2	4	[2]7
Chromium (µg/g)	43	47	45	13
Cobalt (µg/g)	12	13	12	8.6
Copper (µg/g)	77	47	82	[2]41
Iron (percent)	3.1	3.5	3.2	14
Lead (µg/g)	170	38	170	[2]200
Lithium (µg/g)	35	33	37	--
Manganese (µg/g)	610	760	630	[2]460
Mercury (µg/g)	.48	.06	.32	[2].71
Molybdenum (µg/g)	<2	<2	<2	--
Nickel (µg/g)	17	17	17	11
Silver (µg/g)	<2	<2	<2	[2].7
Strontium (µg/g)	280	420	270	--
Uranium (µg/g)	<100	<100	<100	--
Vanadium (µg/g)	83	100	86	25
Zinc (µg/g)	590	200	600	140

[1]Geometric mean of 157 samples (U.S. Environmental Protection Agency, 1987).

[2]Enriched above Helena Valley background concentration (U.S. Environmental Protection Agency, 1987, p. 3.6).

Table 5. Trace-element concentrations in aquatic invertebrates from the Helena Valley, Montana

[Site number: Letter preceeding number indicates medium type (B, biota). All samples are composites representing multiple species, including daphnia (Order Cladocera) and waterboatmen (Order Hemiptera). Concentrations in micrograms per gram of dry sample weight. All concentrations are total. Symbol: <, less than]

Site number (fig. 3)	Sample identification	Date	Moisture content[1] (percent)	Aluminum	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Copper
B2	RRIN0395	08/16/95	89.2	1,016	4.2	19.4	<0.1	<2.0	2.1	4.9	19.6
B2	RRIN0295	08/16/95	92.2	1,324	5.1	23.4	<.1	<2.0	2.3	2.8	18.8
B2	RRIN0195	08/16/95	88.4	658	3.7	9.8	<.1	5.4	1.9	2.6	18.2
B2	RRIN0495	08/16/95	92.9	1,441	5.5	23.4	<.1	2.5	2.1	1.0	18.1
B8	LHIN0395	08/16/95	78.4	229	1.6	26.6	<.1	<2.0	.2	<.5	28.9
B8	LHIN0295	08/16/95	77.8	152	1.0	43.7	<.1	<2.0	.2	.5	28.1
B8	LHIN0195	08/16/95	76.2	140	.6	46.0	<.1	<2.0	.1	<.5	29.9

Site number (fig. 3)	Sample identification	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Strontium	Vanadium	Zinc
B2	RRIN0395	824	1.9	1,272	57.9	0.13	2.2	1.8	2.2	50.4	1.6	105
B2	RRIN0295	993	1.9	1,420	60.5	.17	<2.0	.6	2.0	102	2.1	102
B2	RRIN0195	524	1.1	1,079	46.4	<.05	<2.0	<.5	2.5	26.6	1.0	104
B2	RRIN0495	1,059	2.3	1,436	63.0	.12	<2.0	<.5	2.0	82.6	2.2	98.7
B8	LHIN0395	263	.5	1,173	32.3	.09	<2.0	<.5	1.7	42.0	<.5	149
B8	LHIN0295	239	<.5	1,083	27.9	.09	<2.0	<.5	1.5	10.9	.5	130
B8	LHIN0195	223	<.5	1,059	28.4	.08	<2.0	<.5	1.4	10.9	<.5	143

[1]To convert from concentration of dry sample weight to concentration of wet sample weight, use the equation:
concentration of wet sample weight = concentration of dry sample weight x [1 - (moisture content in percent x 0.01)].

Table 6. Trace-element concentrations in fish from the Helena Valley, Montana

[Site number: Letter preceeding number indicates medium type (B, biota). Concentrations in micrograms per gram of dry sample weight. All concentrations are total. Symbol: <, less than]

Site number (fig. 3)	Sample identification	Date	Taxon	Moisture content[1] (percent)	Aluminum	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Copper
B2	RRC0195	08/16/95	CARP	80.9	71.2	1.2	10.3	<0.1	<2.0	0.3	<0.5	3.4
B2	RRC0295	08/31/95	CARP	81.3	75.9	1.8	9.5	<.1	<2.0	.3	.6	4.8
B2	RRC0395	08/31/95	CARP	80.6	96.2	2.4	9.4	<.1	<2.0	.3	<.5	4.9
B4	TMS0195	08/15/95	LONGNOSE SUCKER	81.8	1,289	5.5	36.7	<.1	<2.0	.8	5.4	10.1
B5	PPS0195	08/17/95	LONGNOSE SUCKER	82.8	779	2.7	22.7	<.1	<2.0	.7	2.5	9.0
B6	LH9501C	06/30/95	CARP	63.9	172	.9	5.6	<.1	<2.0	.1	<.5	3.6
B6	LH9503C	06/30/95	CARP	68.9	74.6	.7	4.0	<.1	<2.0	<.1	<.5	5.5
B6	LH9505C	06/30/95	CARP	67.1	161	.8	4.1	<.1	<2.0	.1	.7	5.0
B6	LH9502C	06/30/95	CARP	64.2	142	1.1	3.8	<.1	<2.0	.1	<.5	4.3
B6	LH9504C	06/30/95	CARP	66.1	36.1	<.5	<1.0	.2	<2.0	<.1	<.5	3.5
B7	SCC0195	08/31/95	CARP	81.1	200	1.0	9.4	<.1	<2.0	<.1	1.6	3.6
B8	LHC0195	08/16/95	CARP	83.5	380	1.4	11.6	<.1	<2.0	<.1	.3	4.6
B8	LHC0395	08/31/95	CARP	82.0	170	.8	10.3	<.1	<2.0	<.1	1.0	5.6
B8	LHC0295	08/31/95	CARP	82.3	246	1.5	12.1	<.1	2.5	<.1	.6	5.5

Site number (fig. 3)	Sample identification	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Strontium	Vanadium	Zinc
B2	RRC0195	132	<0.5	1,384	20.1	0.3	<2.0	1.5	1.5	68.4	<0.5	186
B2	RRC0295	134	.5	1,477	14.7	.3	<2.0	<.5	1.5	70.4	<.5	179
B2	RRC0395	152	<.5	1,435	25.5	.3	<2.0	1.7	.6	75.2	<.5	170
B4	TMS0195	1,514	4.5	2,047	204.1	.2	<2.0	2.4	1.8	58.6	5.6	198
B5	PPS0195	872	8.8	1,790	58.0	.2	<2.0	<.5	1.6	49.4	2.4	160
B6	LH9501C	242	1.9	882	14.8	.1	<2.0	2.4	1.0	36.5	.8	265
B6	LH9503C	217	1.2	964	22.7	.1	<2.0	3.2	1.5	34.9	2.4	249
B6	LH9505C	289	2.0	911	15.0	.2	<2.0	.6	1.6	38.7	1.3	326
B6	LH9502C	248	1.3	794	12.7	.1	<2.0	2.8	1.0	27.0	2.4	168
B6	LH9504C	110	.6	578	6.3	.3	<2.0	.7	1.3	10.4	1.2	497
B7	SCC0195	236	<.5	1,468	12.8	.2	<2.0	<.5	1.9	58.8	2.2	152
B8	LHC0195	350	.8	1,774	23.4	.1	<2.0	<.5	1.9	66.1	1.9	196
B8	LHC0395	208	<.5	1,608	12.5	.1	<2.0	<.5	1.7	66.4	<.5	161
B8	LHC0295	279	.5	1,655	14.1	.1	<2.0	<.5	1.8	67.2	1.5	174

[1]To convert from concentration of dry sample weight to concentration of wet sample weight, use the equation:
concentration of wet sample weight = concentration of dry sample weight x [1 - (moisture content in percent x 0.01)].

Table 7. Trace-element concentrations in water-bird livers from the Helena Valley Regulating Reservoir, Montana

[Site number: Letter preceeding number indicates medium type (B, biota). Concentrations in micrograms per gram of dry sample weight. All concentrations are total. Symbol: <, less than]

Site number (fig. 3)	Sample identification	Date	Taxon	Moisture content[1] (percent)	Aluminum	Arsenic	Barium	Beryllyum	Boron	Cadmium	Chromium	Copper
B1	RRML0495	08/11/95	MALLARD	73.8	<5.0	<0.5	<1.0	<0.1	<2.0	1.5	<0.5	140
B1	RRML0395	08/11/95	MALLARD	72.5	<5.0	1.0	<1.0	<.1	<2.0	1.4	<.5	131
B1	RRML0295	08/11/95	MALLARD	71.8	<5.0	1.0	<1.0	<.1	<2.0	1.4	<.5	180
B1	RRML0195	08/11/95	MALLARD	74.1	<5.0	1.1	<1.0	<.1	<2.0	1.6	<.5	150
B3	RRSL0195	08/11/95	NORTHERN SHOVELER	70.6	<5.0	<.5	<1.0	<.1	<2.0	3.1	<.5	29.2

Site number (fig. 3)	Sample identification	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Strontium	Vanadium	Zinc
B1	RRML0495	1,135	<0.5	652	11.8	0.4	2.9	<0.5	19.0	<0.5	0.5	139
B1	RRML0395	1,197	<.5	702	12.0	.4	2.4	<.5	19.5	<.5	.6	130
B1	RRML0295	1,446	<.5	677	15.6	.4	2.6	<.5	21.1	<.5	.9	150
B1	RRML0195	1,493	<.5	679	12.1	.4	<2.0	.9	20.1	<.5	1.1	137
B3	RRSL0195	4,659	<.5	661	13.2	4.3	5.8	1.2	5.5	<.5	1.8	135

[1]To convert from concentration of dry sample weight to concentration of wet sample weight, use the equation:
concentration of wet sample weight = concentration of dry sample weight x [1 - (moisture content in percent x 0.01)].

Table 8. Organochlorine-compound concentrations in fish from the Helena Valley, Montana (Continued)

Site number (fig. 3)	Sample identification	Date	Taxon	Dieldrin	Endosulfan II	Endrin	HCB	Heptachlor	Heptachlor epoxide
B2	RRC0195	06/16/95	CARP	0.0018	<0.0019	<0.0010	<0.0010	<0.0010	<0.0010
B2	RRC0295	08/31/95	CARP	<.0012	<.0020	<.0010	<.0010	<.0010	<.0010
B2	RRC0395	08/31/95	CARP	<.0009	<.0020	<.0009	<.0009	<.0009	<.0009
B4	TMS0195	08/15/95	LONGNOSE SUCKER	<.0010	<.0020	<.0010	<.0010	<.0010	<.0010
B5	PPS0195	08/17/95	LONGNOSE SUCKER	<.0009	<.0019	<.0009	<.0009	<.0009	<.0009
B6	LH9502C	06/30/95	CARP	.0031	.0007	.0006	.0016	<.0002	.0006
B6	LH9503C	06/30/95	CARP	.0016	.0005	<.0002	.0007	<.0002	.0003
B6	LH9504C	06/30/95	CARP	.0025	.0006	<.0002	.0014	<.0002	.0008
B6	LH9501C	06/30/95	CARP	.0025	<.0004	.0003	.0014	<.0002	.0005
B6	LH9505C	06/30/95	CARP	.0013	<.0004	<.0002	.0013	<.0002	.0007
B7	SCC0195	08/31/95	CARP	<.0010	<.0019	<.0010	<.0010	<.0010	<.0010
B8	LHC0395	08/31/95	CARP	<.0010	<.0020	<.0010	<.0010	<.0010	<.0010
B8	LHC0195	08/16/95	CARP	<.0009	<.0018	<.0009	<.0009	<.0009	<.0009
B8	LHC0295	08/31/95	CARP	<.0015	<.0019	<.0010	<.0010	<.0010	<.0010

Site number (fig. 3)	Sample identification	Taxon	Mirex	Cis-nonachlor	Transnonachlor	Oxychlordane	Total PCB's
B2	RRC0195	CARP	<0.0010	<0.0010	<0.0010	<0.0010	0.0240
B2	RRC0295	CARP	<.0010	<.0010	<.0010	<.0010	.0167
B2	RRC0395	CARP	<.0009	<.0009	<.0009	<.0009	.0141
B4	TMS0195	LONGNOSE SUCKER	<.0010	<.0010	<.0010	<.0010	.1097
B5	PPS0195	LONGNOSE SUCKER	<.0009	<.0009	<.0009	<.0009	.0344
B6	LH9502C	CARP	<.0002	.0029	.0033	.0010	.3241
B6	LH9503C	CARP	<.0002	<.0027	.0036	<.0002	.2810
B6	LH9504C	CARP	.0002	<.0039	.0049	.0012	.4342
B6	LH9501C	CARP	<.0002	<.0019	.0024	.0006	.2023
B6	LH9505C	CARP	.0007	<.0051	.0064	.0013	.6139
B7	SCC0195	CARP	<.0010	<.0010	<.0010	<.0010	.0222
B8	LHC0395	CARP	<.0010	<.0010	<.0010	<.0010	.0328
B8	LHC0195	CARP	<.0009	<.0009	<.0009	<.0009	.0499
B8	LHC0295	CARP	<.0010	<.0010	<.0010	<.0010	.0235

[1]To convert from concentration of dry sample weight to concentration of wet sample weight, use the equation:
concentration of wet sample weight = concentration of dry sample weight x [1 - (moisture content in percent x 0.01)].

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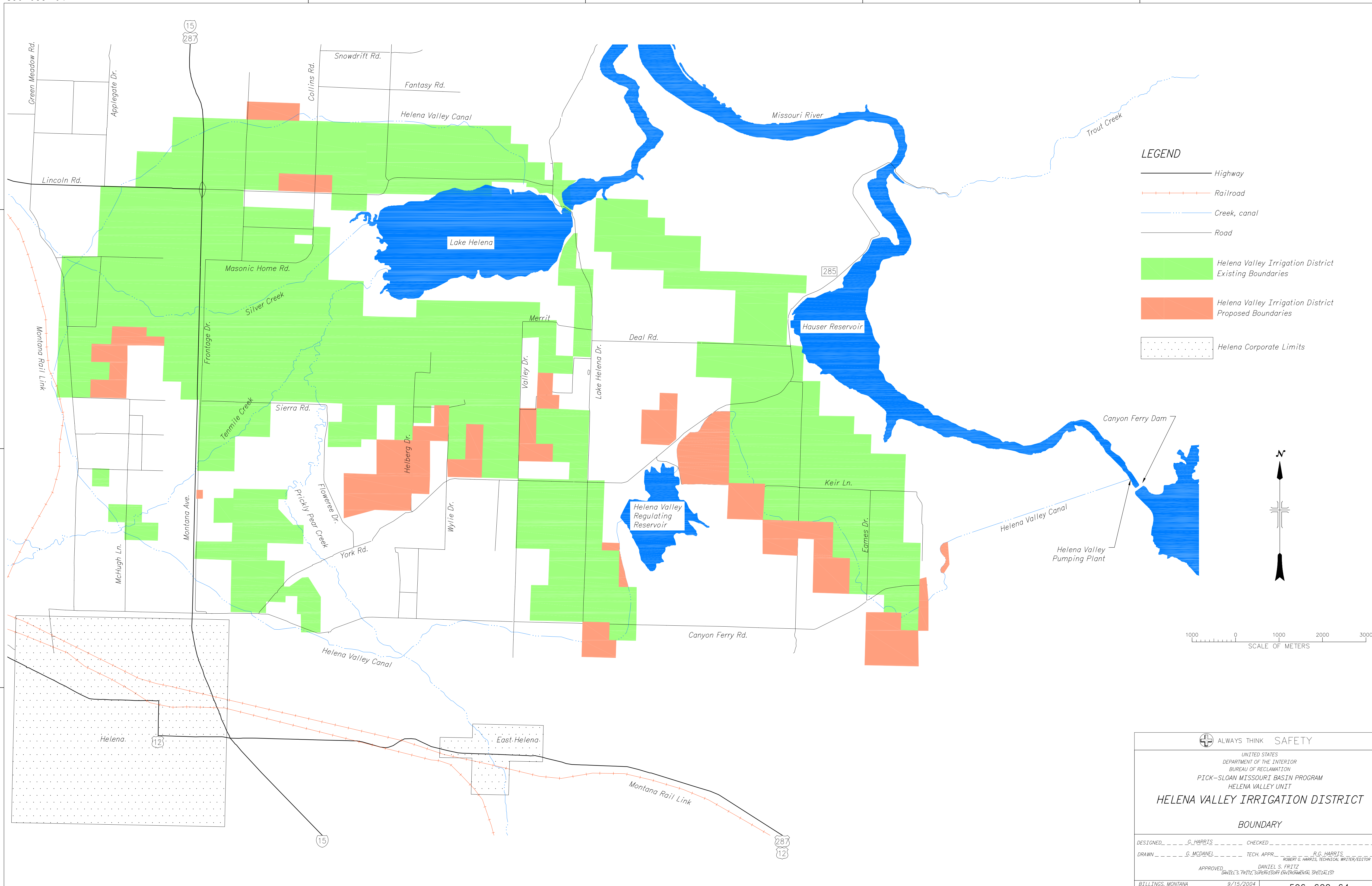

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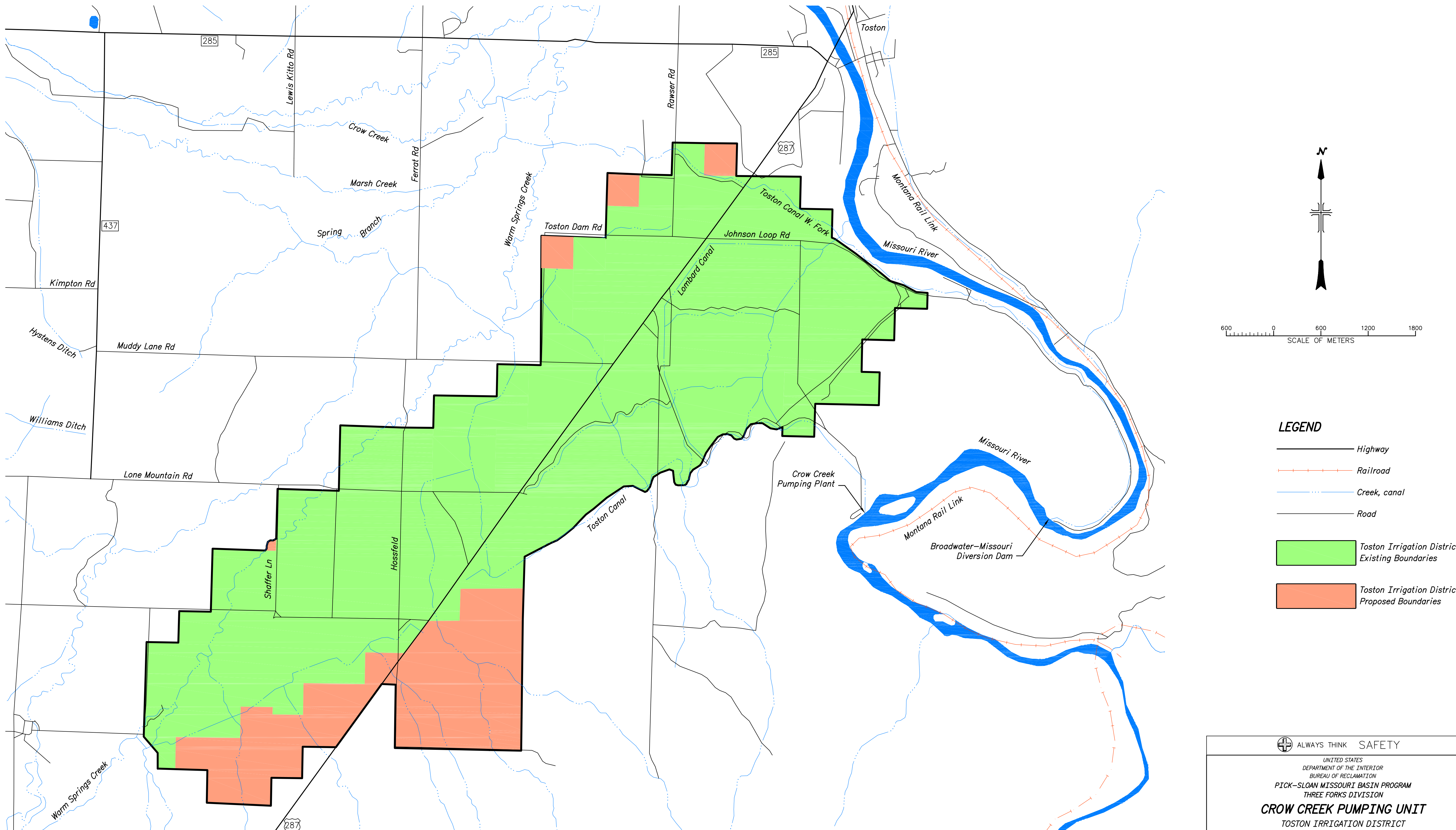

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