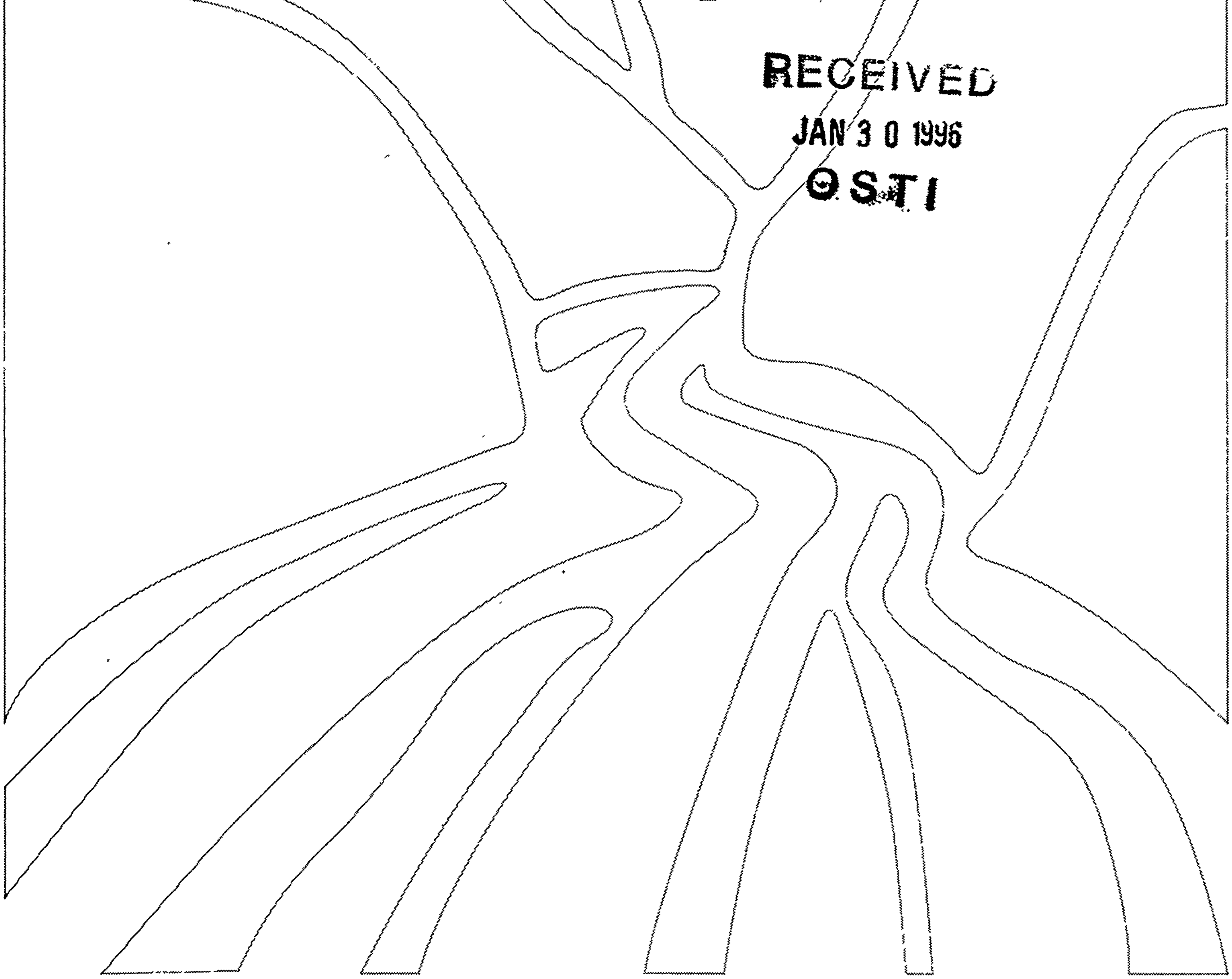
Columbia River System Operation Review

Final Environmental Impact Statement



Appendix F

Irrigation, Municipal and Industrial/Water Supply

BONNEVILLE POWER ADMINISTRATION

US Army Corps of Engineers
North Pacific Division

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

DOE/EIS-0170-App. F

November 1995

PUBLIC INVOLVEMENT IN THE SOR PROCESS

The Bureau of Reclamation, Corps of Engineers, and Bonneville Power Administration wish to thank those who reviewed the Columbia River System Operation Review (SOR) Draft EIS and appendices for their comments. Your comments have provided valuable public, agency, and tribal input to the SOR NEPA process. Throughout the SOR, we have made a continuing effort to keep the public informed and involved.

Fourteen public scoping meetings were held in 1990. A series of public roundtables was conducted in November 1991 to provide an update on the status of SOR studies. The lead agencies went back to most of the 14 communities in 1992 with 10 initial system operating strategies developed from the screening process. From those meetings and other consultations, seven SOS alternatives (with options) were developed and subjected to full-scale analysis. The analysis results were presented in the Draft EIS released in July 1994. The lead agencies also developed alternatives for the other proposed SOR actions, including a Columbia River Regional Forum for assisting in the determination of future SOSs, Pacific Northwest Coordination Agreement alternatives for power coordination, and Canadian Entitlement Allocation Agreements alternatives. A series of nine public meetings was held in September and October 1994 to present the Draft EIS and appendices and solicit public input on the SOR. The lead agencies received 282 formal written comments. Your comments have been used to revise and shape the alternatives presented in the Final EIS.

Regular newsletters on the progress of the SOR have been issued. Since 1990, 20 issues of *Streamline* have been sent to individuals, agencies, organizations, and tribes in the region on a mailing list of over 5,000. Several special publications explaining various aspects of the study have also been prepared and mailed to those on the mailing list. Those include:

- The Columbia River: A System Under Stress
- The Columbia River System: The Inside Story
- Screening Analysis: A Summary
- Screening Analysis: Volumes 1 and 2
- Power System Coordination: A Guide to the Pacific Northwest Coordination Agreement
- Modeling the System: How Computers are Used in Columbia River Planning
- Daily/Hourly Hydrosystem Operation: How the Columbia River System Responds to Short–Term Needs

Copies of these documents, the Final EIS, and other appendices can be obtained from any of the lead agencies, or from libraries in your area.

Your questions and comments on these documents should be addressed to:

SOR Interagency Team
P .O. Box 2988
Portland, OR 97208–2988

PREFACE: SETTING THE STAGE FOR THE SYSTEM OPERATION REVIEW

WHAT IS THE SOR AND WHY IS IT BEING CONDUCTED?

The Columbia River System is a vast and complex combination of Federal and non–Federal facilities used for many purposes including power production, irrigation, navigation, flood control, recreation, fish and wildlife habitat and municipal and industrial water supply. Each river use competes for the limited water resources in the Columbia River Basin.

To date, responsibility for managing these river uses has been shared by a number of Federal, state, and local agencies. Operation of the Federal Columbia River system is the responsibility of the Bureau of Reclamation (Reclamation), Corps of Engineers (Corps) and Bonneville Power Administration (BPA).

The System Operation Review (SOR) is a study and environmental compliance process being used by the three Federal agencies to analyze future operations of the system and river use issues. The goal of the SOR is to achieve a coordinated system operation strategy for the river that better meets the needs of all river users. The SOR began in early 1990, prior to the filing of petitions for endangered status for several salmon species under the Endangered Species Act.

The comprehensive review of Columbia River operations encompassed by the SOR was prompted by the need for Federal decisions to (1) develop a coordinated system operating strategy (SOS) for managing the multiple uses of the system into the 21st century; (2) provide interested parties with a continuing and increased long–term role in system planning (Columbia River Regional Forum); (3) renegotiate and renew the Pacific Northwest Coordination Agreement (PNCA), a contractual arrangement among the region's major hydroelectric–generating utilities and affected Federal agencies to provide for coordinated power generation on the Columbia River system; and (4) renew or develop new Canadian Entitlement Allocation Agreements (contracts that divide Canada's share of Columbia River Treaty downstream power benefits and obligations among three participating public utility districts and BPA). The review provides the environmental analysis required by the National Environmental Policy Act (NEPA).

This technical appendix addresses only the effects of alternative system operating strategies for managing the Columbia River system. The environmental impact statement (EIS) itself and some of the other appendices present analyses of the alternative approaches to the other three decisions considered as part of the SOR.

WHO IS CONDUCTING THE SOR?

The SOR is a joint project of Reclamation, the Corps, and BPA—the three agencies that share responsibility and legal authority for managing the Federal Columbia River System. The National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and National Park Service (NPS), as agencies with both jurisdiction and expertise with regard to some aspects of the SOR, are cooperating agencies. They contribute information, analysis, and recommendations where appropriate. The U.S. Forest Service (USFS) was also a cooperating agency, but asked to be removed from that role in 1994 after assessing its role and the press of other activities.

HOW IS THE SOR BEING CONDUCTED?

The system operating strategies analyzed in the SOR could have significant environmental impacts. The study team developed a three–stage process—scoping, screening, and full–scale analysis of the strategies—to address the many issues relevant to the SOR.

At the core of the analysis are 10 work groups. The work groups include members of the lead and cooperating agencies, state and local government agencies, representatives of Indian tribes, and members of the public. Each of these work groups has a single river use (resource) to consider.

Early in the process during the screening phase, the 10 work groups were asked to develop an alternative for project and system operations that would provide the greatest benefit to their river use, and one or more alternatives that, while not ideal, would provide an acceptable environment for their river use. Some groups responded with alternatives that were evaluated in this early phase and, to some extent, influenced the alternatives evaluated in the Draft and Final EIS. Additional alternatives came from scoping for the SOR and from other institutional sources within the region. The screening analysis studied 90 system operation alternatives.

Other work groups were subsequently formed to provide projectwide analysis, such as economics, river operation simulation, and public involvement.

The three−phase analysis process is described briefly below.

- **Scoping/Pilot Study**—After holding public meetings in 14 cities around the region, and coordinating with local, state, and Federal agencies and Indian tribes, the lead agencies established the geographic and jurisdictional scope of the study and defined the issues that would drive the EIS. The geographic area for the study is the Columbia River Basin (Figure P−1). The jurisdictional scope of the SOR encompasses the 14 Federal projects on the Columbia and lower Snake Rivers that are operated by the Corps and Reclamation and coordinated for hydropower under the PNCA. BPA markets the power produced at these facilities. A pilot study examining three alternatives in four river resource areas was completed to test the decision analysis method proposed for use in the SOR.
- **Screening**—Work groups, involving regional experts and Federal agency staff, were created for 10 resource areas and several support functions. The work groups developed computer screening models and applied them to the 90 alternatives identified during screening. They compared the impacts to a baseline operating year—1992—and ranked each alternative according to its impact on their resource or river use. The lead agencies reviewed the results with the public in a series of regional meetings in September 1992.
- **Full−Scale Analysis**—Based on public comment received on the screening results, the study team sorted, categorized, and blended the alternatives into seven basic types of operating strategies. These alternative strategies, which have multiple options, were then subjected to detailed impact analysis. Twenty−one possible options were evaluated. Results and tradeoffs for each resource or river use were discussed in separate technical appendices and summarized in the Draft EIS. Public review and comment on the Draft EIS was conducted during the summer and fall of 1994. The lead agencies adjusted the alternatives based on the comments, eliminating a few options and substituting new options, and reevaluated them during the past 8 months. Results are summarized in the Final EIS.

Alternatives for the Pacific Northwest Coordination Agreement (PNCA), the Columbia River Regional Forum (Forum), and the Canadian Entitlement Allocation Agreements (CEAA) did not use the three−stage process described above. The environmental impacts from the PNCA and CEAA were not significant and there were no anticipated impacts from the Regional Forum. The procedures used to analyze alternatives for these actions are described in their respective technical appendices.

For detailed information on alternatives presented in the Draft EIS, refer to that document and its appendices.

WHAT SOS ALTERNATIVES ARE CONSIDERED IN THE FINAL EIS?

Seven alternative System Operating Strategies (SOS) were considered in the Draft EIS. Each of the seven SOSs contained several options bringing the total number of alternatives considered to 21. Based on review of the Draft EIS and corresponding adjustments, the agencies have identified 7 operating strategies that are evaluated in this Final EIS. Accounting for options, a total of 13 alternatives is now under consideration. Six of the alternatives remain unchanged from the specific options considered in the Draft EIS. One is a revision to a previously considered alternative, and the rest represent replacement or new alternatives. The basic categories of SOSs and the numbering convention remains the same as was used in the Draft EIS. However, because some of the alternatives have been dropped, the numbering of the final SOSs are not consecutive. There is one new SOS category, Settlement Discussion Alternatives, which is labeled SOS 9 and replaces the SOS 7 category. This category of alternatives arose as a consequence of litigation on the 1993 Biological Opinion and ESA Consultation for 1995.

The 13 system operating strategies for the Federal Columbia River system that are analyzed for the Final EIS are:

SOS 1a Pre Salmon Summit Operation represents operations as they existed from around 1983 through the 1990–91 operating year, prior to the ESA listing of three species of salmon as endangered or threatened.

SOS 1b Optimum Load–Following Operation represents operations as they existed prior to changes resulting from the Regional Act. It attempts to optimize the load–following capability of the system within certain constraints of reservoir operation.

SOS 2c Current Operation/No–Action Alternative represents an operation consistent with that specified in the Corps of Engineers' 1993 Supplemental EIS. It is similar to system operation that occurred in 1992 after three species of salmon were listed under ESA.

SOS 2d [New] 1994–98 Biological Opinion represents the 1994–98 Biological Opinion operation that includes up to 4 MAF flow augmentation on the Columbia, flow targets at McNary and Lower Granite, specific volume releases from Dworshak, Brownlee, and the Upper Snake, meeting sturgeon flows 3 out of 10 years, and operating lower Snake projects at MOP and John Day at MIP.

SOS 4c [Rev.] Stable Storage Operation with Modified Grand Coulee Flood Control attempts to achieve specific monthly elevation targets year round that improve the environmental conditions at storage projects for recreation, resident fish, and wildlife. Integrated Rules Curves (IRCs) at Libby and Hungry Horse are applied.

SOS 5b Natural River Operation draws down the four lower Snake River projects to near river bed levels for four and one–half months during the spring and summer salmon migration period, by assuming new low level outlets are constructed at each project.

SOS 5c [New] Permanent Natural River Operation operates the four lower Snake River projects to near river bed levels year round.

SOS 6b Fixed Drawdown Operation draws down the four lower Snake River projects to near spillway crest levels for four and one–half months during the spring and summer salmon migration period.

SOS 6d Lower Granite Drawdown Operation draws down Lower Granite project only to near spillway crest level for four and one–half months.

SOS 9a [New] Detailed Fishery Operating Plan includes flow targets at The Dalles based on the previous year's end–of–year storage content, specific volumes of releases for the Snake River, the drawdown of Lower Snake River projects to near spillway crest level for four and one–half months, specified spill percentages, and no fish transportation.

SOS 9b [New] Adaptive Management establishes flow targets at McNary and Lower Granite based on runoff forecasts, with specific volumes of releases to meet Lower Granite flow targets and specific spill percentages at run–of–river projects.

SOS 9c [New] Balanced Impacts Operation draws down the four lower Snake River projects near spillway crest levels for two and one–half months during the spring salmon migration period. Refill begins after July 15. This alternative also provides 1994–98 Biological Opinion flow augmentation, integrated rule curve operation at Libby and Hungry Horse, a reduced flow target at Lower Granite due to drawdown, winter drawup at Albeni Falls, and spill to achieve no higher than 120 percent daily average for total dissolved gas.

SOS PA Preferred Alternative represents the operation proposed by NMFS and USFWS in their Biological Opinions for 1995 and future years; this SOS operates the storage projects to meet flood control rule curves in the fall and winter in order to meet spring and summer flow targets for Lower Granite and McNary, and includes summer draft limits for the storage projects.

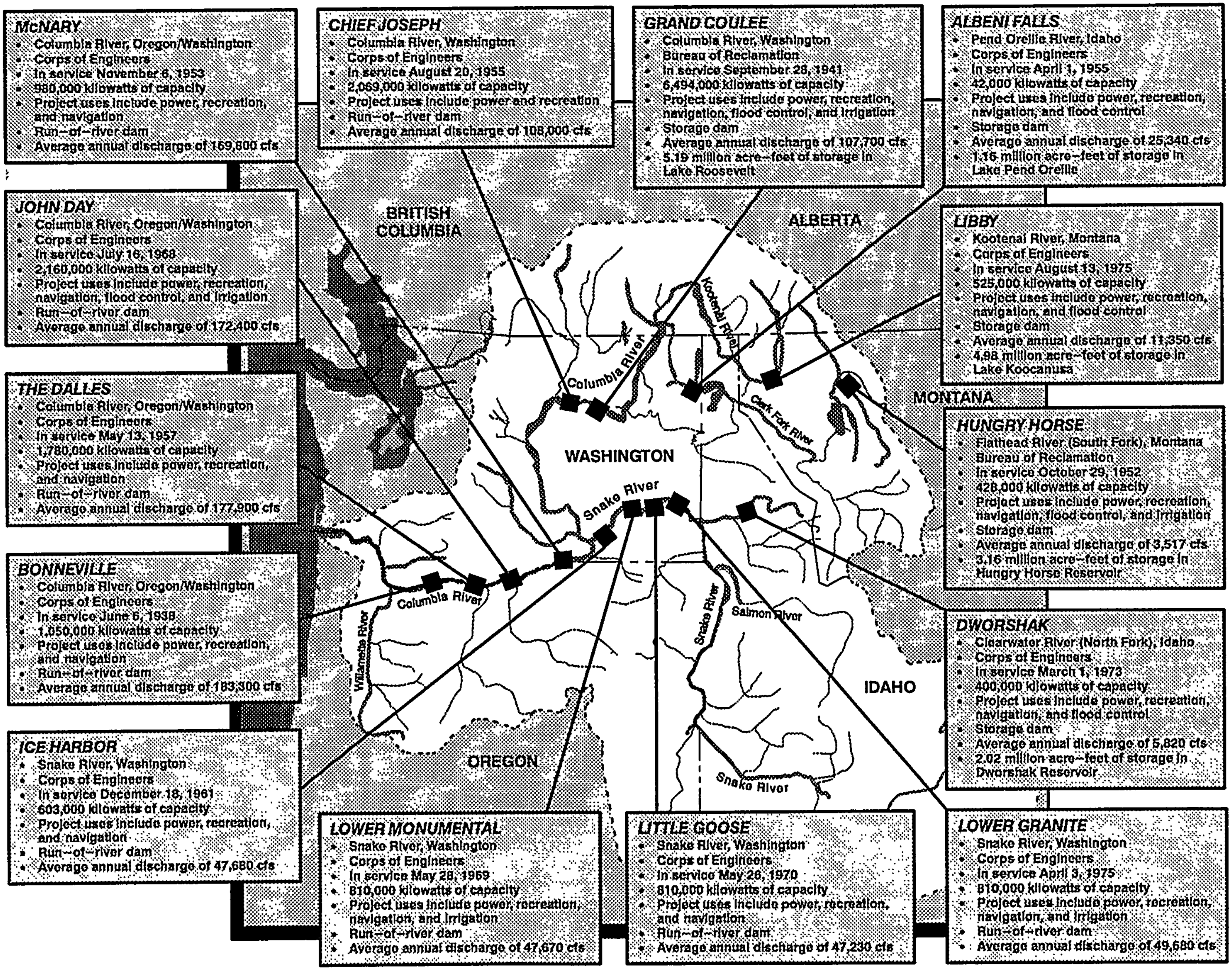
WHAT DO THE TECHNICAL APPENDICES COVER?

This technical appendix is 1 of 20 prepared for the SOR. They are:

A. River Operation Simulation
B. Air Quality
C. Anadromous Fish & Juvenile Fish Transportation
D. Cultural Resources
E. Flood Control
F. Irrigation/Municipal and Industrial Water Supply
G. Land Use and Development
H. Navigation
I. Power
J. Recreation
K. Resident Fish
L. Soils, Geology, and Groundwater
M. Water Quality
N. Wildlife
O. Economic and Social Impacts
P. Canadian Entitlement Allocation Agreements
Q. Columbia River Regional Forum
R. Pacific Northwest Coordination Agreement
S. U. S. Fish and Wildlife Service Coordination Act Report
T. Comments and Responses

Each appendix presents a detailed description of the work group's analysis of alternatives, from the scoping process through full–scale analysis. Several appendices address specific SOR functions (e.g., River Operation Simulation), rather than individual resources, or the institutional alternatives (e.g., PNCA) being considered within the SOR. The technical appendices provide the basis for developing and analyzing alternative system operating strategies in the EIS. The EIS presents an integrated review of the vast wealth of information contained in the appendices, with a focus on key issues and impacts. In addition, the three agencies have prepared a brief summary of the EIS to highlight issues critical to decision makers and the public.

There are many interrelationships among the different resources and river uses, and some of the appendices provide supporting data for analyses presented in other appendices. This Irrigation/M&I appendix relies on supporting data contained in Appendix A. For complete coverage of all aspects of Irrigation/M&I, readers may wish to review both (A and F) appendices in concert.



1 million acre feet = 1.234 billion cubic meters
1 cubic foot per second = 0.028 cubic meters per second

Figure P–1. Projects in the System Operation Review.

TABLE OF CONTENTS

TABLE OF CONTENTS – CONT

TABLE OF CONTENTS – CONT

LIST OF TABLES

LIST OF TABLES – CONT

LIST OF FIGURES

CHAPTER 1

INTRODUCTION: SCOPE AND PROCESS OF IRRIGATION/M&I STUDIES

1.1 GENERAL OVERVIEW

The Columbia River Basin drainage covers 219,000 square miles (567,200 square kilometers) in seven western states and 39,500 square miles (102,300 square kilometers) in British Columbia. Most of the Basin in the United States is located in Washington, Oregon, Idaho, and Montana. Minor portions of the Basin in other states include a small area on the western edge of Wyoming and a small area on the northern edge of Utah and Nevada.

The Columbia River originates at Columbia Lake on the west slope of British Columbia's Rocky Mountain Range. The river flows from Canada into the United States and eventually becomes the border between Oregon and Washington. The Columbia River is 1,214 miles (1,954 kilometers) long; it flows into the Pacific Ocean near Astoria, Oregon.

The Columbia River has an average annual runoff at its mouth of about 198 million acre–feet (244.3 billion cubic meters). The Canadian portion of this runoff is about 25 percent of the total, or 50.2 million acre–feet annually [61.9 billion cubic meters]. Since the 1930's, the Columbia River has been harnessed for the benefit of the Northwest and the nation. Federal agencies have built 30 major dams on the river and its tributaries. Dozens of non–Federal projects have been developed as well. The dams provide flood control, irrigation, navigation, hydroelectric power generation, recreation, fish and wildlife, and streamflows for wildlife, anadromous fish, resident fish, and water quality.

River users are increasingly competing for the limited water resources in the Columbia River Basin. Because several important multiagency contracts and international agreements involving power production rights and obligations will soon expire, it is now appropriate to review future system operations and river use issues.

The Corps of Engineers (Corps), Bonneville Power Administration (BPA), and Bureau of Reclamation (Reclamation) share portions of the complex set of responsibilities and legal authorities for the management of the Columbia River. The three agencies have entered into a study effort, the Columbia River System Operation Review (SOR), to evaluate alternative methods of operating the river system and to determine how best to operate the system in the future.

Since the SOR was initiated, three anadromous fish stocks that utilize the Columbia and Snake Rivers: sockeye, spring/summer chinook, and fall chinook, have been listed as endangered or threatened. Although this has added a new dimension to the study, it does not alter the objectives initially identified at the outset of the study. The investigation will evaluate the impacts of alternative operating strategies.

The SOR provides a public forum where individuals and organizations representing all interests can express their concerns and recommendations for system operation. To ensure continuing representation of public views during the investigation and preparation of the Draft EIS, work groups representing several functional areas have been established and subject matter experts have been invited to participate in the SOR analysis.

1.2 SUMMARY OF IRRIGATION, MUNICIPAL AND INDUSTRIAL WATER ISSUES RAISED DURING THE SCOPING PROCESS – AND DISPOSITION

The following section includes issues raised in the public scoping process, as well as those offered for consideration by members of the Irrigation and M&I

Work Group (I/M&IWG). In certain cases, the comments reflected the geographical interests of those participating at the public meetings –– as participants in one part of the Columbia River Basin expressed different interests than those in other parts of the basin.

Comments have been grouped into appropriate categories.

Comments received at the public scoping meetings on the use of water for agriculture production and for municipal and industrial uses ranged from numerous comments expressing a strong support for existing levels of irrigation use to suggestions by a few that water utilized for irrigated agriculture in the Pacific Northwest be monitored or reduced. There were many comments that related to issues involving irrigation and agriculture in the basin that are outside the scope of SOR. Following is a summary of comments for each category and their disposition. Issues that are outside the scope of SOR are so indicated.

Priority of Use:

Many commenters expressed the opinion that irrigation should be given top priority in the operation of the Federal Columbia River Power System (FCRPS). These opinions were exemplified by statements like "irrigation and power pay the bills", "create jobs and provide a tax base", and "irrigation, power, and flood control were the authorized purposes of the projects". The continuation of irrigation at present levels and for future growth was given high priority by many. Specifically, many comments expressed the opinion that irrigation development on the Federal Columbia Basin Project in central Washington be expanded as originally authorized by Congress. There were some comments that irrigation should coexist with other river purposes and that fishery interest be given equal priority. A few comments stated that irrigated agriculture should be given a lower priority than other uses, including the suggestion that the needs of native ecosystems should be placed first. In general these commenters felt that anadromous and resident fish and wildlife be given additional consideration in operation of the river system, and irrigation should sacrifice if tradeoffs are required.

Disposition: Three of the seven SOR alternative operating strategies have no direct effect on irrigation. Accordingly, other things being equal, existing levels of acreage and production in the Pacific Northwest (PNW) would be maintained.

The issue of giving additional consideration to fish and wildlife and that irrigation should share priority with other uses, including anadromous fisheries is addressed in five SOR alternatives: SOS4 – stable storage project operation, SOS5 –– natural river operation, SOS6 –– drawdown of lower Snake reservoirs, SOS9 –– which includes a number of operational changes and, the Preferred Alternative –– which includes drawdown at John Day and Lower Granite.

The issue of expanding the irrigated acreage of the Federal Columbia Basin Project is outside the scope of SOR and is dependent on other state and Federal actions, including Congressional appropriations. In August 1994, Reclamation announced it was discontinuing plans to issue a final EIS on expansion of the Columbia Basin Project.

Economy & Water Pricing:

Numerous comments stressed the importance of irrigation in the PN, including the production of food and fiber, as well as the importance of the economic infrastructure built around the irrigated agriculture sector. It was recommended that any adverse impact on irrigated agriculture from revised system operations be fully evaluated. There were some opinions expressed about the high cost of irrigation (from a public perspective) and the efficiency of irrigated agriculture in certain areas of the region. It was suggested that the concept of fair pricing of water resources for all users be incorporated into the analysis. One commenter suggested that only those irrigated areas that are most cost effective be retained in production.

Disposition: Three of the seven SOR alternative operating strategies have no direct effect on irrigation and consequently would not adversely effect irrigation and the associated economic infrastructure. Three SOR strategies (SOS5, SOS6, and the Preferred Alternative), those with reservoir drawdown of the lower Snake reservoirs to natural river and a fixed drawdown are strategies designed to give more consideration to non irrigation uses, such as anadromous fish species, resident fish, and wildlife. These alternative strategies involve some degree of adverse impact on irrigation pumpers on the Ice Harbor and John Day pools, as well as irrigation districts receiving water pumped from Grand Coulee.

Establishing a pricing structure for irrigation water and for other uses is outside the scope of SOR and the I/M&IWG.

Water Rights:

The majority of comments on this topic favored maintaining existing water rights for irrigation. In general, it was stated that there is sufficient water in the lower Snake and the Columbia Rivers to meet all established irrigation, municipal, and industrial water rights. The quantity of water diverted for these purposes is small compared to total river flow. The concept of modifying present water right laws to encourage and authorize water transfers was introduced. One commenter stated that water rights should be done away with and all water and water use should be considered a public right.

Disposition: The issue of water rights is outside the scope of SOR. Water rights for irrigation are under state and/or Federal jurisdiction. None of the SOR alternative operating strategies propose to diminish or reduce the priority of water rights, permits, or entitlements held by existing irrigation and M&I water users.

Conservation & Efficiency:

A moderate number of comments indicated the desirability of conservation and increased efficiency and should be incorporated into future water uses. This includes better water planning and management to not only make the best use of the water resources but to decrease electrical energy consumption.

Comments of how to implement conservation ranged from incentive programs aimed at encouraging voluntary adaptation of conservation to pricing mechanisms aimed at forcing adaptation of these measures. Several comments revolved around the wastefulness of water use in irrigation. Some commenters recognized the favorable progress of the irrigation community in adapting new technology and implementing conservation and efficiency measures.

The pros and cons of implementing conservation measures to reduce irrigation diversion was also addressed by some commenters. Some expressed opinions that irrigation conservation measures would release water that would then be available for other uses while others pointed out that the measures would adversely impact fish and wildlife habitat that has been developed as a result of the existing irrigation activity. Several individuals stated that the SOR analysis should not be the vehicle to identify site–specific water conservation opportunities in the northwest.

Disposition: The implementation of measures to increase irrigation efficiency, thereby freeing up water for other uses is beyond the scope of SOR. While the benefits of conservation are recognized, actual implementation is mostly at the field level and it would be inappropriate and beyond the authority of SOR to mandate performance standards. There are a number of efforts ongoing in the PN to identify water saving opportunities, including efficiency improvements, water banks, and other incentives. These efforts are being conducted by a number of entities, including private individuals, irrigation districts, state and Federal agencies, and others.

Pollution:

Several commenters expressed a general concern regarding the water quality of irrigation return flows to the river system. Several commenters noted that irrigation return flows are putting large silt and nutrient loads in the rivers. There were requests that the study address nonpoint pollution sources such as agricultural runoff and municipal and industrial discharges.

Disposition: Three of the seven SOR alternative operating strategies have no impacts on irrigation, thereby neither increasing or decreasing irrigation return flows. The Water Quality Work Group is responsible for evaluating the impacts on water quality of alternative operating strategies for the two strategies (SOS5 and SOS6) that contain proposals for lowered reservoir pools.

Water Resources & Other Issues:

Most of the comments on the general topic of water resources addressed priorities of water use. These have been summarized under this sub–heading. There were several comments about including the Snake River Basin in the SOR analysis. One member of the I/M&IWG felt that the "Upper Snake" basin should be included in the SOR analysis. Reasons for including the Snake Basin included the fact that the Snake Basin is a potential source of water for enhancement of anadromous fish species and it is part of the Columbia River Basin. Arguments were presented on both sides of the issue.

Disposition: The Snake River Basin was excluded in the SOR analysis because:

(1) The Snake River Basin is outside the geographical area of the 14 FCRPS projects;

(2) Because much of the water in the Upper Snake is currently allocated to irrigation through Federal contracts or via State water rights, conversions from irrigation to other uses would require contract or water right recession, or participation by willing sellers in water markets and water banks, Federal and State action, including appropriations, and/or changes in State water rights.

There were few direct comments about M&I supplies. As a summary, comments on M&I generally expressed the belief that M&I uses will continue to be of importance and that all SOR alternatives should accommodate such uses and recognize the need for expansion as population increases.

Table 1–1 summarizes the significant issues and their disposition.

Table 1–1. Issues and Disposition

Issue	Disposition
Priority of Use:	Addressed in alternative strategies.
Continued expansion of Federal Columbia Basin Project in central Washington	Not addressed in alternative strategies.
Economy/Price:	
Impact on irrigation economy	Differentially addressed in alternative strategies.
Establish "fair pricing" of water supplies.	Not addressed. Outside scope of SOR.
Water Rights:	Not addressed. Outside scope of SOR.
Conservation/Efficiency:	
Increase irrigation efficiency	Not addressed. Outside scope of SOR.
Specific water conservation measures	Not addressed. Outside scope of SOR.
Pollution:	
Water quality – irrigation water return flows	Evaluated by Water Quality Work Group.
Water Resources/General:	
Inclusion of Snake Basin in study	Not included. Outside scope of SOR.
Accommodate M&I water requirements	Differentially addressed in alternative strategies.

1.2.1 Irrigation/M&I Issues Raised During the Public Review of the Draft EIS – and Disposition

Comments received on the Draft EIS and the responses are contained in a separate volume to the final EIS.

The essence of public review comments (written and oral) on the Draft EIS regarding irrigation/M&I involved the estimated impact on irrigation and M&I users (pumpers) on the 4 lower Snake reservoirs and John Day. Comments expressed the view that users of these reservoirs, including the local economies, were bearing too large a portion of the costs to save anadromous fish species in the Pacific Northwest. Several comments suggested the Draft EIS analysis understated the economic impact on irrigation.

In regard to those comments directly related to the irrigation/M&I analysis, for the Final EIS analysis : 1) the list of irrigation and M&I pumpers was re–inventoried and resulted in the addition of one pump station on the John Day pool and refinement of data on several other pump stations, 2) O&M costs for pumpers on the 4 lower Snake River projects was increased over that used in the Draft EIS analysis, 3) Modification cost estimates for all stations were reevaluated and revised where necessary, and 4) the farm income analysis used in the Draft EIS analysis was deleted, and a cost–of–pumping analysis was utilized.

In addition to the measurement of impacts, Chapter 5 contains a discussion about the economic viability of reservoir pumpers under drawdown scenarios.

1.3 PUBLIC INVOLVEMENT AND AGENCY COORDINATION

The Irrigation/Municipal and Industrial Work Group included agency staff from Reclamation, BPA, Corps, staff from state and other Federal agencies, individuals with irrigation and environmental interests, and water and land use experts from private firms and state universities. There were two levels of participation: (1) Active participants that attended work group meetings and accepted work tasks associated with the study effort; and (2) Those who did not attend meetings but requested copies of meeting notes and other study materials.

1.3.1 Study Scope of Irrigation/M&I Functions

Changes in the operation of the Federal storage and power system can have a direct and indirect impact on the irrigation and M&I functions. Irrigation and M&I entities pumping from or otherwise utilizing, reservoir pools on the lower Snake and Columbia rivers are directly affected by the manner in which the system is operated, especially by those alternatives with proposed reservoir drawdowns. The modification of pump facilities and the increase in electrical energy required to pump water to meet the accustomed water uses is considered a direct impact. A change in the energy rate charged for electrical energy or a change in grain shipping cost due to changes in the system operation is considered an indirect result of the altered system operation.

The impact on irrigators from lowered water elevations in the affected reservoir pools is evaluated in Chapters 4 and 5. Direct impacts to irrigation interests were evaluated by estimating the increased pumping cost. Chapter 3 identifies study methodology.

The change in pumping cost experienced by M&I users was also quantified. For purposes of this report, it is assumed the increased costs to secure a water supply for M&I purposes will be absorbed by the users and no further analysis, such as a net returns analysis, will be required.

The indirect impact of a changing power rate on all sectors or industries in the PN, including irrigation and M&I, stemming from alternative operating strategies was analyzed by the Economics Work Group. These impacts are on an industry or sector basis (agriculture, metals, etc.) and will include those impacts on irrigation and M&I pumpers in the impact area directly affected as well as in the Columbia River Basin.

1.4 SCREENING PROCESS

The purpose of screening was to identify an array of alternatives for further analysis in the DEIS. The process was a simplified analytical approach that attempted to examine all possible operating alternatives. The work groups for each functional area were responsible for identifying alternative Columbia River system operational scenarios which were favorable to their particular function. From this process and additional scenarios from project management and other sources, a total of 90 alternative scenarios were developed and included in the screening process.

1.4.1 Selection of Irrigation/M&I Alternatives

The I/M&I Work Group, as did other work groups, developed reservoir operations alternatives that would be favorable to these two purposes for the present level of development and for projected development 10 years and 30 years hence. Optimum conditions for irrigation would be full reservoirs from April to October (growing season), while the optimum for M&I would be full reservoir year round.

The I/M&IWG formulated three alternatives that are favorable to Irrigation, including two that assumes an increase in the irrigated acreage of the Columbia River Basin. Alternatives No. 62 and 63 assume increased irrigation depletions of 890,000 (1,098 million cubic meters) and 2.6 million acre feet (3,208 million cubic meters) respectively due to projected increases in the irrigated acreage. Alternatives (62. IRR–OPT1), (63. IRR–OPT2), and (64. IRR–OPT3) are described in detail on pages 37 and 38 of the **"Screening Analysis: A Summary"** document.[1]

A second set of alternatives assumes increased instream flows resulting from a decrease in irrigation diversions. The decrease in diversions and subsequent increase in instream flows in both the Columbia and the Snake Rivers could result from a combination of possible changes in water use and supply conditions. These include improved efficiency in the use of water, decreased consumptive use of water by crops or other plants, new upstream storage, use of uncontracted storage space, buy–back of existing storage rights, acquisition of natural flow rights, and/or lease option programs during low water years. Alternatives (65. RES–IRRFLO), (79. AMG–IRRFLO2), (89. RES–IRRFLO2), and (90. AMG–IRRFLO) are described in detail on pages 38, 40, and 41 of the **"Screening Analysis: A Summary"** document.[2]

1.4.2 Screening Process

For screening, each work group analyzed the effects of operational changes of the 90 alternatives on their particular function. Impacts to the irrigation/M&I functions were limited to reservoir pools on the lower Snake River and the Columbia River from Grand Coulee Dam down to John Day Dam. Cost curves reflecting additional capital investment and operating costs related to different pool elevations were developed for reservoir pools where the impact on irrigation and M&I withdrawals are expected to be greatest. Cost curves (spreadsheet) models were developed for the reservoir pools behind Grand Coulee, Ice Harbor, McNary, and John Day. A detailed description of the irrigation/M&I screening methodology is provided on pages 95 to 106 in Volume 1, **"Screening Analysis Volume 1 – Description and Conclusions, August 1992."**[3]

Of the 90 alternatives, 21 have slight to significant adverse impact on the irrigation community. These (21 alternatives) involved drawdown and major target flow alternatives for enhancement of anadromous fish and other alternatives that include extensive and intensive irrigation water conservation/new storage/water right acquisition program. There are 52 alternatives that improve conditions for irrigation. All other alternatives (17 in number) had little or no impact on irrigation.

1.5 FULL–SCALE ANALYSIS

Although a total of 90 alternatives were initially analyzed in screening. These were blended into 10 alternative strategies based on the screening results. Following additional public review and input , the co–lead agencies consolidated the 10 strategies into the final 7 alternatives addressed in detail in Draft EIS.

For the Draft EIS these seven alternative strategies which had multiple component options resulted in a total of 21 operational options being evaluated in the full scale analysis. The results and tradeoffs for each resource area were contained in a draft technical appendix and summarized in the Draft EIS.

For the Final EIS analysis, several strategies were revised and several added resulting in 7 strategies being evaluated, including the Preferred Alternative. The seven strategies with multiple options resulted in a total of 13 operational options being evaluated in the Final EIS.

A description of the seven alternative operating strategies with multiple component options is contained in Chapter 4, Part 4.1.

The 13 alternative operating options are the subject of a detailed analysis of impacts, which is called the "full–scale" analysis. These options were evaluated by the various work groups for potential impacts to their area of interest, i.e., wildlife, fisheries, power, flood control, irrigation, etc. System hydrological studies called hydroregs, were prepared which simulates each reservoir's operation over the period of record. The hydroregs are the common denominator for evaluation by the various work groups.

The full scale analysis methodology for the irrigation/M&I function is described in Chapter 3, "Study Methods and Procedure," while the results of the analysis are presented in Chapter 4, "Alternatives and Their Impacts." The comparison of alternatives with the Base Case (SOS1A) and with the No Action Alternative (SOS2C) to determine incremental monetary impacts is presented in Chapter 5, "Comparison of Alternatives."

CHAPTER 2

IRRIGATION/M&I IN THE COLUMBIA BASIN TODAY

2.1 INTRODUCTION

Included in this chapter is a general overview of irrigation in the Pacific Northwest, including a tabulation of irrigated acres, irrigation depletions and diversion, by hydrologic basin, and a summary of state water rights as related to issues raised by the public during the scoping process.

Characteristics and conditions of the irrigation and M&I water users in the areas potentially affected by the operation of the Federal system are described. Although irrigation occurs throughout the Columbia River Basin, the irrigation and M&I characteristics and conditions for water users located outside the potentially affected area are not described.

2.2 OVERVIEW OF IRRIGATION/M&I IN THE PACIFIC NORTHWEST

2.2.1 Irrigation Today

Agriculture, including the production from irrigated lands, is an important industry in the economy of the Columbia River Basin. In 1991, crop and livestock sales amounted to $9.7 billion in the region, excluding British Columbia. In addition to the direct effect of these sales on the region's employment and income, the regions' economic base is enhanced. The enhancement results from the induced and stemming impacts generated by the processing, shipping and handling, and transportation of agricultural products, as well as the provision of production inputs to agricultural producers. A vast network of supporting infrastructure has been built up around the production of food and fiber in the region.

Water is one of the regions most important natural resources. In 1989–1990 the irrigated acreage for the Columbia River Basin (including British Columbia) was 7,324,300 acres (2,964,000 hectares), or approximately 4 percent of the regions total area. This acreage includes full and supplemental irrigation service to lands that range from relatively low intensive meadow hay production at high elevations in Idaho, eastern Oregon, and western Montana to intensive irrigation of fruits and vegetables in southern Idaho, Yakima Valley, Willamette Valley, central Washington, Columbia River corridor, and other areas. Idaho has the largest irrigated acreage with approximately 3.33 million acres (1.33 million hectares), while Washington and Oregon have 1.879 million and 1.317 million acres respectively (0.76 million hectares and 0.53 million hectares). Table 2–1 displays the distribution of irrigated acres in the region, including British Columbia, Canada.

Climate is perhaps the most important environmental factor in the region affecting irrigation and its potential. Annual precipitation and the length of the growing season varies widely over the region. Annual precipitation averages 28 inches (711 mm) over the region. However, many of the irrigated areas receive less than 15 inches (381 mm) per year. Precipitation generally increases with elevation. Much of the irrigation practiced in the region is dependent on the use of storage and diversions from rivers and streams, although a significant amount of irrigation occurs from groundwater wells.

Irrigation in the region is practiced over a wide range of agronomic conditions and with varying intensity. The value of crop production in the region can range from $6,000 per acre for high yielding apple and grape orchards with capital intensive drip or solid set systems to $150 per acre for meadow hay–pasture production at high elevations utilizing subirrigation or wild flooding.

Table 2–1. Irrigated Acreage By State – Columbia River Basin

State/Province	Acreage	Percentage
Idaho	3,332,200	45.5
Montana	433,700	5.9
Washington	1,878,900	25.6
Oregon	1,316,600	18.0
Wyoming	94,100	1.3
Utah	5,600	.1
Nevada	70,400	1.0
Total United States	7,131,500	
British Columbia	192,800	2.6
Total for Region	7,324,300	100.0

2.2.2 History of Irrigation in the Region

The biggest stimulus to agricultural development in the region was the discovery of gold and the resulting influx of people requiring food and shelter. With the miners came farmers and cattlemen. Dryland grain and forage production became the most common form of farming, especially in the Willamette Valley of Oregon. However, because vast amounts of land located in the arid area east of the Cascades could not support dry–farming, farmers turned to irrigation. The earliest practice of irrigation in the region was on a small scale by several Indian tribes, including those in the Yakima Valley.

From the beginning of white settlement, individuals and private companies diverted water from streams. Because of the distance from water supply sources the appropriation doctrine of water use was developed and served the region well.

From the early small diversions from streams to irrigate food crops and to produce feed for livestock, irrigation expanded to nearly a half million acres in 1900. Irrigation expanded rapidly after that to 2.3 million acres (0.93 million hectares) by 1910. Irrigation grew to 3.5 million acres (1.41 million hectares) in 1928, to 6.5 million acres (2.63 million hectares) in 1966, to 7.5 million acres (3.03 million hectares) in 1980, a then decreased slightly to the present 7.3 million acres (2.95 million hectares) in 1990.[4]

Many acts of Congress were made to encourage settlement and development of the west, including the Pacific Northwest. These acts included the Donation Land Act 1850–1855, the Homestead Act of 1862, the 1877 Desert Land Act, the Cary Act of 1894, and the 1902 Reclamation Act. Congressional land grants to railroads opened up additional parts of the public domain to development. The railroads provided the needed transportation for farm commodities and livestock. While private enterprise developed a substantial acreage of land in the region, is was apparent by the 1890's that further development would require a strong and active role by the Federal government. The 1902 Reclamation Act provided the authority and funding for the comprehensive development of river basins in the west. Of the 7.3 million acres (2.95 million hectares) irrigated in the region, lands receiving Reclamation water or utilizing Reclamation constructed systems to transport water accounted for approximately 3 million acres (1.21 million hectares) in 1990. In addition, powerplants at Reclamation dams provided the necessary low cost power required to pump water to land areas not reachable by gravity diversions alone.

2.2.3 Characteristics of Agriculture, Production and Value

All portions of the region have some irrigation. The major blocks of concentrated irrigation are located in the Yakima Valley, Boise and Payette valleys, along the Snake River Plain in southern and eastern Idaho, central Washington, north central Washington, the Deschutes basin, and lands adjacent to the Columbia River near the Tri–Cities area. There have been extensive private irrigation developments pumping from the McNary, John Day, and Ice Harbor dam pools.

Irrigated farming is usually characterized by a fairly high degree of diversification and intensive land use. There is no "average" irrigated farm that is representative of the region. In addition, many areas contain irrigated farms that are less than full–time operations on which the owner does not rely for his/her total income.

Commercial family farm size can range from a 40 acre (16 hectares) apple orchard to a 640 acre (259 hectares) cash–grain row crop operation. In addition, there are large size commercial or "corporate farms" that may irrigate thousands of acres. The largest of these are located along the Lower Snake River and immediately downstream below the confluence with the Columbia River. These particularly large operations may contain 10,000 to 20,000 thousand acres (4,000 to 8,000 hectares), and utilize complex high–tech irrigation pumping systems to deliver water to center pivot irrigation systems.

It is of particular interest that center pivot irrigation systems have enabled the irrigation of lands, especially large blocks along the Columbia River, along the Snake Plain, and in central Washington. These lands due to soil texture and topography, would have been classified as nonirrigable under gravity or rill irrigation. Soils in these areas are highly sandy with a low water holding capacity. As such, during the peak irrigation season these soils need water applied as often as every 3 to 4 days, which is impractical under gravity systems. Center pivot systems are able to deliver water at the necessary intervals and at graduated amounts to insure proper plant growth, provide plant cooling, and prevent soil erosion by wind during critical periods.

Production from irrigated land accounts for a substantial portion of the total crop production in the region. The production of some crops like potatoes, sugar beets, hops, mint, and fruit is almost exclusively from irrigated lands. Table 2–2 demonstrates the importance of irrigation and shows total crop production in Washington, Oregon, and Idaho in 1987 as well as the portion estimated to come from irrigation.

The region is the leading producer of many crops grown in the United States. Washington is the leading U.S. producer of apples, asparagus, hops, lentils, concord grapes, sweet cherries, spearmint oil, and pears. Idaho is the leading state in the production of potatoes and second in sugar beets. Oregon leads in the production of peppermint oil and ranks very high in the production of processing vegetables.

2.2.4 Future Increases In Irrigation

It is estimated that the region contains approximately 33 million acres (13.4 million hectares) that are potentially irrigable. These lands have favorable soils, topography, drainage, and climate which makes them suitable for irrigation. However, many of these lands have little or no prospect of irrigation and are better suited to other uses. The Irrigation and M&I Work Group considered possible future increases in irrigated acreage and concluded that only the 87,000 acres (35,200 hectares) currently being studied for irrigation development as part of the existing Columbia Basin Federal Reclamation Project be included as a projected future development. The existing food and fiber supply/demand situation, budget constraints, environmental restrictions, and financial feasibility of Federally sponsored irrigation developments precludes further projected

Table 2–2. Crop Production in Washington, Oregon and Idaho, and the Portion of Production from Irrigated Lands

Crop		Selected Major Commodities	
		Total Production For 3 States [1]	Percent of Total From Irrigated Lands[2]
	Units	Production	Percentage
Corn for grain	Bu.	14,134,000	86.9
Wheat	Bu.	249,907,000	31.0
Potatoes	Cwt	178,452,000	99.0
Hops	Lbs	14,457,000	100.0
Mint, Oil	Lbs	5,748,000	100.0
Hay, alfalfa & mix	Tons	8,480,000	63.7
Vegetables	Acres	331,000	73.2
Orchards	Acres	346,000	85.0
Sugar beets	Tons	4,710,000	100.0

1/Source: 1987 Census of Agriculture data for Idaho, Oregon, and Washington. Data exclude western Montana, and portions of the basin in Wyoming, Utah and Nevada – not able to disaggregate data from total for state.

2/Source: Percentages are estimates utilizing 1987 Census of Agriculture, including the 1988 Irrigation Supplement with 1988 data.

increases in development. As with any economic sector, the irrigation acreage in the region varies annually depending on economic conditions in the agricultural sector, national economic conditions, water supply as well as other considerations.

2.2.5 Use Of Water

Irrigation diversions from the regions streams, rivers, and reservoirs is a function of the crop consumptive use requirement, delivery system losses, and on–farm losses, including application efficiency. Net irrigation depletions, essentially diversions minus return flows, is the more meaningful indicator to system operations because the residual water is the actual amount available to benefit other uses, including the power system. Return flows are available for hydro power generation, fish flows, etc. and need be accounted for in flood control operations. On–farm and system operational efficiencies vary widely over the region. Irrigation application methods have changed significantly in the region.

Sprinkler application essentially started with the introduction of light weight sprinkler pipe in the 1940's and continues to be utilized. With the introduction of wheel roll systems, and especially center pivot irrigation technology, the conversion from gravity to sprinkler application accelerated in the late 1960's and 1970's. Essentially all new irrigation development since the mid 1970's has utilized sprinkler application. Center pivot technology has allowed irrigation of lands that previously would be non–irrigable because of topography, field size, and water holding capability. In certain areas gravity application remains a highly viable and efficient method of application. It is estimated that 43 percent of the irrigation in the region is with gravity systems and 57 percent with sprinkler systems.

The science of irrigation application technology has steadily progressed to where it now includes satellite technology to transmit agricultural and meteorological data to irrigators to improve water management and reduce energy use. Crop water use infromation networks such as AgriMet have been developed to assist irrigation districts and individual irrigators to schedule irrigation, improve application efficiency, and conserve energy.

Total irrigation diversions in the region were 32.56 million acre–feet (40.2 billion cubic meters) for the 1990–1991 base level of development, but with a net depletion 13.73 million acre–feet (16.9 billion cubic meters). Table 2–3 summarizes irrigation diversions and depletions for the hydrologic basins in the region for the 1990–1991 base level of development.

2.2.6 Municipal and Industrial Water Supply

The current level of M&I depletions were not considered to be significant in the measurement of impacts under SOR alternative operating strategies. Approximately 90 percent of the total water withdrawn in the Pacific Northwest is for irrigation. Public water supply and domestic use account for about 4 percent, commercial use about 2 percent, and industrial use about 2 percent. The remaining amount is shared by livestock, mining, and thermoelectric. Water withdrawn for nonagricultural use has a higher return rate than for agricultural uses. Accordingly, total depletion for the M&I uses is estimated at less than 2 percent.[1]

2.3 IRRIGATED ACREAGE AND WATER RIGHTS

2.3.1 Irrigated Acreage

Information about the irrigated land base and the water depletions, due primarily to irrigation activity, is useful in the management of the Columbia River System and provides data for administration of the Canadian Entitlement Allocation Agreement. Under the auspices of the Pacific Northwest River Basins Commission, a detailed tabulation of irrigated acreage within the Pacific Northwest was completed for 1980.

Table 2–3. Irrigation Diversions and Net Depletions by Basin [1]

Hydrologic Basin	Irrigation Diversion Acre–Feet	Net Irrigation Depletion Acre–Feet
Upper Columbia & Kootenai	179,260	113,580
Clark Fork–Pend Oreille & Spokane	1,287,000	768,600
Columbia Plateau, East Cascade, & Yakima	5,632,370	3,425,050
Upper Snake River	14,365,500	4,661,060
Central Snake River	7,545,580	2,623,520
Lower Snake River	849,010	533,490
Mid Columbia	2,352,610	1,334,920
Lower Columbia	59,020	22,300
Willamette	290,670	231,870
Total	**32,561,060**	**13,734,400**

1/Source: "Draft USBR/BPA, Columbia River Basin, System Operation Review, Irrigation Depletion Estimate, September 10, 1993, prepared for Bonneville Power Administration by A.G. Crook Company.

An update of the irrigated acreage and irrigation diversions and depletions for the Columbia River Basin was prepared for BPA. The report entitled "Modified Streamflows – 1990 Level of Development, Columbia River and Coastal Basins, 1929–1989" identifies irrigated acreage, and irrigation diversions and net depletions by hydrologic basin. The I/M&IWG assisted in identifying data sources and collecting and verifying data used to update the irrigated acreage base. Table 2–4 shows irrigated acreages in the Columbia River Basin by state and province for the 1989–1990 period. A more detailed discussion of irrigated acreages, application methods is maintained by the Bureau of Reclamation as a supporting volume to this appendix.

2.3.2 Irrigated Acreage by River Section of Columbia River

The county data for each of the four states were combined into subregions and subareas, each containing one or more tributary basins to the Columbia River. The areas are defined by logical drainage basin areas. Where a county is located in two or more subareas the division of acreage between subareas is based on the proportionate relationship identified in the 1980 Pacific Northwest River Basins Commission report or current information, if more appropriate. Portions of Wyoming, Utah, Nevada, and British Columbia that are also in the Columbia River Basin were included in the tabulation.

There is an estimated 7.3 million irrigated acres (3 million hectares) in the Columbia River Basin. Of this, 46 percent is in Idaho, 18 percent in Oregon, 26 percent in Washington, 6 percent in Montana, and the remaining 4 percent in Nevada, Utah, Wyoming, and British Columbia. The following table shows the irrigated acreage by state and for British Columbia for major segments of the river reaches within the Basin.

Table 2–4. Irrigated Acreage in Columbia River Basin By State – 1989–90

State or Province	Above Grand Coulee	Grand Coulee to Mouth of the Snake	Above Ice Harbor Dam	Ice Harbor Dam to Bonneville Dam	Below Bonneville Dam	Total Irrigated Acres
Idaho	25,800	0	3,306,400	0	0	3,332,200
Montana	433,700	0	0	0	0	433,700
Washington	60,600	1,509,800	77,300	207,900	23,300	1,878,900
Oregon	0	0	502,000	531,500	283,100	1,316,600
British Columbia	89,700	103,100	0	0	0	192,800
Wyoming	0	0	94,100	0	0	94,100
Utah	0	0	5,600	0	0	5,600
Nevada	0	0	70,400	0	0	70,400
Total Acres	**609,800**	**1,612,900**	**4,055,900**	**739,400**	**306,400**	**7,324,300**

2.3.3 Water Rights – Irrigated Agriculture

This section is a summary of state water rights pertaining to irrigated agriculture in the Pacific Northwest. This discussion responds to issues raised during the public scoping process and to increased interest in the possible transfers of water from irrigated agriculture to alternative uses such as instream flows. As pointed out previously, it is beyond the scope and authority of SOR to propose to limit or diminish existing irrigation water rights held by irrigation districts, individuals, and other entities.

The summary discussion follows. A more detailed discussion of water rights, which is the basis for the summary is maintained by the Bureau of Reclamation as a supporting volume to this appendix.

a. The water codes and water laws in each of the Pacific Northwest states are very similar. Each of the states has adopted the appropriation doctrine as the basis for its water right law. This doctrine is well suited for conditions in these states. Water rights vested under the riparian doctrine are recognized in Oregon and Washington, but it is assumed that these, or other claims to vested water rights are not significant for purposes of this study.

b. The administration of water law is centralized in an agency or entity of state government (e.g., department of water resources or state engineer). Montana was the last of the Pacific Northwest states to adopt the centralized system in 1973. Administrative procedures of each state are similar. Increasingly, alternative uses such as instream flows are being recognized under the water right codes of each of the Pacific Northwest states.

c. Most streams in the Pacific Northwest are fully or over appropriated. The water code of each state allows for court adjudications. These adjudications settle disputes among users, provide a means of legally terminating unused water rights and provide a means of accommodating and settling claims to vested rights or Federal reserved water rights. A number of major adjudications are under way, including: the entire state of Montana, the upper Snake River in Idaho, and the Yakima River in Washington.

d. All of the Pacific Northwest states allow water transfers. A cornerstone of the water codes in this regard is that third party water right holders are protected from injury due to water right transfers. As a result, the transferable quantity is almost always limited to the historic consumptive use (evaporation and transpiration). Generally, in the Pacific Northwest, indirect or third party impacts are not recognized. An exception to this is that the State of Idaho requires that any water transfer be evaluated against its impact on the agricultural economy of the area, specifically the farm sector. Also, Washington State Department of Ecology may deny or condition transfers to protect the public interest or to assure maximum net benefits. The transfer process generally includes public notice and otherwise meets established legal and administrative requirements. The determination of the historical consumptive use can often be complicated and expensive. In contrast, temporary water transfers, usually in time of drought, offer considerable flexibility toward solving water supply problems and are considerably easier to effect.

e. A newly evolving area of water right law involves water conservation. The courts have consistently found that water users do not have a right to waste or use water in unreasonable ways. On the other hand, nonuse leads to the loss of the water right. As it is often put: "Eternal vigilance is the price of a good water right!" Consequently water is often diverted when it is not absolutely needed. Oregon has a water law that provides a significant incentive to encourage water salvage through conservation. The water banking allowed in Idaho offers some promise as well, although presently the process is restrictive. Washington's trust water rights program allows for salvaged water to be acquired by the state without loss of priority date and reallocated for public benefit. Incentives to participate are provided by state and federal cost sharing programs.

f. Federal reserved water rights must be integrated into the various states' water appropriation system. Until this is accomplished there will remain considerable uncertainty about the worth of the previously established state water rights. Many Federal water rights, unused and undefined, have been dormant and will be superimposed on the states' priority system. A Federal right that was never used could very well have the highest priority in a river basin and depending on its quantity, could render many established water rights relatively worthless.

In conclusion, it is apparent that legal constraints exist to obtaining and transferring water from agriculture to other alternative uses. Considerable progress has been made along this line; alternative uses such as instream flows for fish are now officially recognized as a beneficial use. Oregon's recent legislation covering water salvaged from water conservation, Idaho's water banking and Washington's trust water rights program are other examples. However, without further changes in the water codes of the Pacific Northwest states it will remain difficult to transfer substantial amounts of water from irrigated agriculture to alternative uses.

2.4 IRRIGATION AND M&I ISSUES – BASIN–WIDE AND AT SPECIFIC LOCATIONS

2.4.1 Introduction

Analysis of SOR operational options indicates that six reservoirs would experience lowered reservoir pools under at least one of the options. The reservoirs by name of dam are: (1) Grand Coulee, (2) Lower Granite, (3) Little Goose, (4) Lower Monumental, (5) Ice Harbor, and (6) John Day. Although irrigation and M&I water use occurs at many locations and reservoirs in the Columbia River Basin, only the six FCRPS reservoirs affected by SOR alternative strategies are included in the impact analysis.

Irrigation water is pumped from reservoirs behind Grand Coulee, Ice Harbor, and John Day dams. M&I water, and related ancillary water, is utilized from all six reservoirs.

2.4.2 Grand Coulee (Lake Roosevelt) – Irrigation

Grand Coulee Dam located in north central Washington on the Columbia River (river mile 596.6) impounds Lake Roosevelt (FDR), which has an active capacity of 5,185,000 acre–feet (6.4 billion cubic meters). The powerplant has a total nameplate capacity of 6,494 MW making it one of the largest in the world. Power generation in excess of that needed to pump water for irrigation, is delivered to BPA for sale to wholesale customers. The dam is part of the Federally authorized Columbia Basin Project, a multipurpose project constructed by the Bureau of Reclamation with the authorized purposes of power, flood control, irrigation, and navigation. An extensive system of irrigation pumping plants, canals and laterals, storage reservoirs, and a drainage system has been constructed to serve the authorized irrigation acreage. The project supplies water to approximately 557,500 acres (225,600 hectares) in Grant, Adams, and Franklin counties, Washington. In addition, approximately 97,000 acres (39,300 hectares) are served by interim water service contracts, ground water licenses, or other arrangements.

Water is delivered to project lands via a pumping plant located on the south side and immediately upstream of the dam. The pumping plant lifts water approximately 300 feet (91 meters) from FDR to Banks Lake, an offstream equalizing reservoir with an active storage capacity of 715,000 acre–feet (882 million cubic meters). The pumping plant consists of 12 units, units 1–6 (P1–6) are pumping units only, while units 7–12 (P/G7–12) are pump–generating units. As such, the P/G units can pump water as well as generate electricity, in which case water is returned from Banks Lake to FDR.

From Banks Lake water is supplied to irrigation water users, represented by three irrigation districts, which have contracted with the United States for a water supply. The Columbia Basin Project is authorized to irrigate approximately 1,095,000 acres (443,100 hectares). With 557,500 acres (225,600 hectares) currently irrigated, irrigation of the remaining authorized acreage has been the subject of numerous investigations and feasibility studies. In the late 1970's a second conveyance facility called the Bacon Siphon and Tunnel No. 2 was constructed in anticipation of irrigation of the remaining acreage and to alleviate peak delivery shortages of the Bacon Siphon and Tunnel No. 1. The expansion or development of the second half of the project was evaluated in a draft EIS published in September, 1989 and a supplement to the draft published in September, 1993. Work on the final EIS was discontinued in 1994.

The Columbia Basin Project being endowed with favorable soils, climate, and water supply produces a wide variety of crops, and generated approximately $550 million in crop sales (farmgate value) in 1992. The production of these crops generates additional income and employment in Washington that are induced and/or stemming from processing, shipping, and the provision of inputs utilized by farmers in production. In addition to irrigation and power benefits, recreation and fish and wildlife opportunities are significant in the area, the result of numerous water bodies created by the project, slack water on FDR, and habitat development from irrigation, and return flows. Figure 2–1 is a picture showing Grand Coulee Dam, Lake Roosevelt in the foreground, pump–generating plant and feeder canal to Banks Lake, and Banks Lake in the background. Figure 2–2 is a map showing the location of Grand Coulee Dam and the irrigated lands of the Columbia Basin Project.

SOR alternative operating strategies that lower the level of FDR during the irrigation (pumping) season increase the pumping cost because of the increased pumping head to Banks Lake, i.e., additional electrical energy is needed to run the pumps. Individual irrigators pay pumping cost including additional pumping through their representative irrigation district.

2.4.3 Grand Coulee – M&I

Minor amounts of water are pumped from FDR Lake and from nearby bank storage, at several locations on the lake and reservoir. The water is used for M&I and small tract irrigation. Due to the minor amount of water involved and the potential impacts, these installations were not included in the impact analysis.

2.4.4 Lower Granite, Little Goose, and Lower Monumental

Lower Granite, Little Goose, and Lower Monumental dams are located on the Snake River at river mile 107.5, 70.3, and 41.6 respectively. The three are run–of–river projects constructed by the Corps of Engineers. The authorized purposes for all three projects are power, navigation, recreation, fish and wildlife, and irrigation. As run–of–river projects, the reservoir level fluctuations are kept to a narrow range, although in recent years have been operated at or near minimum operating pool (MOP) during parts of the spring and summer to minimize salmonid smolt travel time through the reservoir.

M&I Water Use

M&I pumping installations at these reservoirs include Corps of Engineers wildlife pumps, a sand and gravel operation, Whitman county Parks, Clarkston golf course, Washington State Parks, and Idaho State Parks. A total of nine installations are located on Lower Granite pool, two on Lower Monumental, and two on Little Goose.

2.4.5 Ice Harbor — Irrigation

Ice Harbor Dam is located on the Snake River at river mile 9.7 and the reservoir (Lake Sacajawea) extends upstream approximately 32 miles (51.5 kilometers). Ice Harbor was constructed by the Corps of Engineers with the authorized purposes being power, navigation, recreation, fish and wildlife, and irrigation. Ice Harbor is a run–of–river project like Lower Granite, Little Goose, and Lower Monumental. Reservoir level fluctuations at Ice Harbor are kept to a narrow range, although in recent years the reservoir has been operated at or near MOP during parts of the spring and summer.

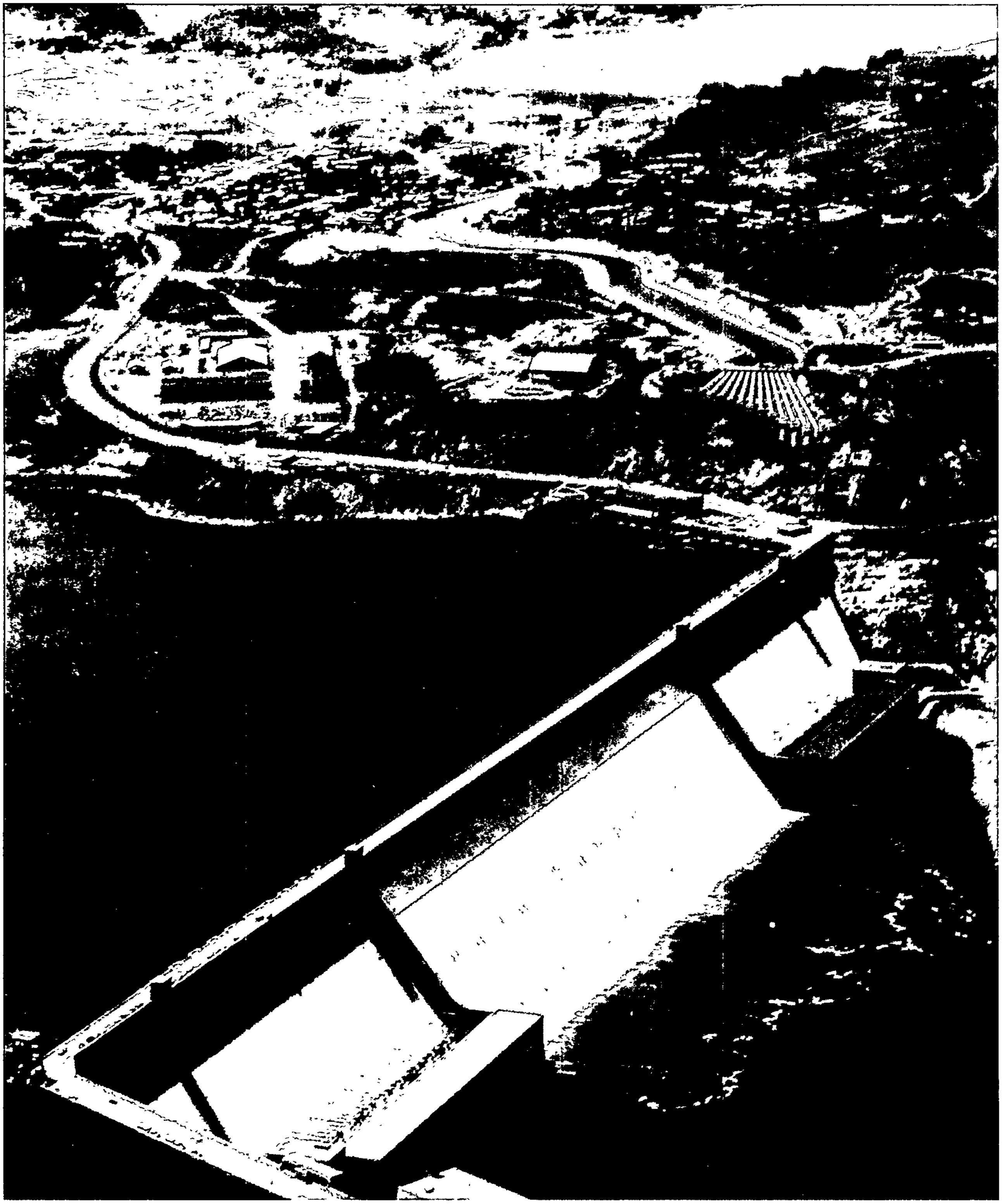


Figure 2–1. Grand Coulee Dam

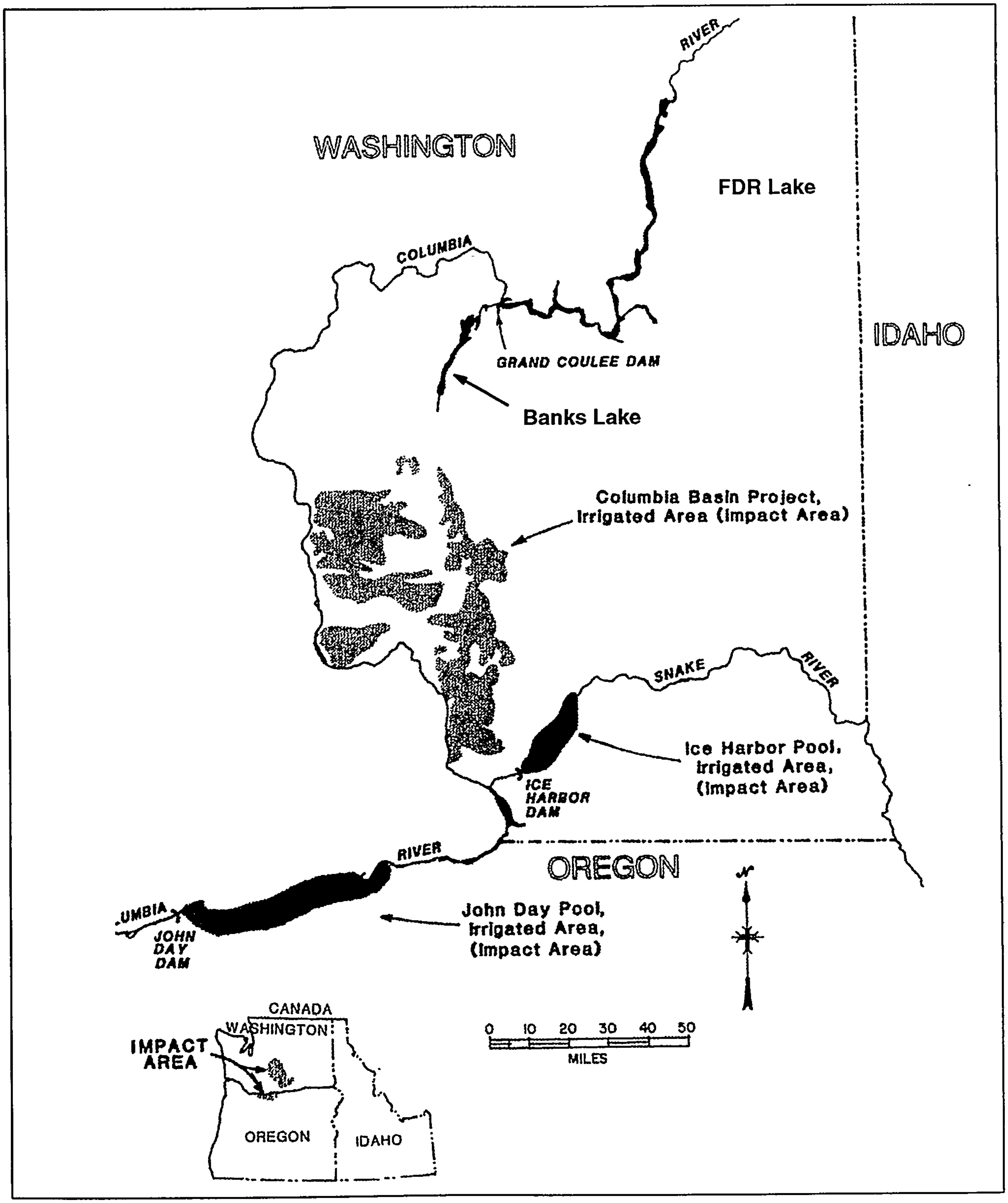


Figure 2–2. Irrigated Impact Areas

Since the construction of Ice Harbor Dam in the early 1960's, private entities have funded the irrigation of lands adjacent to the reservoir in Franklin County (north side) and Walla Walla County (south side). Figure 2–3 shows a typical irrigation pumping plant located on the Ice Harbor or John Day pool.

Figure 2–2 shows the general location of the lands irrigated from the Ice Harbor pool. A tabulation by consultants to the Corps of Engineers identified 13 irrigation pumpers irrigating 36,389 acres (14,700 hectares) from the reservoir pool. Many of these entities are large corporate operations. Irrigation pumpers utilize pumping plants or collection systems located on the reservoir bank to pump water to lands lying essentially adjacent to the reservoir. Irrigation entities pumping from reservoir pools utilize natural flow water rights permitted or granted by the Washington Department of Ecology as well as easements and permits issued by the Corps of Engineers.

Five of the 13 SOR operating options contain proposals to lower the Ice Harbor reservoir pool which would affect irrigation pumping by increasing the pumping lift (head) and necessitating the modification of pumping plants.

2.4.6 Ice Harbor — Municipal and Industrial Water Supply

In addition, to commercial irrigation pumping from the Ice Harbor pool, a total of three pumps used by the Corps of Engineers to irrigate wildlife habitat would be affected by SOR alternatives that lower the reservoir pool.

Figure 2–3. Typical Irrigation Pumping Plant

2.4.7 John Day — Commercial Irrigation

John Day Dam is located on the Columbia River at river mile 347 and the reservoir extends upstream to McNary Dam. The dam was constructed by the Corps of Engineers for the authorized purposes of power, recreation, navigation, flood control, irrigation, fish and wildlife, and water quality. The normal operating pool normally fluctuates between 265 feet (80.8 m) and 268 feet (81.7 m) during the irrigation season and between 260 and 265 feet at other times of the year. The reservoir has some flood control capacity although it is usually operated as a run–of–river project.

A significant amount of private irrigation has developed on the Oregon side (Sherman and Gilliam counties) and on the Washington side (Klickitat and Benton counties) of the reservoir. Figure 2–2 shows the general location of the lands irrigated from the John Day pool. A tabulation by consultants to the Corps of Engineers identified 25 irrigation pumpers irrigating 139,500 acres (56,455 hectares) from the reservoir pool. Many of these entities are large corporate operations. Irrigation pumpers utilize pumping plants or collection systems located on the reservoir bank to pump water to lands lying essentially adjacent to the reservoir.

Irrigation entities pumping from reservoir pools utilize water rights permitted or granted by Oregon Water Resources Department on the Oregon side and by the Washington Department of Ecology on the Washington side as well as easements and permits issued by the Corps of Engineers.

Seven of the 13 SOR operating options contain proposals to lower the John Day reservoir pool, including the Preferred Alterative, which would affect irrigation pumping by increasing the pumping lift (head) and necessitating the modification of pumping plants.

2.4.8 John Day — Municipal and Industrial Water Supply

In addition, to commercial irrigation from the John Day pool, non–commercial irrigation users, termed M&I users were identified that would be affected by alternative operating strategies. These M&I type uses include two fish hatcheries, city of Boardman water supply, city of Umatilla sewage treatment outlet, individual ground water wells located on the river bank, an aluminum plant, a school and dredging required at the mouth of the Umatilla River at the confluence with the Columbia River.

CHAPTER 3

STUDY METHODS AND PROCEDURE

3.1 OVERVIEW

This chapter identifies the study methods and procedures used to measure the monetary impacts of SOR alternative operating strategies on entities who pump from, or are otherwise affected by the operation of, reservoir pools on the Columbia and Lower Snake rivers. The analysis is called the "**full–scale analysis**." This chapter also references the results of the screening analysis as the product of formulated operating strategies identified earlier in the SOR screening process.

Along with a discussion of study methods and procedures, the germane assumptions and the parameters or constraints of study procedures are identified and addressed in this chapter.

3.2 SCREENING RESULTS AND SUMMARY

The results of the screening analysis, which was prior to the full–scale analysis are contained in "Screening Analysis: A Summary" and "Screening Analysis", Volume 1, Description and Conclusions, August 1992.

3.3 FULL SCALE ANALYSIS

The full scale analysis was made for each of the 13 SOR operating options, including the Prefered Alternative.

The full scale analysis of impacts on reservoir pumpers affected by alternative operating strategies is divided into two components: (1) The first is for irrigation pumping associated with commercial agriculture termed "commercial irrigation," and (2) The second component is for M&I users, which includes pumpers who utilize reservoir water for municipal and industrial purposes (M&I), water for fish hatcheries, Corps of Engineers pumping for recreation areas and wildlife habitat, irrigation of state parks, and other entites that would be directly affected by lowered reservoir pools.

Analysis of alternative operating strategies reveals that of the 14 reservoirs in the FCRPS six reservoirs would experience lowered pool levels impacting irrigation and M&I users. Those reservoirs are (by dam) Lower Granite, Little Goose, Lower Monumental, Ice Harbor, John Day, and Grand Coulee. Exhibit A contains a summary of the simulated hydrology studies, called hydroregs showing end of month elevations for the period of record for the six reservoir pools.

Pumping from reservoir pools for commercial irrigation was identified for three reservoirs – those behind Grand Coulee, John Day, and Ice Harbor dams. Pumping from Grand Coulee is almost exclusively by the Bureau of Reclamation which delivers water to irrigation districts of the Federally constructed Columbia Basin Project. There is some minor irrigation and M&I pumping from Grand Coulee (Lake Roosevelt or FDR) by individuals.

Irrigation water is pumped from John Day and Ice Harbor pools by private individuals or corporations. These entities utilize appropriative state water rights, and permits issued by the Corps of Engineers to irrigate lands adjacent to the two reservoir pools.

The full scale analysis utilized the increased pumping cost to measure impacts on irrigation resulting from reservoir drawdown for John Day, Ice Harbor pools, and Grand Coulee.

Impacts on M&I pumpers were also measured by determining the pumping plant modification cost, and the increased operation, maintenance, and pumping cost for those installations to obtain a total annual cost.

Power Rate Impacts on Pumping

Theoretically, reservoir drawdowns could adversely affect FCRPS power production causing power rate increases.

Increased pumping requirements associated with reservoir drawdown (increased lift) were evaluated at the existing power rates charged by the local utilities, and not at the induced power rate. The Power Appendix discusses potential power rate impacts on classes of power customers.

Discounting For Occurrence of Value

Because the SOR operating options have different implementation dates it was necessary to discount the annual occurrence of monetary measures for each alternative (pumping cost) to year 1 of the analysis, or 1995. This procedure, consistent with standard time value of money evaluation concepts, is necessary to insure that the comparison among SOR alternatives is on an equal basis. The Federal discount rate for fiscal year 1995 of 7.75 percent and a 3.0 percent "real" interest rate with a 100 year period of analysis was used to discount and amortize values to obtain an annual equivalent value.

The implementation, or on–line, dates for alternatives is listed below.

Alternative Strategy	Implementation Date
SOS1 & SOS2	1995
SOS4c	1995
SOS5b	2010
SOS5c	2000
SOS6b	2005
SOS6d	2000
SOS9a and c	2005
SOS9b	1995
Preferred Alternative	1998

3.3.1 Impact of Reservoir Drawdowns on Commercial Irrigation

3.3.1.1 Grand Coulee

The Bureau of Reclamation pumps water from Lake Roosevelt to Banks Lake an offstream reservoir, for use by irrigators who belong to irrigation districts served by the Columbia Basin Project in central Washington. In accordance with the project Congressional authorization, the electrical energy necessary to run the pumps (called project pumping) is furnished by project generation. On farm (or non-project) pumping requirements are obtained from local utilities. Electrical power to run the 12 pumps comes directly from the hydroelectrical power units at Grand Coulee. Project pumping is approximately 960 million kwhrs annually which is approximately 4.7 percent of the total generation at Grand Coulee (Coulee). Generation in excess of project needs is delivered and available for use by the Federal Columbia River Power System as operated by BPA. [5/6]

Currently, the Columbia Basin Project provides water to approximately 557,500 acres (225,600 hectares), which includes a small amount of lands served by pumping from the McNary pool. In addition, approximately 97,000 acres (39,250 hectares) are served by interim water service contracts, ground water licenses, or other arrangements.

The irrigation pumping requirement at Coulee for each of the 13 operational options was determined in mwhrs and monetized at the current repayment rate of .95 mills per kwh, which is based on the cost of operation and maintenance of power units 1–18 at Coulee.

The pumping requirement at Grand Coulee was modeled as a function of: (1) The amount of water pumped annually; (2) The head differential between Banks Lake and Grand Coulee, (3) The operating characteristics, including pump efficiency, for each of the 12 pumps available for pumping use, and (4) monthly (14 periods) pumping requirement (in mwhrs) for each year in the period of analysis, and (5) Variable power operations at Coulee in effect to optimize power generation. The model yields the monthly pumping requirement (in mwhrs) for each year in the period of analysis, 1929 through 1978. The 14 periods per year are consistent with the SOR hydroregs which splits April and August into 15 day periods – hence a total of 14 periods per year.

The major variable affecting the amount of water pumped is the irrigated acreage. The average historical monthly pumping requirement for the period 1988 through 1992 was utilized to reflect the current level of irrigation development and water use efficiencies. Because the elevation at Banks Lake varies only slightly during the pumping season and is not impacted directly by the SOR alternatives, the average monthly (14 periods) elevations for the 1988 through 1992 period were used to calculate head differentials between Banks Lank and FDR Lake. The hydroregs identified end of month elevations at FDR Lake for each SOR alternative. The pumping model utilized end of month elevations for each month of the 50 year period of record (1929 through 1978) in the determination of head differentials. Computations of pumping head reflect beginning–of–month to end–of–month data to derive the average for the month.

The first six pumping units at Coulee (P1–P6) are pumping units only, while the second six units (PG 7–12) are pump/generating units. The model reflects the difference in pumping efficiency over the differential head range between the pumping units and the pump/generating units, as well as the constraint, that the pump/generating units are not operated when the elevation at Coulee (FDR) is lower than certain prescribed seasonal elevations.

The summary of the pumping requirements and the monetization of that pumping at a rate of .95 mills per kwh ($.00095 per kwh) is shown in Chapter 4. Additional information is included in Exhibit A.

3.3.1.2 Ice Harbor and John Day Reservoirs

The impact on commercial irrigation pumpers affected by possible drawdowns of the Ice Harbor (Lake Sacajawea) and John Day (Lake Umatilla) pools was measured by estimating the increased pumping cost for each pump station.

Utilizing the estimated increased pumping cost as the measure of the impact was a change from the farm income methodology utilized in the Draft EIS analysis.

Other than Grand Coulee, John Day and Ice Harbor are the only reservoirs with irrigation pumpers affected by alternative strategies. Impacts on M&I users is described in section 3.3.2. Many of the SOR options have no effect on reservoir pool levels and thus there is no direct impact on pumpers.

The effect of lowered pool levels on reservoir irrigation pumpers is manifested by the increased cost to maintain the existing level of delivery. Pumping plants are operated and maintained by individual owners, and under reservoir drawdowns pumping plants would require modification in order to continue operation. In addition to pump modification, additional operation, maintenance, and power costs would be incurred. Pump modification cost estimates were prepared by the Corps of Engineers and private engineering consultants. Modification costs are necessary, in general, to lower the intake structure, extend the intake lines further into the reservoir pool, to dredge a channel to the intake line, or some combination of these.

Sources and Price Indexing

Modification costs were prepared to reconnaissance level of detail for all types of pump stations to the spillway and run–of–river elevation. Costs were price indexed to 1992 using the ENR Index.

Adjusting to Average Elevations

The hydroregs specify end of month elevations for the period of record. Average elevations for the month were calculated by using data for the beginning and end of month values. The resulting average elevation was used to calculate increased costs. It was not necessary to prepare a critical period analysis because the hydroregs show the reservoirs involved are drawn down to the same elevation for every month of the period of record.

Modification costs are assumed necessary when the water surface is lower than the present capability of the pumping station. Pump modification costs reflect the lowest drawdown month for the particular alternative based on the hydroregs. Interviews conducted by consultants with pump station owners identified the water surface level where each pump was affected. Estimates of pumping plant data were used where information was not available. Pump modification cost estimates for elevations between where the pump was affected and spillway height were interpolated, as well as for points between spillway and run of river elevations.

Increased Operation and Maintenance Cost

Operation and maintenance cost associated with the pump modification cost were estimated at 3 percent of the modification cost for John Day, and at 5 percent for the 4 lower Snake reservoirs.

Based on input received from pumpers and engineering consultants in the area, the O&M was increased from 3 percent in the Draft EIS to 5 percent for this analysis for the 4 lower Snake reservoirs. There is a lack of actual performance data for the operation of these pumping stations at lower pool elevations.

Increased Power Cost

Increased power costs were estimated using monthly water pumping requirements, local utility power rates, and estimates of the increased energy needed to pump from the lower water surface based on information developed by consultants.

Exhibit A contains supporting information developed by the Corps of Engineers regarding pump station information, including the development of cost data.

As a general rule, the agricultural operations of the Ice Harbor and John Day reservoir pumpers are characterized by very large farms, some of which are greater than 20,000 acres (8,000 hectares), high yields, a high level of irrigation management practices including center pivot irrigation systems, and large amounts of hired labor. Cropping on these lands is influenced by the high capital investment costs for pumping plants, plus above average pumping costs, and by soil texture. Subsequently, these operations depend on income from high value crops like potatoes, vegetables, and fruit, while accepting marginal returns (but enough to cover variable cost) from other rotational crops like wheat and corn.

Electrical power rates for irrigation pumping were the current rates for the areas in question. A rate of 29 mill per kwh was used for pumping from the Ice Harbor Pool which is based on the average irrigation rate charged by local utilities. For the John Day pool a rate of 25 and 33.5 mills per kwh was used for pumpers on the Washington and Oregon side respectively which are the current representative irrigation rates charged by local utilities.

Pump Modification Cost and Operating and Power Cost

Pumping plant modification cost, including the increased operating and power cost, was developed by the Corps of Engineers for the appropriate level of reservoir drawdown utilizing modification cost provided by consultants. The modification cost is only applied to those SOR alternatives with a proposed drawdown. Hydroreg studies indicate end of month elevations during the pumping season which is the essential variable on which modification and increased operating costs are based.

Modification cost to irrigation pumps were identified with Ice Harbor for SOR alternatives SOS5b, SOS5c, SOS6b, SOS9a, and SOS 9c and those plans plus SOS6d and the Preferred Alternative for John Day. Modification cost and the increased operating and power costs are shown in Table 3–1 for the applicable SOR alternative operating strategies.

3.3.2 Impact on M&I Users (Nonagricultural Irrigation and Other Uses)

In addition to commercial irrigation, other reservoir water users have been identified who would be impacted by proposed drawdowns of the six reservoir pools. These uses include conventional M&I water uses, plus fish hatcheries, parks, irrigation of wildlife habitat and several other entities who have operations on the reservoirs. As a group they are called M&I users for this analysis.

The impact of alternative operating strategies on nonagricultural and other entities pumping from reservoir pools was identified by estimating the pump modification cost and the increased operation and maintenance cost, including power. The number of users by reservoir pool who will be impacted by drawdown are identified as follows:

Reservoir Pool	Number of Pumpers Affected	
Lower Granite	9	• Sand and gravel company • Whitman County Parks – pumps • Clarkston golf course • Corps of Engineers pumps (3) • Washington State Parks – pumps • Idaho State Parks – pumps
Lower Manumental	2	• Corps of Engineers wildlife pumps
Little Goose	2	• Corps of Engineers wildlife pumps
Ice Harbor	3	• Corps of Engineers wildlife pumps
John Day	7	• (Fish hatcheries at Umatilla and Irrigon • City of Boardman water supply • City of Umatilla sewage treatment outlet • Individual ground–water wells • Dredging Umatilla River mouth • Aluminum company
Grand Coulee	0 [1]	

1/ Minor amounts of water are pumped from Coulee (Lake Roosevelt) bank storage and directly from the reservoir at several locations. The water is used for M&I and small tract irrigation. A review of reservoir elevation changes indicates that pump modification cost would be very minor, if required at all, and with only minor increases in operating costs. The impacts were considered insignificant for this analysis.

The modification cost and the increased operation and maintenance and power cost for M&I users (nonagricultural irrigation and other reservoir pool water pumpers) are shown in Tables 3–2 and 3–3 respectively.

Table 3–1. SOR Alternatives – Modification Cost and Increased Operating Cost, Commercial Irrigation[1]

SOR Study No.	John Day Capital – $	John Day Annual OM&P	Ice Harbor Capital – $	Ice Harbor Annual OM&P
SOS1a	0	0	0	0
SOS1b	0	0	0	0
SOS2c	0	0	0	0
SOS2d	0	0	0	0
SOS4c	0	0	0	0
SOS5b	14,340,000	664,000	28,300,000	1,800,000
SOS5c	14,340,000	664,000	28,300,000	1,838,000
SOS6b	14,340,000	664,400	15,000,000	889,000
SOS6d	14,340,000	664,400	0	0
SOS9a	10,790,000	578,000	15,000,000	890,000
SOS9b	0	0	0	0
SOS9c	14,340,000	708,000	16,020,000	890,000
Pref. Alt.	14,340,000	751,000	0	0

1/ Values not discounted for plan implementation date.

Table 3–2. Modification Cost, M&I Pumpers[1]

SOR Alternatives	John Day $	Ice Harbor $	Lower Granite $	Little Goose $	Lower Monumental $
SOS1a	0	0	0	0	0
SOS1b	0	0	0	0	0
SOS2c	0	0	0	0	0
SOS2d	0	0	0	0	0
SOS4c	0	0	0	0	0
SOS5b	36,147,000	1,467,500	3,523,000	705,000	852,000
SOS5c	36,147,000	1,467,000	3,523,000	705,000	852,000
SOS6b	36,147,000	767,500	2,983,000	286,000	401,000
SOS6d	36,147,000	0	2,983,000	0	0
SOS9a	36,147,000	767,500	2,983,000	286,000	390,000
SOS9b	0	0	0	0	0
SOS9c	36,147,000	818,700	3,258,000	385,000	532,000
Pref. Alt.	39,524,000	0	0	0	0

1/Values not discounted for plan implementation date.

Table 3–3. Increased Annual Operation, Maintenance and Power Cost, M&I Pumpers[1]

SOR Alternatives	John Day $	Ice Harbor $	Lower Granite $	Little Goose $	Lower Monumental $
SOS1a	0	0	0	0	0
SOS1b	0	0	0	0	0
SOS2c	0	0	0	0	0
SOS2d	0	0	0	0	0
SOS4c	0	0	0	0	0
SOS5b	2,551,750	77,000	177,000	39,000	44,000
SOS5c	2,551,750	78,000	178,000	76,000	44,000
SOS6b	2,551,750	40,000	150,000	15,000	21,000
SOS6d	2,551,750	0	150,000	0	0
SOS9a	2,551,750	40,000	150,000	15,000	20,000
SOS9b	0	0	0	0	0
SOS9c	2,551,750	41,000	163,000	20,000	27,000
Prev. Alt.	2,551,750	0	0	0	0

1/Values not discounted for plan implementation date.

CHAPTER 4

ALTERNATIVES AND THEIR IMPACTS

4.1 GENERAL DESCRIPTION OF ALTERNATIVES

Seven alternative System Operating Strategies (SOS) were considered in the Draft EIS. Each of the 7 SOSs contained several options, bringing the total number of alternatives considered to 21. This Final EIS also evaluates 7 operating strategies, with a total of 13 alternatives now under consideration when accounting for options. Section 4.1 of this chapter describes the 13 alternatives and provides the rationale for including these alternatives in the Final EIS. Operating elements for each alternative are summarized in Table 4.1. Later sections of this chapter describe the effects of these alternatives on irrigation.

The 13 final alternatives represent the results of the third analysis and review phase completed since SOR began. In 1992, the agencies completed an initial effort, known as "Screening" which identified 90 possible alternatives. Simulated operation for each alternative was completed for five water year conditions ranging from dry to wet years, impacts to each river use area were estimated using simplified analysis techniques, and the results were compared to develop 10 "candidate SOSs." The candidate SOSs were the subject of a series of public meetings held throughout the Pacific Northwest in September 1992. After reviewing public comment on the candidate strategies, the SOR agencies further reduced the number of SOSs to seven. These seven SOSs were evaluated in more detail by performing 50–year hydroregulation model simulations and by determining river use impacts. The impact analysis was completed by the SOR workgroups. Each SOS had several options so, in total, 21 alternatives were evaluated and compared. The results were presented in the Draft EIS, published in July, 1994. As was done after Screening, broad public review and comment was sought on the Draft EIS. A series of nine public meetings was held in September and October 1994, and a formal comment period on the Draft EIS was held open for over 4 1/2 months. Following this last process, the SOR agencies have again reviewed the list of alternatives and have selected 13 alternatives for consideration and presentation in the Final EIS.

Six options for the alternatives remain unchanged from the specific options considered in the Draft EIS. One option (SOS 4c) is a revision to a previously considered alternative, and the rest represent replacement or new alternatives. The basic categories of SOSs and the numbering convention remains the same as was used in the Draft EIS. However, because some of the alternatives have been dropped, the final SOSs are not numbered consecutively. There is one new SOS category, Settlement Discussion Alternatives, which is labeled SOS 9 (see Section 4.1.6 for discussion).

The 13 alternatives have been evaluated through the use of a computerized model known as HYDROSIM. Developed by BPA, HYDROSIM is a hydroregulation model that simulates the coordinated operation of all projects in the Columbia River system. It is a monthly model with 14 total time periods. April and August are split into two periods each, because major changes can occur in streamflows in the first and second half of each of these months. The model is based on hydrologic data for a 50–year period of record from 1928 through 1978. For a given set of operating rule inputs and other project operating requirements, HYDROSIM will simulate elevations, flows, spill, storage content and power generation for each project or river control point for the 50–year period. For more detailed information, please refer to Appendix A, River Operation Simulation.

The following section describes the final alternatives and reviews the rationale for their inclusion in the Final EIS.

Table 4–1. SOS Alternative–1

Summary of SOS

SOS 1 Pre-ESA Operation	SOS 2 Current Operations	SOS 4 Stable Storage Project Operation
SOS 1 represents system operations before changes were made as a result of the ESA listing of three Snake River salmon stocks. SOS 1a represents operations from 1983 through the 1990–91 operating year, influenced by Northwest Power Act; SOS 1b represents how the system would operate without the Water Budget and related operations to benefit anadromous fish. Short-term operations would be conducted to meet power demands while satisfying nonpower requirements.	SOS 2 reflects operation of the system with interim flow improvement measures in response to the ESA salmon listings. It is consistent with the 1992–93 operations described in the Corps' 1993 Interim Columbia and Snake River Flow Improvement Measures Supplemental EIS. SOS 2c represents the operating decision made as a result of the 1993 Supplemental EIS and is the no action alternative for the SOS. Relative to SOS 1a, primary changes are additional flow augmentation in the Columbia and Snake Rivers and modified pool levels at lower Snake and John Day reservoirs during juvenile salmon migration. SOS 2d represents operations of the 1994-98 Biological Opinion issued by NMFS, with additional flow aumentation measures compared to SOS 2c.	SOS 4 would coordinate operation of storage reservoirs to benefit recreation, resident fish, wildlife, and anadromous fish, while minimizing impacts to power and flood control. Reservoirs would be managed to specific elevations on a monthly basis; they would be kept full longer, while still providing spring flows for fish and space for flood control. The goal is to minimize reservoir fluctuations while moving closer to natural flow conditions. SOS 4c attempts to accommodate anadromous fish needs by shaping mainstem flows to benefit migrations and would modify the flood control operations at Grand Coulee.

Actions by Project

	SOS 1	SOS 2	SOS 4
LIBBY	**SOS 1a** Normal 1983–1991 storage project operations **SOS 1b** • Minimum project flow 3 kcfs • No refill targets • Summer draft limit of 5–10 feet	**SOS 2c** Operate on system proportional draft as in SOS 1a **SOS 2d** • Provide flow augmentation for salmon and sturgeon when Jan. to July forecast is greater than 6.5 MAF • Meet sturgeon flows of 15, 20, and 12.5 kcfs in May, June, and July, respectively, in at least 3 out of 10 years	**SOS 4c** • Meet specific elevation targets as indicated by Integrated Rule Curves (IRCs); IRCs are based on storage content at the end of the previous year, determination of the appropriate year within the critical period, and runoff forecasts beginning in January • IRCs seek to keep reservoir full (2,459 feet) June-Sept; minimum annual elevation ranges from 2,399 to 2,327 feet, depending on critical year determination • Meet variable sturgeon flow targets at Bonners Ferry during May 25-August 16 period; flow targets peak as high as 35 kcfs in the wettest years

KAF = 1.234 million cubic meters   MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–1

SOS 5 Natural River Operation	SOS 6 Fixed Drawdown	SOS 9 Settlement Discussion Alternatives	SOS PA
SOS 5 would aid juvenile salmon by increasing river velocity. The four lower Snake River projects would have new outlets installed, allowing the reservoirs to be drawn down to near the original river elevation. The "natural river" operation would be done for 4 1/2 months in SOS 5b and year-round in SOS 5c. John Day would also be operated at MOP for 4 months, and flow augmentation measures on the Columbia River portion of the basin would continue as in SOS 2c.	SOS 6 involves drawing down lower Snake River projects to fixed elevations below MOP to aid anadromous fish. SOS 6b provides for fixed drawdowns for all four lower Snake projects for 4 1/2 months; SOS 6d draws down Lower Granite only for 4 1/2 months. John Day would also be operated at MOP for 4 months, and flow augmentation measures on the Columbia River portion of the basin would continue as in SOS 2c.	SOS 9 represents operations suggested by the USFWS, NMFS, the state fisheries agencies, Native American tribes, and the Federal operating agencies during the settlement discussions in response to the *IDFG v. NMFS* court proceedings. This alternative has three options, SOSs 9a, 9b, and 9c, that represent different scenarios to provide increased river velocities for anadromous fish by establishing flow targets during migration and to carry out other actions to benefit ESA-listed species. The three options are termed the Detailed Fishery Operating Plan (9a), Adoptive Management (9b), and the Balanced Impacts Operation (9c).	SOS PA represents the operation recommended by NMFS and the USFWS Biological Opinions issued March 1, 1995. This SOS supports recovery of ESA-listed species by storing water during the fall and winter to meet spring and summer flow targets, and protects other resources by setting summer draft limits to manage negative effects, by providing flood protection, and by providing for reasonable power generation.

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Operate on system proportional draft as in SOS 1a **SOS 5c** Operate on system proportional draft as in SOS 1a	**SOS 6b** Operate on system proportional draft as in SOS 1a **SOS 6d** Operate on system proportional draft as in SOS 1a	**SOS 9a** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period • Provide sturgeon flow releases April-Aug. to achieve up to 35 kcfs at Bonner's Ferry with appropriate ramp up and ramp down rates **SOS 9b** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation • Provide sturgeon flow releases similar to SOS 2d • Can draft to elevation 2,435 by end of July to meet flow targets **SOS 9c** • Operate to the Integrated Rule Curves and provide sturgeon flow releases as in SOS 4c	**SOS PA** • Operate on minimum flow up to flood control rule curves beginning in Jan., except during flow augmentation period • Strive to achieve flood control elevations in Dec. in all years and by April 15 in 75 percent of years • Provide sturgeon flows of 25 kcfs 42 days in June and July • Provide sufficient flows to achieve 11 kcfs flow at Bonner's Ferry for 21 days after maximum flow period • Draft to meet flow targets, to a minimum end of Aug. elevation of 2,439 feet, unless deeper drafts needed to meet sturgeon flows

1 kcfs = 28 cms 1 ft = 0.3048 meter

Table 4–1. SOS Alternative–2
Actions by Project

	SOS 1	SOS 2	SOS 4
HUNGRY HORSE	**SOS 1a**	**SOS 2c**	**SOS 4c**
	Normal 1983–1991 storage project operations	Operate on system proportional draft as in SOS 1a	• Meet specific elevation targets as indicated by Integrated Rule Curves (IRCs), similar to operation for Libby • IRCs seek to keep reservoir full (3,560 feet) June-Sept.; minimum annual elevation ranges from 3,520 to 3,450 feet, depending on critical year
	SOS 1b	**SOS 2d**	
	• No maximum flow restriction from mid-Oct. to mid-Nov. • No draft limit; no refill target	Operate on system proportional draft as in SOS 1a	

	SOS 1	SOS 2	SOS 4
ALBENI FALLS	**SOS 1a**	**SOS 2c**	**SOS 4c**
	Normal 1983–1991 storage project operations	Operate on system proportional draft as in SOS 1a	Elevation targets established for each month, generally 2,056 feet Oct.–March, 2,058 to 2,062.5 feet April–May, 2,062.5 feet (full) June, 2,060 feet July–Sept. (but higher if runoff high); Oct.–March drawdown to 2,051 feet every 6th year
	SOS 1b	**SOS 2d**	
	No refill target	Operate on system proportional draft as in SOS 1a	

KAF = 1.234 million cubic meters   MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–2

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Operate on system proportional draft as in SOS 1a **SOS 5c** Operate on system proportional draft as in SOS 1a	**SOS 6b** Operate on system proportional draft as in SOS 1a **SOS 6d** Operate on system proportional draft as in SOS 1a	**SOS 9a** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period **SOS 9b** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation • Can draft to meet flow targets, to a minimum end-of-July elevation of 3,535 feet **SOS 9c** • Operate to the Integrated Rule Curves as in SOS 4c	**SOS PA** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period • Strive to achieve flood control elevations by April 15 in 75 percent of the years • Draft to meet flow targets, to a minimum end-of-August elevation of 3,540 feet

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Operate on system proportional draft as in SOS 1a **SOS 5c** Operate on system proportional draft as in SOS 1a	**SOS 6b** Operate on system proportional draft as in SOS 1a **SOS 6d** Operate on system proportional draft as in SOS 1a	**SOS 9a** Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period **SOS 9b** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period • Can draft to meet target flows, to a minimum end-of-July elevation of 2,060 feet **SOS 9c** • Elevation targets established for each month, generally no lower than 2,056 feet Dec.—April, no lower than 2,057 feet end of May, full (2,062.5 feet) June—Aug., 2,056 feet Sept.—Nov.	**SOS PA** • Operate to flood control elevations by April 15 in 90 percent of the years • Operate to help meet flow targets, but do not draft below full pool through Aug.

1 kcfs = 28 cms

1 ft = 0.3048 meter

Table 4–1. SOS Alternative–3
Actions by Project

	SOS 1	SOS 2	SOS 4
GRAND COULEE	**SOS 1a** • Operate to meet Water Budget target flows of 134 kcfs at Priest Rapids in May [1/] • Meet minimum elevation of 1,240 feet in May **SOS 1b** • No refill target of 1,240 feet in May • Maintain 1,285 feet June–Sept.; minimum 1,220 feet rest of year • No May–June flow target	**SOS 2c** • Storage of water for flow augmentation from January through April • Supplemental releases (in conjunction with upstream projects) to provide up to 3 MAF additional (above Water Budget) flow augmentation in May and June, based on sliding scale for runoff forecasts • System flood control space shifted from Brownlee, Dworshak **SOS 2d** • Contribute, in conjunction with upstream storage projects, up to 4 MAF for additional flow augmentation • Operate in summer to provide flow augmentation water and meet downstream flow targets, but draft no lower than 1,280 feet	**SOS 4c** • Operate to end-of-month elevation targets, as follows: 1,288 Sept.-Nov 1,287 Dec. 1,270 Jan. 1,260 Feb. 1,270 Mar. 1,272 Apr. 15 1,275 Apr. 30 1,280 May 1,288 Jun.-Aug. • Meet flood control rule curves only when Jan.-June runoff forecast exceeds 68 MAF

	SOS 1	SOS 2	SOS 4
PRIEST RAPIDS	**SOS 1a** • Meet May-June flow targets [1/] • Maintain minimum flows to meet Vernita Bar Agreement [2/] **SOS 1b** • No May flow target • Meet Vernita Bar Agreement	**SOS 2c** Operate as in SOS 1a **SOS 2d** Operate as in SOS 1a	**SOS 4c** Operate as in SOS 1a

1/ Flow targets are weekly averages with weekend and holiday flows no less than 80 percent of flows over previous 5 days.
2/ 55 kcfs during heavy load hours October 15 to November 30; minimum instantaneous flow 70 kcfs December to April
KAF = 1.234 million cubic meters MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–3

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b	**SOS 6b**	**SOS 9a**	**SOS PA**
Operate on system proportional draft and provide flow augmentation as in SOS 2c	Operate on system proportional draft and provide flow augmentation as in SOS 2c	• Operate to meet flood control requirements and Vernita Bar agreement • Provide flow augmentation releases to help meet targets at The Dalles of 220-300 kcfs April 16-June 15, 200 kcfs June 16-July 31, and 160 kcfs Aug. 1-Aug.31, based on appropriate critical year determination • In above average runoff years, provide 40% of the additional runoff volume as flow augmentation	• Operate to achieve flood control elevations by April 15 in 85% of years • Draft to meet flow targets, down to minimum end-of-Aug. elevation of 1,280 feet • Provide flow augmentation releases to meet Columbia River flow targets at McNary of 220-260 kcfs April 20-June 30, based on runoff forecast, and 200 kcfs July-Aug.
SOS 5c	**SOS 6d**	**SOS 9b**	
Operate on system proportional draft and provide flow augmentation as in SOS 2c	Operate on system proportional draft and provide flow augmentation as in SOS 2c	• Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period • Can draft to meet flow targets, bounded by SOS 9a and 9c targets, to a minimum end-of-July elevation of 1,265 feet	
		SOS 9c	
		• Operate to meet McNary flow targets of 200 kcfs April 16-June 30 and 160 kcfs in July • Can draft to meet flow targets, to a minimum end-of-July elevation of 1,280 feet • Contribute up to 4 MAF for additional flow augmentation, based on sliding scale for runoff forecasts, in conjunction with other upstream projects • System flood control shifted to this project	

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b	**SOS 6b**	**SOS 9a**	**SOS PA**
Operate as in SOS 1a	Operate as in SOS 1a	Operate as in SOS 1a	Operate as in SOS 1a
SOS 5c	**SOS 6d**	**SOS 9b**	
Operate as in SOS 1a	Operate as in SOS 1a	Operate as in SOS 1a	
		SOS 9c	
		Operate as in SOS 1a	

1 kcfs = 28 cms

1 ft = 0.3048 meter

Table 4–1. SOS Alternative–4

Actions by Project

	SOS 1	SOS 2	SOS 4
SNAKE RIVER ABOVE BROWNLEE	**SOS 1a** Normal 1990—91 operations; no Water Budget flows	**SOS 2c** Release up to 427 KAF (190 KAF April 16—June 15; 137 KAF Aug.; 100 KAF Sept.) for flow augmentation	**SOS 4c** Same as SOS 1a
	SOS 1b Same as SOS 1a	**SOS 2d** • Release up to 427 KAF, as in SOS 2c • Release additional water obtained by purchase or other means and shaped per Reclamation releases and Brownlee draft requirements; simulation assumed 927 KAF available	

	SOS 1	SOS 2	SOS 4
BROWNLEE	**SOS 1a** • Draft as needed (up to 110 KAF in May) for Water Budget, based on target flows of 85 kcfs at Lower Granite • Operate per FERC license • Provide system flood control storage space	**SOS 2c** Same as SOS 1a except for additional flow augmentation as follows: • Draft up to 137 KAF in July, but not drafting below 2,067 feet; refill from the Snake River above Brownlee in August • Draft up to 100 KAF in Sept. • Shift system flood control to Grand Coulee • Provide 9 kcfs or less in November; fill project by end of month • Maintain November monthly average flow December through April	**SOS 4c** Same as SOS 1a except slightly different flood control rule curves
	SOS 1b • No maximum flow restriction from mid-Oct. to mid-Nov. • No draft limit; no refill target	**SOS 2d** Same as SOS 2c, plus pass additional flow augmentation releases from upstream projects	

KAF = 1.234 million cubic meters   MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–4

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Same as SOS 1a	**SOS 6b** Same as SOS 1a	**SOS 9a** Provide up to 1.927 MAF through Brownlee for flow augmentation, as determined by Reclamation	**SOS PA** Provide 427 KAF through Brownlee for flow augmentation, as determined by Reclamation
SOS 5c Same as SOS 1a	**SOS 6d** Same as SOS 1a	**SOS 9b** Provide up to 927 KAF through Brownlee as determined by Reclamation	
		SOS 9c Provide up to 927 KAF through Brownlee as determined by Reclamation	

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Same as SOS 4c	**SOS 6b** Same as SOS 4c	**SOS 9a** • Draft up to 110 KAF in May, 137 KAF in July, 140 KAF in Aug., 100 KAF in Sept. for flow augmentation • Shift system flood control to Grand Coulee	**SOS PA** Draft to elevation 2,069 feet in May, 2,067 feet in July, and 2,059 feet in Sept., passing inflow after May and July drafts
SOS 5c Same as SOS 4c	**SOS 6d** Same as SOS 4c	**SOS 9b** • Draft up to 190 KAF April-May, 137 KAF in July, 100 KAF in Sept. for flow augmentation • Shift system flood control to Grand Coulee • Provide an additional 110 KAF in May if elevation is above 2,068 feet and 110 KAF in Sept. if elevation is above 2,043.3 feet	
		SOS 9c Same as SOS 9b	

1 kcfs = 28 cms   1 ft = 0.3048 meter

Table 4–1. SOS Alternative–5

Actions by Project

	SOS 1	SOS 2	SOS 4
DWORSHAK	**SOS 1a** • Draft up to 600 KAF in May to meet Water Budget target flows of 85 kcfs at Lower Granite • Provide system flood control storage space **SOS 1b** • Meet minimum project flows (2 kcfs, except for 1 kcfs in August); summer draft limits; maximum discharge requirement Oct. to Nov. (1.3 kcfs plus inflow) • No Water Budget releases	**SOS 2c** Same as SOS 1a, plus the following supplemental releases: • 900 KAF or more from April 16 to June 15, depending on runoff forecast at Lower Granite • Up to 470 KAF above 1.2 kcfs minimum release from June 16 to Aug. 31 • Maintain 1.2 kcfs discharge from Oct. through April, unless higher required • Shift system flood control to Grand Coulee April–July if runoff forecasts at Dworshak are 3.0 MAF or less **SOS 2d** • Operate on 1.2 kcfs minimum discharge up to flood control rule curve, except when providing flow augmentation (April 10 to July 31) • Provide flow augmentation of 1.0 MAF plus 1.2 kcfs minimum discharge, or 927 KAF and 1.2 kcfs, from April 10–June 20, based on runoff forecasts, to meet Lower Granite flow target of 85 kcfs • Provide 470 KAF from June 21 to July 31 to meet Lower Granite flow target of 50 kcfs • Draft to 1,520 feet after volume is expended, if Lower Granite flow target is not met; if volume is not expended, draft below 1,520 feet until volume is expended	**SOS 4c** Elevation targets established for each month: 1,599 feet Sept.-Oct.; flood control rule curves Nov.-April; 1,595 feet May; 1,599 feet June-Aug.;

KAF = 1.234 million cubic meters MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–5

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b • Operate to local flood control rule curve • No proportional draft for power • Shift system flood control to lower Snake projects • Provide Water Budget flow augmentation as in SOS 1a • Draft to refill lower Snake projects if natural inflow is inadequate **SOS 5c** • Operate to flood control during spring • Refill in June or July and maintain through August • Draft for power production during fall	**SOS 6b** Same as SOS 5b **SOS 6d** Same as SOS 5b	**SOS 9a** • Remove from proportional draft for power • Operate to local flood control rule curves, with system flood control shifted to Grand Coulee • Maintain flow at 1.2 kcfs minimum discharge, except for flood control or flow augmentation discharges • Operate to meet Lower Granite flow targets (at spillway crest) of 74 kcfs April 16–June 30, 45 kcfs July, 32 kcfs August **SOS 9b** • Similar to SOS 9a, except operate to meet flow targets at Lower Granite ranging from 85 to 140 kcfs April 16–June 30 and 50-55 kcfs in July • Can draft to meet flow targets to a min. end-of-July elevation of 1,490 feet **SOS 9c** • Similar to SOS 9a, except operate to meet Lower Granite flow target (at spillway crest) of 63 kcfs April-June • Can draft to meet flow targets to a min. end-of-July elevation of 1,520 feet	**SOS PA** • Operate on minimum flow-up to flood control rule curve year-round, except during flow augmentation period • Draft to meet flow targets, down to min. end-of-Aug. elevation of 1,520 feet • Sliding-scale Snake River flow targets at Lower Granite of 85 to 100 kcfs April 10–June 20 and 50 to 55 kcfs June 21-Aug. 31, based on runoff forecasts

1 kcfs = 28 cms 1 ft = 0.3048 meter

Table 4–1. SOS Alternative–6
Actions by Project

	SOS 1	SOS 2	SOS 4
LOWER SNAKE	**SOS 1a** • Normal operations at 4 lower Snake River projects (within 3 to 5 feet of full pool, daily and weekly fluctuations) • Provide maximum peaking capacity of 20 kcfs over daily average flow in May **SOS 1b** Same as 1a, except: • No minimum flow limit (11,500 cfs) during fall and winter • No fish-related rate of change in flows in May	**SOS 2c** • Operate reservoirs within 1 foot above MOP from April 16 to July 31 • Same as SOS 1a for rest of year **SOS 2d** Same as SOS 2c	**SOS 4c** Same as SOS 2c

	SOS 1	SOS 2	SOS 4
LOWER COLUMBIA	**SOS 1a** • Normal operations at 4 lower Columbia projects (generally within 3 to 5 feet of full pool, daily and weekly fluctuations) • Restricted operation of Bonneville second powerhouse **SOS 1b** Same as 1a, except no restrictions on Bonneville second powerhouse	**SOS 2c** Same as SOS 1a except: lower John Day to minimum irrigation pool (approx. 262.5 feet) from April 15 to Aug. 31; operate within 1.5 feet of forebay range, unless need to raise to avoid irrigation impacts **SOS 2d** Same as SOS 2c	**SOS 4c** Same as SOS 2c, except operate John Day within 2 feet of elevation 263.5 feet Nov. 1 through June 30

KAF = 1.234 million cubic meters   MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–6

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b	**SOS 6b**	**SOS 9a**	**SOS PA**
• Draft 2 feet per day starting Feb. 18 • Operate at natural river level, approx. 95 to 115 ft below full pool, April 16-Aug. 31; drawdown levels by project as follows, in feet: Lower Granite 623 Little Goose 524 L. Monumental 432 Ice Harbor 343 • Operate within 3 to 5 ft of full pool rest of year • Refill from natural flows and storage releases	• Draft 2 feet per day starting April 1 • Operate 33 feet below full pool April 16-Aug. 31; drawdown levels by project as follows, in feet: Lower Granite 705 Little Goose 605 L. Monumental 507 Ice Harbor 407 • Operate over 5-foot forebay range once drawdown elevation reached • Refill from natural flows and storage releases • Same as SOS 1a rest of year	• Operate 33 feet below full pool (see SOS 6b) April 1-Aug. 31 to meet L. Granite flow targets (see Dworshak); same as SOS 1a rest of year • Spill to achieve 80/80 FPE up to total dissolved gas cap of 120% daily average; spill cap 60 kcfs at all projects	• Operate at MOP with 1 foot flexibility between April 10 - Aug. 31 • Refill three lower Snake River pools after Aug. 31, Lower Granite after Nov. 15 • Spill to achieve 80% FPE up to total dissolved gas cap of 115% 12-hour average; spill caps range from 7.5 kcfs at L. Monumental to 25 kcfs at Ice Harbor
SOS 5c	**SOS 6d**	**SOS 9b**	
Same as SOS 5b, except drawdowns are permanent once natural river levels reached; no refill	• Draft Lower Granite 2 feet per day starting April 1 • Operate Lower Granite near 705 ft for 4 1/2 months, April 16-Aug. 31	• Operate at MOP, with 1 foot flexibility April 1-Aug. 31; same as SOS 1a rest of year • Spill to achieve 80/80 FPE up to total dissolved gas cap of 120% daily average; spill caps range from 18 kcfs at L. Monumental to 30 kcfs at L. Granite	
		SOS 9c	
		• Operate 35 to 45 feet below full pool April 1-June 15 to meet L. Granite flow targets (see Dworshak), refill by June 30; same as SOS 1a rest of year • Spill to achieve 80/80 FPE, as in SOS 9b	

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b	**SOS 6b**	**SOS 9a**	**SOS PA**
Same as SOS 2, except operate John Day within 1.5 feet above elevation 257 feet (MOP) from May 1 through Aug. 31; same as SOS 2c rest of year	Same as SOS 5	• Same as SOS 5, except operate John Day within 1 foot above elevation 257 feet April 15-Aug. 31 • McNary flow targets as described for Grand Coulee • Spill to achieve 80/80 FPE, up to total dissolved gas cap of 120% daily average, as derived by agencies	• Pool operations same as SOS 2c, except operate John Day at 257 feet (MOP) year-round, with 3 feet of flexibility March-Oct. and 5 feet of flexibility Nov.-Feb. • Spill to achieve 80% FPE up to total dissolved gas cap of 115% 12-hour average; spill caps range from 9 kcfs at John Day to 90 kcfs at The Dalles
SOS 5c	**SOS 6d**	**SOS 9b**	
Same as SOS 5b	Same as SOS 5	• Same as SOS 2, except operate John Day at minimum irrigation pool or 262.5 feet with 1 foot of flexibility from April 16-Aug. 31 • McNary flow targets as described for Grand Coulee • Spill to achieve 80/80 FPE, up to total dissolved gas cap of 120% daily average, as derived by Corps	
		SOS 9c	
		Same as SOS 9b, except operate John Day at minimum operating pool	

1 kcfs = 28 cms 1 ft = 0.3048 meter

4.1.1 SOS 1-Pre-ESA Operation

This alternative represents one end of the range of the SOR strategies in terms of their similarity to historical system operations. This strategy reflects Columbia River system operations before changes were made as a result of the ESA listing of three Snake River salmon stocks. This SOS has two options:

- **SOS 1a (Pre–Salmon Summit Operation)** represents operations as they existed from 1983 through the 1990–91 operating year, including Northwest Power Act provisions to restore and protect fish populations in the basin. Specific volumes for the Water Budget would be provided from Dworshak and Brownlee reservoirs to attempt to meet a target flow of 85 kcfs (2,380 cms) at Lower Granite Dam in May. Sufficient flows would be provided on the Columbia River to meet a target flow of 134 kcfs (3,752 cms) at Priest Rapids Dam in May. Lower Snake River projects would operate within 3 to 5 feet (0.9 to 1.5 m) of full pool. Other projects would operate as they did in 1990–91, with no additional water provided from the Snake River above Brownlee Dam.

- **SOS 1b (Optimum Load–Following Operation)** represents operations as they existed prior to changes resulting from the Northwest Power Act. It is designed to demonstrate how much power could be produced if most flow–related operations to benefit anadromous fish were eliminated including: the Water Budget; fish spill requirements; restrictions on operation of Bonneville's second powerhouse; and refill targets for Libby, Hungry Horse, Grand Coulee, Dworshak, and Albeni Falls. It assumes that transportation would be used to the maximum to aid juvenile fish migration.

4.1.2 SOS 2-Current Operations

This alternative reflects operation of the Columbia River system with interim flow improvement measures made in response to ESA listings of Snake River salmon. It is very similar to the way the system operated in 1992 and reflects the results of ESA Section 7 consultation with NMFS then. The strategy is consistent with the 1992–93 operations described in the Corps' *1993 Interim Columbia and Snake Rivers Flow Improvement Measures Supplemental EIS* (SEIS). SOS 2 also most closely represents the recommendations issued by the NMFS Snake River Salmon Recovery Team in May 1994. Compared to SOS 1, the primary changes are additional flow augmentation in the Columbia and Snake Rivers and modified pool levels at lower Snake and John Day reservoirs during juvenile salmon migration. This strategy has two options:

- **SOS 2c (Final SEIS Operation- No Action Alternative)** matches exactly the decision made as a result of the 1993 SEIS. Flow augmentation water of up to 3.0 MAF (3.7 billion m^3) on the Columbia River (in addition to the existing Water Budget) would be stored during the winter and released in the spring in low–runoff years. Dworshak would provide at least an additional 300 KAF (370 million m^3) in the spring and 470 KAF (580 million m^3) in the summer for flow augmentation. System flood control shifts from Dworshak and Brownlee to Grand Coulee would occur through April as needed. It also provides up to 427 KAF (527 million m^3) of additional water from the Snake River above Brownlee Dam.

- **SOS 2d (1994–98 Biological Opinion)** matches the hydro operations contained in the 1994–98 Biological Opinion issued by NMFS in mid–1994. This alternative provides water for the existing Water Budget as well as additional water, up to 4 MAF, for flow augmentation to benefit the anadromous fish migration. The additional water of up to 4 MAF would be stored in Grand Coulee, Libby and Arrow, and provided on a sliding scale tied to runoff forecasts. Flow targets are established at Lower Granite and McNary.

In cases such as the SOR, where the proposed action is a new management plan, the No Action Alternative means continuing with the present course of action until that action is changed (46 FR 13027). Among all of the strategies and options, SOS 2c best meets this definition for the No Action Alternative.

4.1.3 SOS 4-Stable Storage Project Operation

This alternative is intended to operate the storage reservoirs to benefit recreation, resident fish, wildlife, and anadromous fish while minimizing impacts of such operation to power and flood control. Reservoirs would be kept full longer, but still provide spring flows for fish and space for flood control. The goal is to minimize reservoir fluctuations while moving closer to natural flow conditions. For the Final EIS, this alternative has one option:

- **SOS 4c (Stable Storage Operation with Modified Grand Coulee Flood Control)** applies year–round Integrated Rule Curves (IRCs) developed by the State of Montana for Libby and Hungry Horse. Other reservoirs would be managed to specific elevations on a monthly basis; they would be kept full longer, while still providing spring flows for fish and space for flood control. The goal is to minimize reservoir fluctuations while moving closer to natural flow conditions. Grand Coulee would meet elevation targets year–round to provide acceptable water retention times; however, upper rule curves would apply at Grand Coulee if the January to July runoff forecast at the project is greater than 68 MAF (84 billion m^3).

4.1.4 SOS 5-Natural River Operation

This alternative is designed to aid juvenile salmon migration by drawing down reservoirs (to increase the velocity of water) at four lower Snake River projects. SOS 5 reflects operations after the installation of new outlets in the lower Snake River dams, permitting the lowering of reservoirs approximately 100 feet (30 m) to near original riverbed levels. This operation could not be implemented for a number of years, because it requires major structural modifications to the dams. Elevations would be: Lower Granite – 623 feet (190 m); Little Goose – 524 feet (160 m); Lower Monumental – 432 feet (132 m); and Ice Harbor – 343 feet (105 m). Drafting would be at the rate of 2 feet (0.6 m) per day beginning February 18. The reservoirs would refill again with natural inflows and storage releases from upriver projects, if needed. John Day would be lowered as much as 11 feet (3.3 m) to minimum pool, elevation 257 feet (78.3 m), from May through August. All other projects would operate essentially the same as in SOS 1a, except that up to 3 MAF (3.7 billion m^3) of water (in addition to the Water Budget) would be provided to augment flows on the Columbia River in May and June. System flood control would shift from Brownlee and Dworshak to the lower Snake River projects. Also, Dworshak would operate for local flood control. This alternative has two options:

- **SOS 5b (Four and One–half Month Natural River Operation)** provides for a lower Snake River drawdown lasting 4.5 months, beginning April 16 and ending August 31. Dworshak would be drafted to refill the lower Snake River projects if natural inflow were inadequate for timely refill.

- **SOS 5c (Permanent Natural River Operation)** provides for a year–round drawdown, and projects would not be refilled after each migration season.

4.1.5 SOS 6-Fixed Drawdown

This alternative is designed to aid juvenile anadromous fish by drawing down one or all four lower Snake River projects to fixed elevations approximately 30 to 35 feet (9 to 10 m) below minimum operating pool. As with SOS 5, fixed drawdowns depend on prior structural modifications and could not be instituted for a number of years. Draft would be at the rate of 2 feet (0.6 m) per day beginning April 1. John Day would be lowered to elevation 257 feet (78.3 m) from May through August. All other projects would operate essentially the same as under SOS 1a, except that up to 3 MAF (3.7 billion m^3) of water would be provided to augment flows on the Columbia River in May and June. System flood control would shift from Brownlee and Dworshak to the lower Snake projects. Also, Dworshak would operate for local flood control. This alternative has two options:

- **SOS 6b (Four and One–half Month Fixed Drawdown)** provides for a 4.5–month drawdown at all four lower Snake River projects beginning April 16 and ending August 31. Elevations would be: Lower Granite – 705 feet (215 m); Little Goose – 605 feet (184 m); Lower Monumental – 507 feet (155 m); and Ice Harbor – 407 feet (124 m).
- **SOS 6d (Four and One–half Month Lower Granite Fixed Drawdown)** provides for a 4.5–month drawdown to elevation 705 feet at Lower Granite beginning April 16 and ending August 31.

4.1.6 SOS 9-Settlement Discussion Alternatives

This SOS represents operations suggested by USFWS and NMFS (as SOR cooperating agencies), the State fisheries agencies, Native American tribes, and the Federal operating agencies during the settlement discussions in response to a court ruling in the *IDFG v. NMFS* lawsuit. The objective of SOS 9 is to provide increased velocities for anadromous fish by establishing flow targets during the migration period and by carrying out other actions that benefit ESA–listed species. The specific options were developed by a group of technical staff representing the parties in the lawsuit. The group was known as the Reasonable and Prudent Alternatives Workgroup. They developed three possible operations in addition to the 1994–98 Biological Opinion. This strategy has three options:

- **SOS 9a (Detailed Fishery Operating Plan [DFOP])** establishes flow targets at The Dalles based on the previous year's end–of–year storage content, similar to how PNCA selects operating rule curves. Grand Coulee and other storage projects are used to meet The Dalles flow targets. Specific volumes of releases are made from Dworshak, Brownlee, and upper Snake River to try to meet Lower Granite flow targets. Lower Snake River projects are drawn down to near spillway crest level for 4 1/2 months. Specific spill percentages are established at run–of–river projects to achieve no higher than 120 percent daily average total dissolved gas. Fish transportation is assumed to be eliminated.
- **SOS 9b (Adaptive Management)** establishes flow targets at McNary and Lower Granite based on runoff forecasts. Grand Coulee and other storage projects are used to meet the McNary flow targets. Specific volumes of releases are made from Dworshak, Brownlee, and the upper Snake River to try to meet Lower Granite flow targets. Lower Snake River projects are drawn down to minimum operating pool levels and John Day is at minimum irrigation pool level. Specific spill percentages are established at run–of–river projects to achieve no higher than 120 percent daily average for total dissolved gas.
- **SOS 9c (Balanced Impacts Operation)** draws down the four lower Snake River projects to near spillway crest levels for 2 1/2 months during the spring salmon migration period. Full drawdown level is achieved on April 1. Refill begins after June 15. This alternative also provides 1994–98 Biological Opinion flow augmentation (as in SOS 2d), IRC operation at Libby and Hungry Horse, a reduced flow target at Lower Granite due to drawdown, limits on winter drafting at Albeni Falls, and spill to achieve no higher than 120 percent daily average for total dissolved gas.

4.1.7 SOS PA-Preferred Alternative

This SOS represents the operation recommended by NMFS and USFWS in their respective Biological Opinions issued on March 1, 1995. SOS PA is intended to support recovery of ESA–listed species by storing water during the fall and winter to meet spring and summer flow targets, and to protect other resources by managing detrimental effects through maximum summer draft limits, by providing public safety through flood protection, and by providing for reasonable power generation. This SOS would operate the system during the fall and winter to achieve a high confidence of refill to flood control elevations by April 15 of each year, and use this stored water for fish flow augmentation. It establishes spring flow targets at McNary and Lower Granite based on runoff forecasts, and a similar sliding scale flow target at Lower Granite and a fixed flow target at McNary for the summer. It establishes summer draft limits at Hungry Horse, Libby, Grand Coulee, and Dworshak. Libby is also operated to provide flows for Kootenai River white sturgeon. Lower Snake River projects are drawn down to minimum operating pool levels during the spring and summer. John Day is operated at minimum operating pool level year–round. Specific spill percentages are established at run–of–river projects to achieve 80–percent FPE, with no higher than 115–percent 12–hour daily average for total dissolved gas measured at the forebay of the next downstream project.

4.1.8 Rationale for Selection of the Final SOSs

Table 4–2 summarizes the changes to the set alternatives from the Draft EIS to the Final EIS. SOS 1a and 1b are unchanged from the Draft EIS. SOS 1a represents a base case condition and reflects system operation during the period from passage of the Northwest Power Planning and Conservation Act until ESA listings. It provides a baseline alternative that allows for comparison of the more recent alternatives and shows the recent historical operation. SOS 1b represents a limit for system operation directed at maximizing benefits from development–oriented uses, such as power generation, flood control, irrigation and navigation and away from natural resources protection. It serves as one end of the range of alternatives and provides a basis for comparison of the impacts to power generation from all other alternatives. Public comment did not recommend elimination of this alternative because it serves as a useful milepost. However, the SOR agencies recognize it is unlikely that decisions would be made to move operations toward this alternative.

In the Draft EIS, SOS 2 represented current operation. Three options were considered. Two of these options have been eliminated for the Final EIS and one new option has been added. SOS 2c continues as the No Action Alternative. Maintaining this option as the No Action Alternative allows for consistent comparisons in the Final EIS to those made in the Draft EIS. However, within the current practice category, new operations have been developed since the original identification of SOS 2c. In 1994, the SOR agencies, in consultation with the NMFS and USFWS, agreed to an operation, which was reflected in the 1994–98 Biological Opinion. This operation (SOS 2d) has been modeled for the Final EIS and represents the most "current" practice. SOS 2d also provides a good baseline comparison for the other, more unique alternatives. SOS 2a and 2b from the Draft EIS were eliminated because they are so similar to SOS 2c. SOS 2a is identical to SOS 2c except for the lack of an assumed additional 427 KAF of water from the upper Snake River Basin. This additional water did not cause significant changes to the effects between SOS 2a and 2c. There is no reason to continue to consider an alternative that has impacts essentially equal to another alternative. SOS 2b is also similar to SOS 2c, except it modified operation at Libby for Kootenai River white sturgeon. Such modifications are included in several other alternatives, namely SOS 2d, 9a, 9c, and the Preferred Alternative.

SOS 3a and 3b, included in the Draft EIS, have been dropped from consideration in the Final EIS. Both of these alternatives involved anadromous fish flow augmentation by establishing flow targets based on runoff forecast on the Columbia and Snake Rivers. SOS 3b included additional water from the upper Snake River Basin over what was assumed for SOS 3a. This operation is now incorporated in several new alternatives, including SOS 9a and 9b. Public comment also did not support continued consideration of the SOS 3 alternatives.

Table 4–2. Summary of Alternatives in the Draft and Final EIS

Draft EIS Alternatives	Final EIS Alternatives
SOS 1 Pre–ESA Operation	SOS 1 Pre–ESA Operation
SOS 1a Pre–Salmon Summit Operation	SOS 1a Pre–Salmon Summit Operation
SOS 1b Optimum Load Following Operation	SOS 1b Optimum Load Following Operation
SOS 2 Current Practice	SOS 2 Current Practice
SOS 2a Final Supplemental EIS Operation	SOS2c Final Supplemental EIS Operation – No–Action Alternative
SOS 2b Final Supplemental EIS with Sturgeon Operations at Libby	**SOS 2d 1994–98 Biological Opinion Operation**
SOS2c Final Supplemental EIS Operation – No–Action Alternative	
SOS 3 Flow Augmentation	
SOS 3a Monthly Flow Targets	
SOS 3b Monthly Flow Targets with additional Snake River Water	
SOS 4 Stable Storage Project Operation	SOS 4 Stable Storage Project Operation
SOS 4a1 Enhanced Storage Level Operation	**SOS 4c Enhanced Operation with modified Grand Coulee Flood Control**
SOS 4a3 Enhanced Storage Level Operation	
SOS 4b1 Compromise Storage Level Operation	
SOS 4b3 Compromise Storage Level Operation	
SOS 4c Enhanced Operation with modified Grand Coulee Flood Control	
SOS 5 Natural River Operation	SOS 5 Natural River Operation
SOS 5a Two Month Natural River Operation	SOS 5b Four and One Half Month Natural River Operation
SOS 5b Four and One Half Month Natural River Operation	**SOS 5c Permanent Natural River Operation**
SOS 6 Fixed Drawdown	SOS 6 Fixed Drawdown
SOS 6a Two Month Fixed Drawdown Operation	SOS 6b Four and One Half Month Fixed Drawdown Operation
SOS 6b Four and One Half Month Fixed Drawdown Operation	SOS 6d Four and One Half Month Lower Granite Drawdown Operation
SOS 6c Two Month Lower Granite Drawdown Operation	
SOS 6d Four and One Half Month Lower Granite Drawdown Operation	
SOS 7 Federal Resource Agency Operations	**SOS 9 Settlement Discussion Alternatives**
SOS 7a Coordination Act Report Operation	**SOS 9a Detailed Fishery Operating Plan**
SOS 7b Incidental Take Statement Flow Targets	**SOS 9b Adaptive Management**
SOS 7c NMFS Conservation Recommendations	**SOS 9c Balance Impacts Operation**
	SOS Preferred Alternative

Bold indicates a new or revised SOS alternative

SOS 4 originally included 5 options in the Draft EIS. They were similar in operation and impact. In SOS 4a and 4b, the primary feature was the use of Biological Rule Curves for Libby and Hungry Horse reservoirs. SOS 4c also included these rule curves but went further by optimizing the operation of the other storage projects, particularly Grand Coulee and Dworshak. For the Final EIS, the SOR agencies have decided to update the alternative by substituting the IRC for the Biological Rule Curves and by eliminating SOS 4a and 4b. The IRCs are a more recent, acceptable version of minimum elevations for Libby and Hungry Horse. Significant public comment in support of this alternative with IRCs was received. Similar to SOS 2 above, SOS 4a and 4b were not different enough in operation or impacts to warrant continued consideration.

The Natural River (SOS 5) and the Spillway Crest Drawdown (SOS 6) alternatives in the Draft EIS originally included options for 2 months of drawdown to the appropriate pool level and 4 1/2 months of drawdown. The practicality of 2–month drawdowns was questioned during public review, particularly for the natural river. It did not appear that the time involved in drawing down the reservoirs and later refilling them provided the needed consideration for other uses. Flows are restricted to refill the reservoirs at a time when juvenile fall chinook are migrating downstream and various adult species are returning upstream. The 2 1/2 month drawdown strategies (SOS 5a, 6a, and 6c) have been dropped from the Final EIS. However, 2 1/2 month spillway crest drawdown at all four lower Snake projects is still an element in SOS 9c, so the impacts associated with this type of operation are assessed in the Final EIS.

A new option was added to SOS 5, namely SOS 5c. This option includes natural river drawdown of the lower Snake River projects on a permanent, year–round basis. The Corps received comment on this type of alternative during the review of Phase I of the SCS, a reconnaissance assessment of potential physical modifications for the system to enhance fish passage. Many believe the cost for such modification would be less than that required for periodic, temporary drawdowns, which would require specialized facilities to enable the projects to refill and operate at two different pool elevations.

SOS 7 Federal Resource Agencies Operations, which included 3 options in the Draft EIS, has been dropped from the Final EIS and replaced with an alternative now labeled as SOS 9 that also has 3 options. SOS 7a was suggested by the USFWS and represented the State fishery agencies and tribes' recommended operation. Since the issuance of the Draft EIS, this particular operation has been revised and replaced by the DFOP (SOS 9a). The SOR agencies received comment that the DFOP was not evaluated, but should be. Therefore, we have included this alternative exactly as proposed by these agencies; it is SOS 9a. SOS 7b and 7c were suggested by NMFS through the 1993 Biological Opinion. This opinion suggested two sets of flow targets as a way of increasing flow augmentation levels for anadromous fish. The flow targets came from the Incidental Take Statement and the Conservation Recommendation sections of that Biological Opinion. The opinion was judged as arbitrary and capricious as a result of legal action, and these operational alternatives have been replaced with other alternatives that were developed through settlement discussions among the parties to this lawsuit. SOS 7b and 7c have been dropped, but SOS 9b and 9c have been added to represent operations stemming from NMFS or other fishery agencies. In particular, SOS 9b is like DFOP but has reduced flow levels and forgoes drawdowns. It is a modification to DFOP. SOS 9c incorporates elements of operation supported by the State of Idaho in its "Idaho Plan." It includes a 2 1/2–month spillway crest drawdown on the lower Snake River projects and several other elements that attempt to strike a balance among the needs of anadromous fish, resident fish, wildlife and recreation.

Shortly after the alternatives for the Draft EIS were identified, the Nez Perce Tribe suggested an operation that involved drawdown of Lower Granite, significant additional amounts of upper Snake River water, and full pool operation at Dworshak (i.e., Dworswak remains full year round). It was labeled as SOS 8a. Hydroregulation of that operation was completed and provided to the Nez Perce Tribe. No technical response has been received from the Nez

Perce Tribe regarding the features or results of this alternative. However, the elements of this operation are generally incorporated in one or more of the other alternatives, or impose requirements on the system or specific projects that are outside the range considered reasonable. Therefore, this alternative has not been carried forward into the Final EIS.

The Preferred Alternative represents operating requirements contained in the 1995 Biological Opinions issued by NMFS and USFWS on operation of the FCRPS. These opinions resulted from ESA consultation conducted during late 1994 and early 1995, which were a direct consequence of the lawsuit and subsequent judgement in *Idaho v. NMFS*. The SOR agencies are now implementing this operating strategy and have concluded that it represents an appropriate balance among the multiple uses of the river. This strategy recognizes the importance of anadromous fish and the need to adjust river flows to benefit the migration of all salmon stocks, as well as the needs of resident fish and wildlife species at storage projects.

4.2 IMPACTS – FULL SCALE ANALYSIS

A full scale analysis was made for each of the 13 SOR operational options. Monetary impacts for each alternative are presented in this section.

The impacts on reservoir pumpers who might be impacted by each option are presented in two parts: (1) The first part is for irrigation pumping associated with commercial agriculture termed "commercial irrigation"; and (2) The second part is for M&I users, which includes pumpers who utilize reservoir water for municipal and industrial purposes (M&I), fish hatcheries, Corps of Engineers pumping for recreation areas and wildlife habitat, and other uses.

Impacts on commercial irrigators have been identified for pumpers from reservoirs behind Grand Coulee, Ice Harbor and John Day dams. Impacts on M&I users have been identified for reservoirs behind Ice Harbor, John Day, Lower Granite, Lower Monumental, and Little Goose dams.

Discounting For Time Of Occurrence

Because SOR alternative strategics have different implementation dates it was necessary to discount all values to year 1 of the analysis, or 1995. Monetary impacts are expressed as annual equivalent values (present worthed and amortized) at both 7.75 percent (the Federal discount rate) and 3.0 percent.

4.2.1 Impact of Reservoir Drawdown on Commercial Irrigation

Impacts of SOR operational options on reservoir pumpers classified as commercial irrigation was analyzed for two categories of users: (1) Irrigators receiving water from Grand Coulee; and (2) Entities pumping water from the John Day and Ice Harbor pools.

4.2.1.1 Grand Coulee

Water is pumped from Lake Roosevelt (Coulee) to Banks Lake by Reclamation for use by irrigators who belong to irrigation districts served by the Federally constructed Columbia Basin Project. As authorized by Congress and through appropriate contracts with the irrigation districts, Reclamation, among other provisions, delivers water to the districts. The districts pay pumping costs based on criteria established in the contract. The current repayment rate (1993) is .95 mills per kwh ($.00095/kwh).

The irrigation pumping requirements at Coulee were identified for each of the 13 SOR operational options, which includes the Base Case (SOS1a), the No Action Alternative (SOS2c), and the Preferred Alternative. Chapter 3 describes the variables and measurement standards used to model the pumping requirement.

It was assumed that modification of the pumping plant units at Coulee would not be required.

The existing annual irrigation pumping requirement at Coulee and the repayment cost to pump the water is approximately 969,000 mwhrs and $920,300 respectively under the Base Case (SOS1a). Table 4–3 shows the annual pumping requirement in mwhrs and the monetary valuation of that power at the repayment rate for each of the 13 SOR operational options.

Alternative operating strategies have a relatively minor effect on the irrigation pumping cost at Coulee. This impact is illustrated in the graph in Figure 4–1. The greatest impact occurs under option SOS9a with an annual pumping cost of $946,200, an increase of $25,900 over the Base Case.

4.2.1.2 Ice Harbor and John Day

Commercial irrigation has been identified with 13 pumpers irrigating 36,389 acres (14,726 hectares) from the Ice Harbor pool and 25 pumpers irrigating 139,500 acres (56,455 hectares) from the John Day pool.

Chapter 3 contains the discussion of the measurement standards and determinants of the increased pumping cost. Supporting Section A contains additional information.

All estimates were discounted for time of plan implementation to yield an annual equivalent value at both 7.75 and 3.0 percent.

Proposed reservoir drawdowns on the Ice Harbor and John Day pools impact the income of irrigators by increasing the cost to own and operate pumping plant systems located on or adjacent to the reservoir pool. Increased cost include the capital cost necessary to modify the pumping plant as well as the increased annual operation and maintenance cost, and the increased power cost due to greater lift requirements (total dynamic head). Exhbit A contains information on pumping plant modification costs, including operating and power cost, as developed and furnished by the Corps of Engineers.

Tables 4–4 and 4–5 show estimates of the annual equivalent increased pumping cost at 7.75 and 3.0 percent for each of the 13 SOR operating options for the Ice Harbor and John Day pools respectively. Alternatives are marked with either a "yes" or "no" to indicate if pump modification and increased operating cost are required.

Table 4–3. Grand Coulee – Irrigation Pumping Requirement – Annual Equivalent Pumping Cost (Irrigation pumping from Lake Roosevelt to Banks Lake) (Federal Columbia Basin Project)

SOR Study No.	Annual Megawatt Hours of Pumping	Value of Energy at Repayment Rate @ $.00095/kwh	Implementation Date	Annual Equivalent Value @ 3%	Annual Equivalent Value @ 7.75%
SOS1a	968,701	$ 920,300	1995	920,300	920,300
SOS1b	968,667	920,200	1995	920,200	920,200
SOS2c	959,254	911,300	1995	911,300	911,300
SOS2d	955,776	908,000	1995	908,000	908,000
SOS4c	939,874	892,900	1995	892,900	892,900
SOS5b	959,279	911,300	2010	911,300	911,300
SOS5c	959,279	911,300	2000	911,300	911,300
SOS6b	959,279	911,300	2005	911,300	911,300
SOS6d	959,279	911,300	2000	911,300	911,300
SOS9a	995,961	946,200	2005	946,200	946,200
SOS9b	964,975	916,700	1995	916,700	916,700
SOS9c	965,614	917,300	2005	917,300	917,300
Pref. Alt	956,300	908,500	1998	908,500	908,500

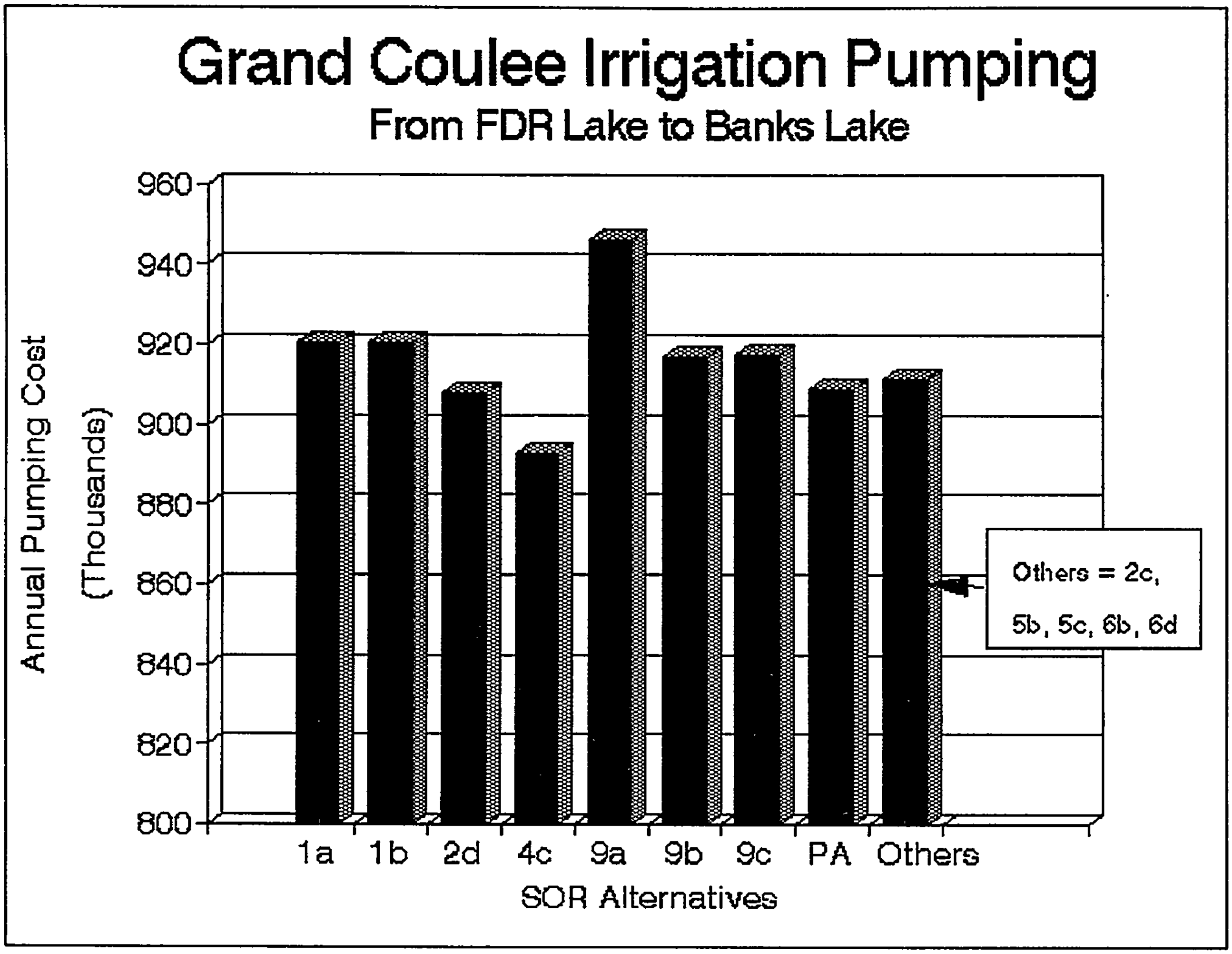


Figure 4–1. Grand Coulee Irrigation

Ice Harbor

Impacts on pumpers occur under SOS5b, SOS5c, SOS6b, SOS9a and SOS9c. The greatest impact occurs under SOS5c with an annual increase in pumping cost of approximately $3.1 million, which is equivalent to $84 per acre.

John Day

Impacts occur under SOS5b, SOS5c, SOS6b, SOS6d, SOS9a, SOS9c, and the Preferred Alternative. The greatest impact occurs under the Preferred Alternative with an annual increased pumping cost of $1.7 million, which is equivalent to $12 per acre.

4.2.2 Impacts on M&I Water Users – Pumpers

The impact on M&I users directly affected by reservoir drawdowns was analyzed in terms of the cost to modify pumping plants and the associated increased operating and power cost. These costs allow the entities to continue pumping from the reservoir pools, or otherwise operate their facilities, under reservoir drawdown conditions as identified in the hydroregs.

Table 4–4. Ice Harbor Irrigation – Increased Annual Pumping Cost

SOR Study No.	Acres Irrigated	Pump Modification Required	Implementation Date	Annual Equivalent Value @ 3% $000	Annual Equivalent Value @ 7.75% $000
SOS1a	36,389	no	1995	0	0
SOS1b	36,389	no	1995	0	0
SOS2c	36,389	no	1995	0	0
SOS2d	36,389	no	1995	0	0
SOS4c	36,389	no	1995	0	0
SOS5b	36,389	yes	2010	2,305.4	1,443.8
SOS5c	36,389	yes	2000	3,164.7	3,072.9
SOS6b	36,389	yes	2005	1,377.4	1,080.9
SOS6d	36,389	no	2000	0	0
SOS9a	36,389	yes	2005	1,378.1	1,081.3
SOS9b	36,389	no	1995	0	0
SOS9c	36,389	yes	2005	1,427.6	1,126.2
Pref. Alt.	36,389	no	1998	0	0

See Exhbit A for derivation annual equivalent values.

Table 4–5. John Day Irrigation – Increased Annual Pumping Cost

SOR Study No.	Acres Irrigated	Pump Modification Required	Implementation Date	Annual Equivalent Value @ 3% $000	Annual Equivalent Value @ 7.75% $000
SOS1a	139,500	no	1995	0	0
SOS1b	139,500	no	1995	0	0
SOS2c	139,500	no	1995	0	0
SOS2d	139,500	no	1995	0	0
SOS4c	139,500	no	1995	0	0
SOS5b	139,500	yes	2010	1,013.8	650.7
SOS5c	139,500	yes	2000	1,375.0	1,373.0
SOS6b	139,500	yes	2005	1,181.1	945.2
SOS6d	139,500	yes	2000	1,375.0	1,373.0
SOS9a	139,500	yes	2005	945.9	748.4
SOS9b	139,500	no	1995	0	0
SOS9c	139,500	yes	2005	1,213.2	966.1
Pref. Alt.	139,500	yes	1998	1,540.2	1,663.7

See Exhbit A for derivation annual equivalent values.

Impacts on M&I pumpers were identified at six reservoir pools: Lower Granite, Lower Monumental, Little Goose, Ice Harbor, John Day. Minor impacts on M&I and small tract irrigation were identified at Grand Coulee but were not evaluated further.

Table 4–6 shows the annual unadjusted increase in pumping cost, the plan implementation dates, and the increased annual equivalent pumping cost at 7.75 and 3.0 percent. Columns with a zero entry indicate that pump modification and increase operating cost was not required under that alternative. Exhbit A contains additional information pursuant to the development of data for increased pumping plant cost.

Impacts on M&I pumpers was identified for SOR options SOS5b, SOS5c, SOS6b, SOS6d, SOS9a, SOS9c, and the Preferred Alternative. Increased annual equivalent pumping cost range from approximately $2.1 million for SOS5b to $4.7 million for Preferred Alternative (@ 7.75 percent).

The basic reason the impacts are greatest for the Preferred Alternative is that the John Day pool is drawn down year–round rather than for 2 to 4.5 months.

Chapter 5, presents the comparison of alternatives and the incremental impacts between the alternatives and the Base Case (SOS1a) and the No Action Alternative (SOS2c).

Table 4–6. Increased Annual Pumping Cost – M&I Pumpers 1/2/3/

Annual Cost of Pump Modification Plus Operation, Maintenance, and Power

SOR Study No.	Pump Modification Required	Implementation Date	Annual Equivalent Value @ 3% $000	Annual Equivalent Value @ 7.75% $000
SOS1a	no	1995	0	0
SOS1b	no	1995	0	0
SOS2c	no	1995	0	0
SOS2d	no	1995	0	0
SOS4c	no	1995	0	0
SOS5b	yes	2010	3,256.9	2,111.0
SOS5c	yes	2000	4,520.1	4,483.8
SOS6b	yes	2005	3,617.3	2,921.6
SOS6d	yes	2000	4,126.2	4,100.5
SOS9a	yes	2005	3,616.0	2,920.6
SOS9b	no	1995	0	0
SOS9c	yes	2005	3,662.5	2,957.8
Pref. Alt.	yes	1998	4,273.4	4,670.3

1/See Exhbit A for derivation of increased pumping costs.

2/Impacts on Grand Coulee M&I pumpers considered insignificant.

3/Annual cost includes amortization of pump modification cost, plus increased operation, maintenance, and pumping power cost.

CHAPTER 5

COMPARISON OF ALTERNATIVES

5.1 OVERVIEW

This chapter presents the comparison of impacts among alternatives. Accordingly, the incremental differences or tradeoffs in the monetary value of impacts between alternatives and the Base Case (SOS1a) and the No Action Alternative (SOS2c) are displayed for the Irrigation/M&I analysis. In order to assist and facilitate decisions regarding operation of the Federal Columbia River System, the incremental changes or differences between alternatives is displayed and the more significant impacts discussed.

5.2 SUMMARY

Annual monetary impacts on irrigation and M&I reservoir pumpers affected by SOR strategies with drawdown proposals range from no change in pumping cost to $6.3 million with the Preferred Alternative and to $8.9 million under SOS 5c. Pumping cost reductions (negative values) reflect those alternatives where pumping cost at Grand Coulee are reduced over the Base Case (SOS1a) or the No Action option (SOS2c). Incremental impacts for all categories of users is represented graphically in Figure 5–1.

The $6.3 million annual increase in pumping cost with the Preferred Alternative reflects the year–round drawdown of John Day, which is significantly influenced by the increase in costs for John Day M&I users ($4.67 million) and for John Day irrigation pumpers ($1.66 million).

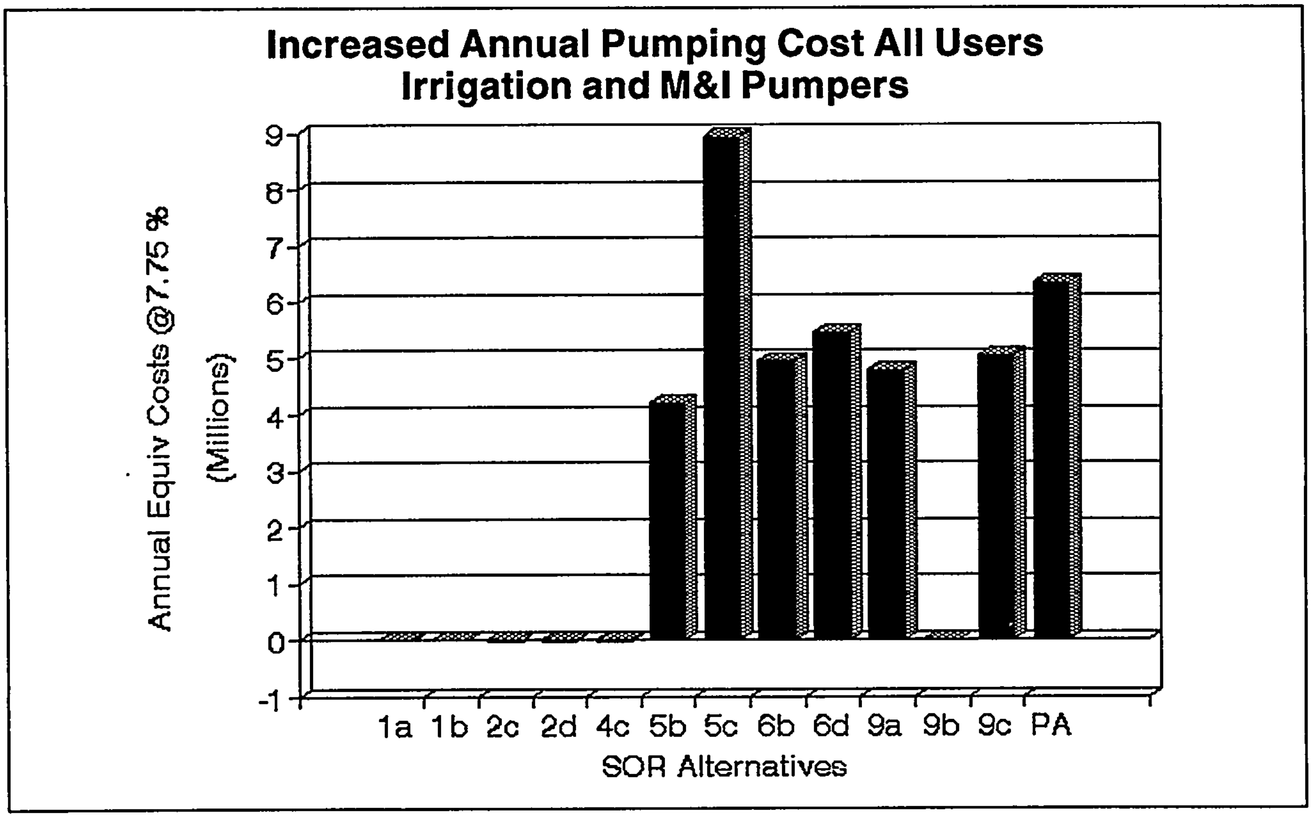


Figure 5–1. Impacts – All Categories

5.2.1 Commercial Irrigation – Grand Coulee

Analysis of the irrigation pumping requirement at Grand Coulee indicates that SOR alternative operating strategies with drawdowns would have a relatively minor effect on pumping. Some alternatives have a lower irrigation pumping cost than the Base Case or the No Action Alternative. The incremental increase in pumping energy from the Base case (SOS1a) to the alternative with the highest use is approximately 3 percent –– or from 968,700 mwhs (SOS1a) to 995,900 mwhrs in (SOS9a). The increased pumping cost would be approximately $25,900 annually.

Analysis of the hydroregs show alternative SOS9a drafting FDR Lake to unprecedented levels during the spring and summer. Consequently, during certain months of critical water years irrigation deliveries from Banks Lake may not be fully met. This is because pumping from FDR Lake to Banks Lake cannot keep up with peak irrigation demand as the efficiency of the pumping units decrease as the level of FDR Lake goes down.

In addition to those months when irrigation demand cannot be fully met under SOS9a, it should be noted that during critical water periods the pumping units are operating for extended periods of time and at head differentials greater than historical levels. The amount of increased wear on the pumping units at these operating levels is unknown and is a concern to project operators. The loss of farm income from not meeting full irrigation demand and any increase operation and maintenance expenses was not evaluated for alternative SOS9a.

In summary, with the exception of the above discussion, the irrigation pumping impacts at Grand Coulee would be relatively small.

Table 5–2 shows incremental change in the irrigation pumping requirement at Grand Coulee. The table shows the pumping cost for each option as well as the incremental change (increase/decrease) between the option and the Base Case (SOS1a) and between the option and the No Action option (SOS2c).

5.2.2 Commercial Irrigation – John Day and Ice Harbor

Chapter 4 presented the impact on pumping cost for the 13 SOR options. Pumping costs are increased for those options with drawdown. In order to continue full crop production, pumping plants must be modified and increased operation and power cost incurred. These additional costs reduce farm income over options without drawdown.

Increased pumping costs have been discounted for time of occurrence based on the implementation dates for the various options. The result is expressed as an annual equivalent value.

The discounting for time of occurrence can reduce the values substantially from the unadjusted values reflecting the time value of money. Impacts when expressed on an annual equivalent basis tend to mask the immediate impact on pumpers when a drawdown is implemented. Entities must finance the capital investment cost to modify their pumps as well as to pay the increased annual O&M and power cost out of current cash flow or retained earnings. Irrigation pumpers, in particular, can not pass on the increased cost. Some M&I pumpers could pass on the cost in the form of increased rates to customers. These entities tend to have a shorter time horizon than the 100 year period used in this analysis, as well as a different debt/capital structure.

Table 5–1. Comparative Summary – All Users (Irrigation + M&I) 1/

Study No.	Incremental Annual Equivalent Impacts – All Pumpers Between Alternative And: Base Case SOS1a $1,000 2/ 3/	No Action Alternative SOS2c $1,000 2/ 3/
SOS1a	0	9.0
SOS1b	–.1	8.9
SOS2c	–9.0	0
SOS2d	–12.3	–3.3
SOS4c	–27.4	–18.4
SOS5b	4,196.6	4,205.6
SOS5c	8,920.7	8,929.7
SOS6b	4,938.7	4,947.7
SOS6d	5,464.5	5,473.5
SOS9a	4,776.2	4,785.2
SOS9b	–3.6	5.4
SOS9c	5,047.1	5,056.1
Pref. Alt.	6,322.2	6,331.2

1/ Includes: (1) Increased pumping cost at Grand Coulee; (2) Increased pumping cost for Ice Harbor and John Day commercial irrigation pumpers; and (3) Increased pumping cost for M&I users.

2/ Annual equivalent values at 7.75%.

3/ A positive number indicates an increase in pumping cost, a negative number indicates an decrease in pumping cost.

Table 5–2. Grand Coulee – Incremental Annual Irrigation Pumping Cost

Study No.	Annual Pump Cost @ Repay Rate	Incremental Pumping Cost Between Alternative And: 3/ Base Case SOS1a $1,000 1/	No Action Alternative SOS2c $1,000 2/
SOS1a	920,300	0	9.0
SOS1b	920,200	–.1	8.9
SOS2c	911,300	–9.0	0
SOS2d	908,000	–12.3	–3.3
SOS4c	892,900	–27.4	–18.4
SOS5b	911,300	–9.0	0
SOS5c	911,300	–9.0	0
SOS6b	911,300	–9.0	0
SOS6d	911,300	–9.0	0
SOS9a	946,200	25.9	34.9
SOS9b	916,700	–3.6	5.4
SOS9c	917,300	–3.0	6.0
Pref. Alt.	908,500	–11.8	–2.8

1/ Difference between Alternative Plan and SOS1a.

2/ Difference between Alternative Plan and SOS2c.

3/ A positive number indicates an increase in pumping cost, a negative number indicates a decrease in pumping cost.

5.2.2.1 Ice Harbor

Five SOR options propose drawdowns of the Ice Harbor pool. They are SOS5b, SOS5c, SOS6b, SOS9a, and SOS9c. Option SOS5c draws down the Ice Harbor pool 95.7 feet (29.2 meter) during the pumping season while other alternatives draw down the pool approximately 32 feet. Accordingly, pumping cost increases are greater under SOS5c

Annual pumping cost increases range from $1.1 million under SOS6b, SOS9a, and SOS9c to $3.1 million under SOS5c. Table 5–3 is a comparison of the increased pumping cost between alternative plans and the Base Case and the No Action Alternative. Figure 5–2 graphically illustrates the increased pumping cost for Ice Harbor.

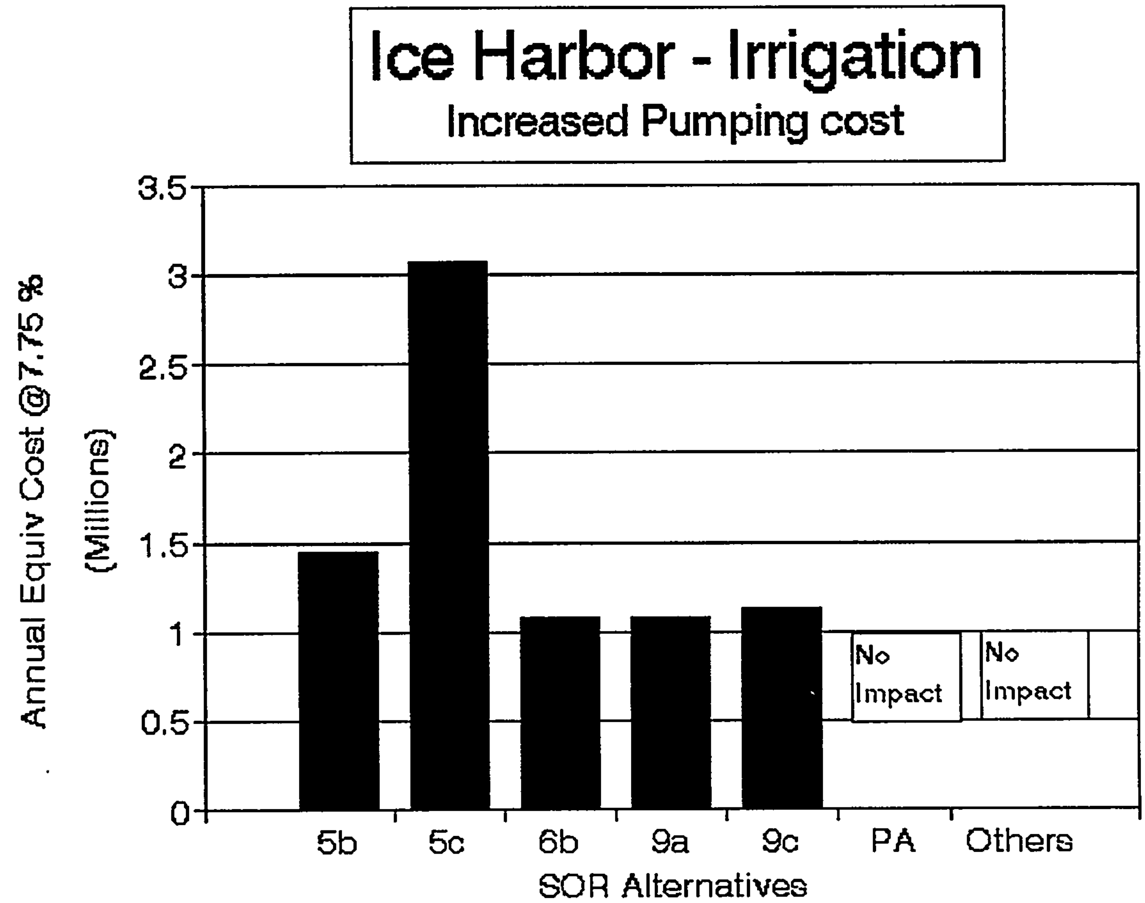


Figure 5–2. Ice Harbor Irrigation

Table 5–3. Annual Increase in Pumping Cost – Ice Harbor Irrigation

Study No.	Incremental Increase in Pumping Cost Between Alternative And: Base Case SOS1a $1,000 1/	No Action Alternative SOS2c $1,000 1/
SOS1a	0	0
SOS1b	0	0
SOS2c	0	0
SOS2d	0	0
SOS4c	0	0
SOS5b	1,443.8	1,443.8
SOS5c	3,072.9	3,072.9
SOS6b	1,080.9	1,080.9
SOS6d	0	0
SOS9a	1,081.3	1,081.3
SOS9b	0	0
SOS9c	1,126.2	1,126.2
Pref. Alt	0	0

1/ Annual equivalent values at 7.75 percent.

5.2.2.2 John Day

Seven SOR options propose drawdown of the John Day pool. These are SOS5b, SOS5c, SOS6b, SOS6d, SOS9a, SOS9c and the Preferred Alternative. The essential difference between options as far as drawdown is concerned, is the length of the drawdown during the irrigation season. Drawdown proposals at John Day result in relatively less monetary impacts on a per acre basis than at Ice Harbor because the drawdown is less –– 6.5 feet (2 meters) at John Day versus up to 95.7 feet (29.2 meters) at Ice Harbor. However, a greater acreage is irrigated from the John Day pool, 139,500 acres versus 36,389 acres (56,455 versus 14,726 hectares) from Ice Harbor.

Drawdowns of the John Day pool result in an increase in pumping cost ranging from $651 thousand to $1.7 million under the Preferred Alternative, or $5 to $12 per acre respectively.

The $1.7 million increase under the Preferred Alternative reflects the year–round drawdown of John Day. Table 5–4 is a comparison of the increased pumping cost between options and the Base Case and the No Action option. Figure 5–3 illustrates the increased pumping cost for John Day.

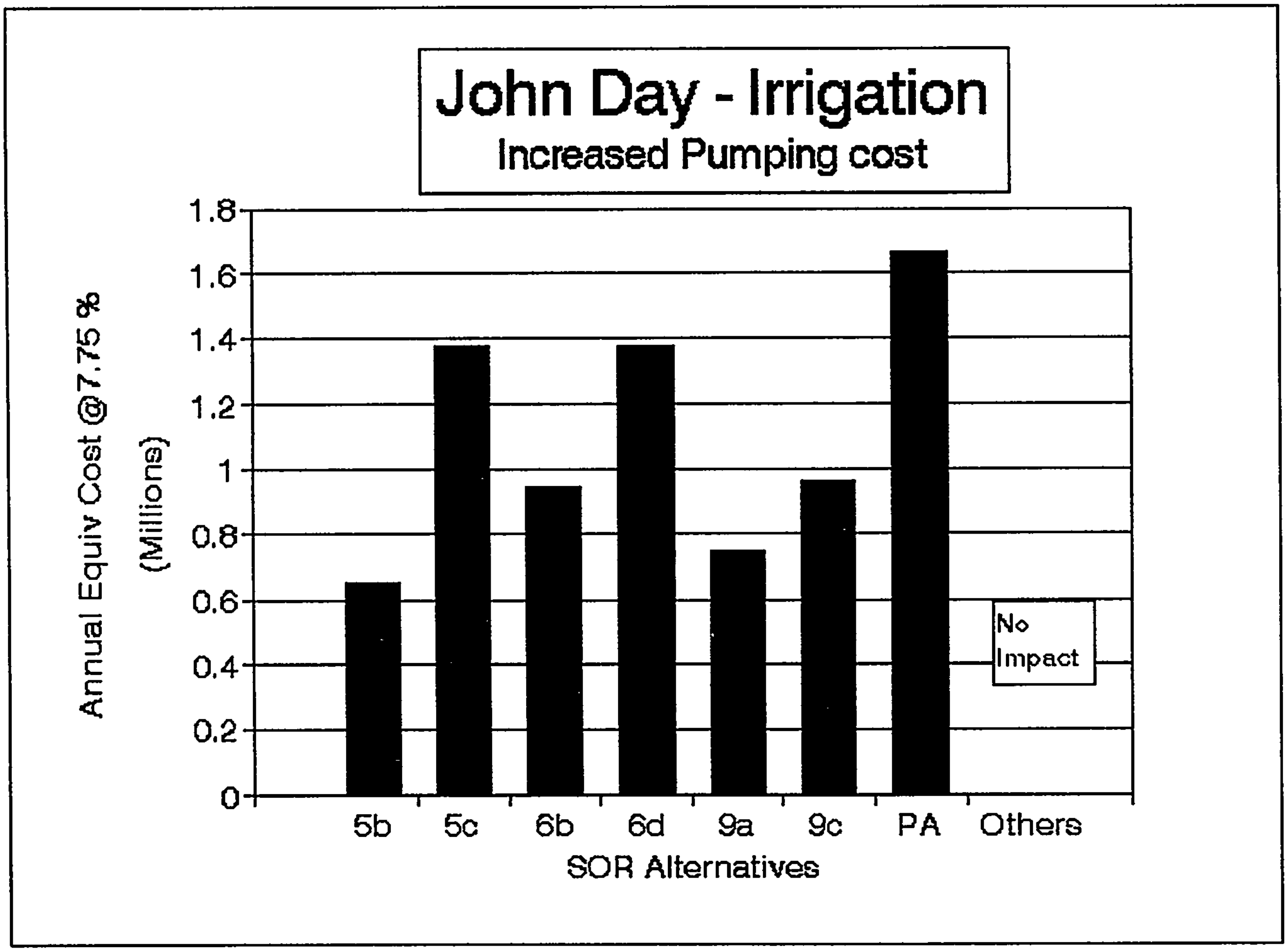


Figure 5–3. John Day Irrigation

Table 5–4. Annual Increase in Pumping Cost – John Day Irrigation

Study No.	Incremental Increase in Pumping Cost Between Alternative And: Base Case SOS1a $1,000 1/	No Action Alternative SOS2c $1,000 1/
SOS1a	0	0
SOS1b	0	0
SOS2c	0	0
SOS2d	0	0
SOS4c	0	0
SOS5b	650.7	650.7
SOS5c	1,373.0	1,373.0
SOS6b	945.2	945.2
SOS6d	1,373.0	1,373.0
SOS9a	748.4	748.4
SOS9b	0	0
SOS9c	966.1	966.1
Pref. Alt	1,663.7	1,663.7

1/ Annual equivalent values at 7.75 percent.

5.2.3 M&I Pumpers

Seven SOR options propose drawdowns of one or all of the six reservoirs. These are SOS5b, SOS5c, SOS6b, SOS6d, SOS9a, SOS9c, and the Preferred Alternative.

In addition to commercial irrigation, M&I pumpers would be impacted by reservoir drawdowns at six project pools. The reservoirs are those behind Lower Granite, Lower Monumental, Little Goose, Ice Harbor, John Day, and Grand Coulee dams. The impact on these reservoir pumpers was evaluated by estimating the pumping plant modification cost plus the increased annual operation, maintenance, and pumping power cost. These estimates were presented in chapter 4, Alternatives and Their Impacts.

Drawdowns at the six reservoirs result in annual equivalent pumping cost increases (including modification) ranging from $2.1 million under SOS5b to $4.7 million annually under the Preferred Alternative. The increased pumping cost for the Preferred Alternative reflects the relatively high modification and pumping cost for the John Day M&I pumping stations. Table 5–5 is a comparison of the incremental increases in pumping cost between alternative plans and the Base Case and the No Action Alternative. Figure 5–4 illustrates the incremental increases in annual equivalent pumping cost.

As with irrigation, discounting for time of occurrence and expressing the value as an annual equivalent with a 100 year period of analysis, tends to mask the immediate impact on individual entities when a particular drawdown option is implemented.

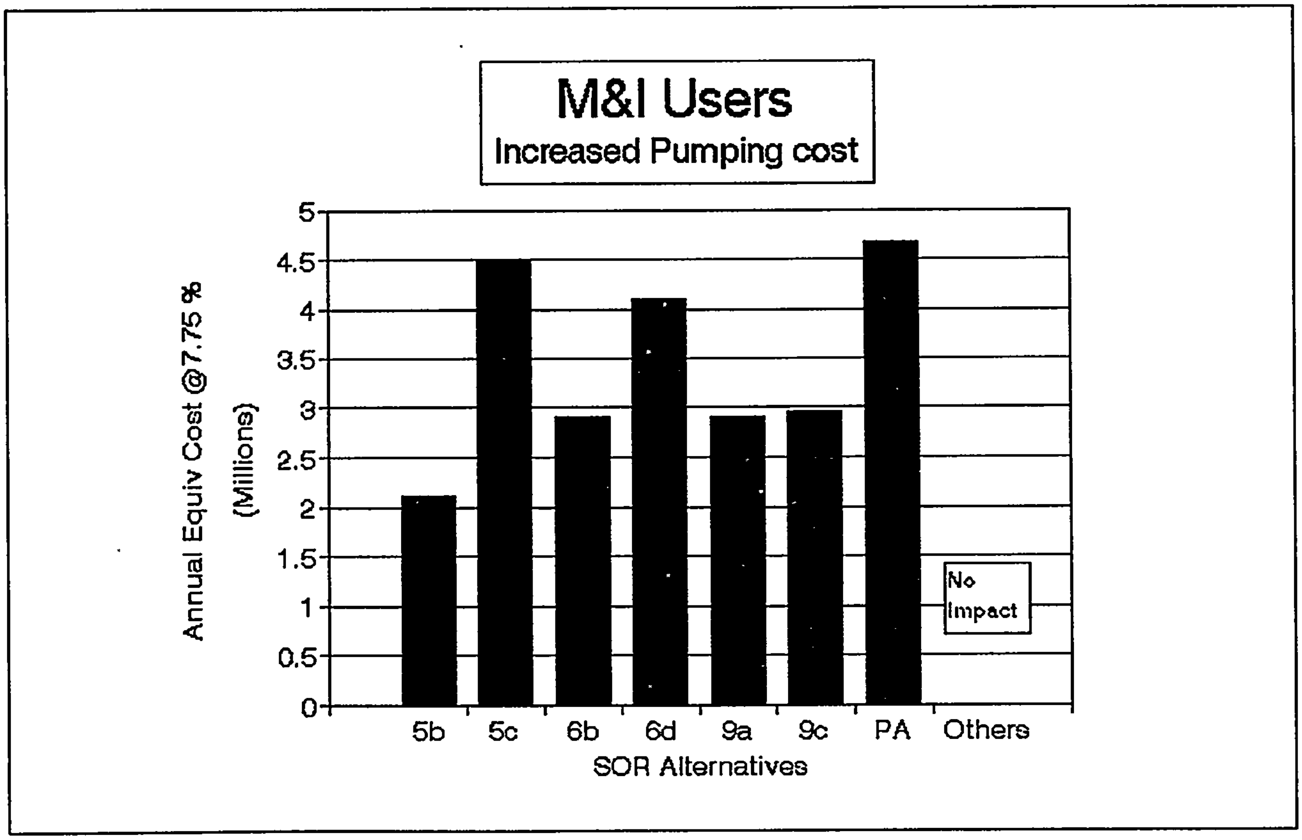


Figure 5–4. M&I Pumpers

Table 5-5. Increased Annual Equivalent Pumping Cost – M&I Pumpers [1/2/]

Study No.	Increase in Pumping Cost Between Alternative And: Base Case SOS1a $1,000 [1/]	No Action Alternative SOS2c $1,000 [1/]
SOS1a	0	0
SOS1b	0	0
SOS2c	0	0
SOS2d	0	0
SOS4c	0	0
SOS5b	2,111.1	2,111.1
SOS5c	4,483.8	4,483.8
SOS6b	2,921.6	2,921.6
SOS6d	4,100.5	4,100.5
SOS9a	2,920.6	2,920.6
SOS9b	0	0
SOS9c	2,957.8	2,957.8
Pref. Alt	4,670.3	4,670.3

1/ Annual cost includes: Amortization of modification cost, increased operation and maintenance, and the increased pumping cost. Annual equivalent values at 7.75%

2/ Modification of pump facilities for pumpers on Lower Granite, Lower Monumental, Little Goose, Ice Harbor, and John Day.

5.3 ECONOMIC VIABILITY OF IRRIGATION AND M&I PUMPING OPERATION UNDER DRAWDOWN SCENARIOS

Estimates of pump modification cost and the increased operation, maintenance and power costs were made using the best available information. Information from engineering consultants with hands–on knowledge of designing and installing river pumping systems was utilized in the analysis.

Operation and maintenance costs were increased over customary engineering rates or charges for the 4 lower Snake reservoirs to reflect the additional wear on pumps and motors because of the possibility of increased sedimentation –– both deposited and in suspension. However, irrigation and M&I pumps have not historically been operated for extended periods under drawdown situations. Accordingly, there is some uncertainty as to the actual long term impact on pumping operations.

Drawdown proposals, for example, range from approximately 32 to 95.7 feet at Ice Harbor and 6.5 feet for John Day. In addition to the depth of drawdown, the length of the pumping season and the duration of the drawdown also affects pumping cost. SOR alternatives propose drawdowns of 2.5 months, 4.5 months, and year–round.

The greater the drawdown the greater the increase in pumping cost – resulting in a decrease in farm income in the case of commercial irrigation. And, in the case of an M&I utility, the increase in cost is added to the rate base and passed on to consumers.

5.3.1 Impact of Drawdown on Economic on Viability of Irrigation Pumpers – Ice Harbor and John Day

Commercial irrigation would only be affected by drawdowns at Grand Coulee, Ice Harbor, and John Day. The impact on irrigators receiving water from FDR Lake (Coulee) is relatively small and was presented in Chapter 5.2.1.

Chapter 4 showed 5 of the 13 alternatives for Ice Harbor with increased pumping cost ranging from $1.1 million to $3.1 million (SOS5c). which is equivalent to $30 to $84 per acre. Seven of the 13 alternatives for John Day showed increased pumping cost ranging from $651 thousand up to $1.7 million for the Preferred Alternative, which is equivalent to $5 to $12 per acre. John Day has a larger irrigated acreage and smaller pumping cost increase than Ice Harbor which results in a significantly lower cost per acre. To facilitate comparison between categories of farm inputs, pumping costs are normally expressed on a per acre or per acre foot basis.

While it could be hypothesized that an annual cost increase of $5 per acre could be accommodated by most irrigators over the long run, a pumping cost increase of $84 per acre is a significant impact to the viability of individual farming operations. Other things being equal, the impact on Ice Harbor irrigators is more severe than on John Day irrigators.

As an illustration of the relative significance of the pumping cost increase under the "worst case" scenario,based on crop enterprise studies for the area, an $84 per acre cost increase in pumping cost represents the following percentage of the estimated variable crop production cost for representative crops: alfalfa – 33.7%, potatoes – 4.9%, wheat – 45.5%, corn – 23.2%, and apples – 3.7%.

Irrigation pumpers at these reservoirs, like other farmers, have little capability to pass pumping cost increases on to consumers. Accordingly, in the short–run, and in the absence of direct reimbursement from other sources, the increase in pumping cost could be expected to come from operating income in the form of a reduced return to operator labor, management, or capital investment.

In the long–run, irrigation farming, like any enterprise, must earn a return sufficient to keep resources (land, labor, capital, and management) in production –– compared to returns in alternative investments.

Irrigation Crop Production Criteria

Individual irrigators have varying production cost and profitability based on differences in their capital structure (debt–equity relationships), crop production cost, cropping, yields, as well as exogenous variables. As such, there would be a range in variation as to how individual irrigators would respond to increased pumping cost.

Production theory indicates that in the short run, producers must cover variable cost in order to continue their operations. In the long run, however, all costs (fixed and variable) must be covered. Under drawdown situations irrigators must obtain financing capability to cover short term operating loans and finance the pump modification cost itself, and over time continue to replace capital assets, such as tractors, sprinkler systems. etc.

The following responses, or a combination thereof could be expected under drawdown situations, depending on the relative magnitude of the increase in pumping cost.

a. Continue to operate and accept a lower return to operator labor, management, and equity capital. And possibly make internal changes in the production mix and crop mix to increase production efficiencies.

b. Sell the irrigated farmland, possibly at a lower price. In which case the farm value will be recapitalized at a lower value so that expected returns equates with costs.

c. Lease out the farm to other operators. which assumes the new operator has a lower capitalization structure and/or a higher operating profit margin.

d. Consolidate operations with other farmers with the goal of achieving greater production efficiencies.

e. Return some or all of farm to dryland farming or grazing.

Changes in Crop Production Practices

Observation of typical irrigation pumpers on the Ice Harbor and John Day pool indicate an already high level of irrigation application technology, capital investment, and production practices. Also, due to the nature of the soils in the mid–Columbia area, crop rotation requirement for potatoes and vegetables, and above average water delivery cost, the cropping flexibility is somewhat limited. However, in the long–run things can change, as evidenced by the relatively recent introduction of growing hybrid poplar trees for wood pulp production under irrigation in the mid–Columbia area..

Discussions with agricultural economists in the PNW and the results of price–elasticity of demand studies for electricity in the PNW indicate that in the short–run irrigators would not make significant changes in cropping or the input mix in response to increased pumping cost.

It is recognized that in the long–run irrigators may respond to any increase in production cost, including pumping cost, by changing their agronomic practices, cropping patterns, and adopting different technologies, including water application amounts. These changes occur over time in an ongoing attempt to optimize their position on the production function.

This is especially relevant for larger changes in cost that may trigger or induce changes in the production mix and cropping pattern. An increase in pumping costs would be one of the changes that would induce such changes in the production mix and cropping patterns. Discussion with agricultural economists in the PNW confirm that these production mix and cropping changes will occur faster and to a greater extent given larger increments of change in production cost than for smaller ones. Price elasticity of demand studies indicate that in the short–run farmers are relatively unresponsive to external changes in production cost (elasticity less than 1.0). In other words, a 10 percent increase in electrical pumping rates would lead to a less than 10 percent decrease in the demand for electricity.

A joint study conducted by Northwest Economic Associates and Washington State University indicate electricity price elasticities for the short–run of –.49 as the regional average, and for the long–run price elasticities varied from .66 to –1.32 with a weighted regional average of –.81. Both estimates were made using an econometric model. The study also estimated price elasticity of demand for electricity by PNW irrigators using a mathematical programming model. The results of the programming model indicated that the short–run demand for electricity by irrigators is inelastic (low elasticities). Also, the elasticities for small price increases (0–33%) are lower in absolute values than those for large price increases (34–100%). The elasticity at the lowest price increase for the region was estimated at –.14, with state–level elasticities ranging from –.08 for Washington to –.33 for Montana.

Accordingly, a 95+ foot drawdown at Ice Harbor is likely to induce a greater change in the production mix and cropping patterns and in the overall ownership patterns and capital structure of operators than the 6.5 foot drawdown at John Day, other things being equal.

The Preferred Alternative proposes a 6.5 foot drawdown of John Day which impacts irrigation and M&I pumper from that reservoir. The 4 lower Snake reservoirs are only drawn down to within the normal operating range of pumps, –– no pumping cost impacts were identified. The monetary impacts on John Day irrigation and M&I pumpers was presented in chapters 4 and 5. The response of individual irrigation pumpers to pumping cost increases under the Preferred Alternative depends on the capital/debt structure and the crop production efficiency of the individual. And as previously discussed, the impact on John Day pumpers would not be as great as on Ice Harbor irrigators under SOS5c. Any response by irrigation pumpers to an increase in pumping cost is played out in a dynamic environment interacting with other variables like commodity markets and production cost conditions in the PNW, the nation, and indeed in the world market.

5.4 MITIGATION FOR IMPACTS ON IRRIGATION AND M&I PUMPERS

As discussed in the above sections, several SOR alternatives would adversely impact irrigation pumping from reservoir pools behind John Day, Ice Harbor, and Grand Coulee, and M&I pumping from John Day and the 4 lower Snake River projects. Under the Preferred Alternative, only irrigation and M&I pumpers on the John Day pool would be affected.

Methods or ways to avoid or lessen the impact on irrigation and M&I pumpers is referred to as mitigation. Irrigation pumpers, in particular, have little or no opportunity to pass on the increased cost to customers or other users. Therefore, in reality, the only way to mitigate is for other entities to assume the increased cost. Several of the impacted commercial M&I pumpers may be able to pass on the increased cost in the form of rate increases or product prices. Non commercial M&I pumpers, like the Corps of Engineers wildlife irrigation systems, and public parks, would seek additional appropriations. In which case, the particular state or national taxpayers assume the cost.

It is not the purpose of this section to recommend specific mitigation. However, if mitigation is recommended as part of the EIS Record of Decision the question becomes one of how to externalize or pass on the increased cost, and who should be required to participate.

If the increased pumping cost are externalized and paid for by others, such as system electrical ratepayers or taxpayers, then pump owners are essentially insulated from the cost increase, and the associated indirect impacts affecting changes in cropping patterns, irrigation technology, on–farm work force, etc.

The dynamics and interrelationship of crop production costs and cropping patterns, crop practices, and the farm income position was discussed in Part 5.3. Of course, in the long–run, exogenous variables can also effect cropping patterns and practices.

If the pump modification and increased operating costs are assumed by irrigation pump owners, the increased production cost could induce changes in cropping patterns, irrigation technology, on farm work force, and agrinomic practices in varying degrees.

5.4.1 Adverse Effects on Irrigation Pumpers

The relative importance and affects of pumping cost increases (pump modification and pumping) on farm profitability was discussed in Part 5.3. Adverse effects for potential mitigation are discussed as follows.

Grand Coulee (FDR Reservoir)

The irrigation pumping cost differences among SOR alternative plans is relatively small. In comparison to the Base Case, irrigation pumping cost under some alternatives is actually reduced, including the Preferred Alternative. Accordingly, it is assumed that mitigation to irrigators is not required.

However, as discussed in section 5.2.1 if a Grand Coulee operation other than the Preferred Alternative is implemented, there is concern by project operators of the operability of the pumping units at Coulee. Under SOS 9a for example, the pumping units at Coulee are operated at the head differentials and for extended periods of time. Although pump modification was not considered necessary, operators are concerned about the possibility of increased wear and the ability to meet full irrigation demand during the peak season of critical water years is uncertain.

John Day

Presently, there are 139,500 acres irrigated from the John Day pool. Pumping cost increases for those SOR alternatives with drawdown range from $5 to $12 per acre, which is the annual equivalent cost of pump modification and the increased annual operation, maintenance, and power cost. The largest increase in pumping cost is under the Preferred Alternative with a pumping cost increase of $12 per acre on an annual equivalent basis (@7.75 %). It was assumed that a $12 per acre cost increase would not, by itself, significantly change cropping patterns and practices. The more significant and immediate impact is the initial pump modification investment required to maintain operability under drawdown conditions.

Ice Harbor

Presently, there are 35,389 acres irrigated from the Ice Harbor pool. Pumping cost increases for those SOR alternatives with drawdown range from $30 to $84 per acre on an annual equivalent basis (@7.75 %). There is no drawdown of the Ice Harbor pool under the Preferred Alternative. With a $84 per acre cost increase under other alternatives, several potential changes in irrigation farming operations may occur, including the possible reversion of some farms to dryland farming. These scenarios were detailed in Part 5.3.

As the Preferred Alternative does not propose drawdown of Ice Harbor, irrigation pumpers are not directly affected.

For both John Day and Ice Harbor, if an alternative with drawdown is selected, adverse impacts on irrigation pumpers could be fully avoided by assigning the pump modification cost and the increased operation, maintenance, and power costs to other entities. Impacts could be lessened by requiring other entities to assume the pump modification cost.

5.4.2 Adverse Effect on M&I Pumpers

M&I pumping is by local water systems, golf courses, fish hatcheries, sand and gravel companies, and government agencies operating parks and irrigating wildlife areas. It is assumed that these operations will continue under drawdown alternatives.

The Preferred Alternative proposes drawdown of John Day only, and not the four lower Snake River projects.

Adverse effects on commercial M&I pumpers could be avoided by assigning the pump modification cost and increased operation, maintenance, and power costs to other entities. Adverse impacts on non commercial M&I pumpers would probably be compensated for by seeking additional appropriations from local, state, and national governments.

CHAPTER 6

LIST OF PREPARERS

Irrigation and M&I interests were represented by a 31 member team know as the "Irrigation and M&I Work Group." The Work Group included people with a wide array of experience and interest in irrigation and M&I water supply. Most of the Work Group consisted of agricultural economists, irrigation water management and utilization specialists, and agricultural engineers. The members of the Irrigation/M&I Work Group are listed in table 6–1.

The appendix was written under direction of the Irrigation/M&I Work Group Coordinator. Information on irrigated acreages, irrigation water diversions, and net irrigation depletions was provided by the AG Crook Company, under contract with BPA. Work Group members provided valuable input in scoping and defining the analysis, formulation, and screening of irrigation/M&I alternatives, evaluation of potential irrigation alternatives as possible inclusion into the final SOR alternative operating strategies, scoping and defining the analysis for full scale analysis of the selected operating strategies, and technical review of the appendix.

Individuals directly responsible for preparing this appendix, including those providing major input and review are shown in table 6–2.

Table 6–1. Members of Irrigation/M&I Work Group

Aillery, Marcel
Economic Research Service
US Dept Agriculture

Brockway, Charles, Dr.
University of Idaho
Research & Extension Center

Cawlfield, Larry

Detering, Stan, RPCB
Bonneville Power Administration

Erickson, Dick
East Columbia Basin Irrigation Dist

Garrison, Karen
Natural Resources Defense Council

Graham, Dan, Dr.

Johns, Eldon, D–5752
US Bureau of Reclamation

Kaumheimer, Dave
US Fish and Wildlife Service

Kitchin, Debbie
Northwest Power Planning Council

Lawson, Chris E.
Ebasco Environmental

Ley, Tom
Washington State University

Lufkin, Thom
Water Resources Dept.
Washington Dept. of Ecology

McDonald, Frank
US Army Corps of Engineers

Miller, Elouise
Columbia River Inter–Tribal
Fish Commission

Newsom, Michael
Bonneville Power Administration

Norris, Barry
Oregon Water Resource Dept.

Powers, Allen
US Bureau of Reclamation

Reiners, Allen
Work Group Coordinator
US Bureau of Reclamation

Robertson, Alan
Idaho Dept. Water Resources

Roush, Eldon

Sarantitis, Barbara
National Marine Fisheries Service

Shank, Bob, PG
Bonneville Power Administration

Tominaga, Lynn
Idaho Water Users Assoc.

Trefry, Stu
Washington Dept. Agriculture

Trimmer, Walter L., Dr.
Oregon State University
Dept. of Agricultural Engineering

Turner, Robert
Washington Department of
Fisheries

Ward Phil Asst. Director
Oregon Dept. of Agriculture

Weber, Edward E.
Oregon Dept. of Agriculture

Westeson, Jerry, Dr.
Montana State University
Civil & Agriculture Engineering

Ziari, Fred
IRZ Consulting

Table 6–2. List of Preparers and Contributors

Name	Education/Years of Experience	Experience and Expertise	Role In Preparation
Bonneville Power Administration			
Bob Shank	B.S. Biology MRP Environmental Science 11 years	Multipurpose resource planning and evaluation. NEPA compliance	Scoping and formulation of irrigation alternatives. Appendix scoping and review.
Corps of Engineers			
Jim Fredericks Economist	B.S. Economics 6 years	Economic analysis of water resources development projects.	Increased pumping costs for irrigation and M&I pumpers. Appendix analysis/review. Appendix writing.
Frank McDonald	M.S. Industrial Engineering Regional Economist Professional Engineer 19 years	Economic analysis of water resources development projects.	Formulation of irrigation alternatives.
Individual			
Dick Erickson	Manager, East Columbia Basin I.D., B.S. Agricultural Engineering Professional, Engineer 19 years	Irrigation System Management Maintenance and operations. Public Administration.	Irrigation data – water use and acreages formulation of irrigation alternatives.
State of Idaho			
Dr. Charles Brockway University of Idaho Research and Extensions	B.S. Civil Engineering M.S. Civil Engineering Ph.D. Water Resource Engineering 31 years	Hydrology – Ground–water and surface water systems. Water Systems – design, evaluation, and management.	Hydrology – Snake River Basin. Formulation of irrigation alternatives.
Alan Robertson, IDWR Supervisor/Hydrology	B.S. M.S. Agricultural Engineering	Hydrology – surface and ground water. Irrigation.	Hydrology of Irrigation. Formulation of irrigation alternatives.
US Bureau of Reclamation			
Allen Reiners Economist	B.S. Agricultural Economics M.S. Agricultural Economics 27 years	Economic Justification Analysis – Financial Analysis Repayment and Contracts	Irrigation and M&I Work Group Coordinator Economics Work Group Appendix preparation and writing.
Harold Ward Economist	B.S. Agricultural Economics M.S. Agricultural Economics 37 years	Economic Justification Analysis – Water Resources Financial	Irrigation and M&I Work Group Coordinator (retired) Economics Work Group Appendix writing. Retired December 1992.
Harry Taylor Engineer	B.S. Civil Engineering 22 years	Water Operations – Hydrology	Operation Studies Grand Coulee Pumping Requirements
Eldon Johns	MS Agricultural Hydrology	Water Rights – Irrigation	Water Rights, Technical Review SNAG. Appendix writing.
Allen Powers	B.S. Natural Resources Management, M.S. Earth Science Education	Water Management	Irrigation Management. Appendix Review.

CHAPTER 7

REFERENCES

1/"Screening Analysis: A Summary, The Columbia River System", Columbia River System Operation Review (SOR) Interagency Team, August 1992.

2/Ibid.

3/"Screening Analysis – Volume 1, Description and Conclusions, Columbia River System Operation Review, Columbia River System Operation Review (SOR) Interagency Team, August 1992.

4/Source: "1990 Level Modified Streamflow, 1928–1989," Columbia River and Coastal Basins, Prepared for Bonneville Power Administration by A.G. Crook Company, April 1993.

5/Note: Relift project pumping occurs at various locations on the Columbia Basin project. The alternative operating strategies would not effect this pumping. A small amount of Columbia Basin Project water is pumped from the McNary pool near Burbank, Washington site, which would not be affected by alternative strategies.

6/Impacts at Coulee do not include those associated with a non operating 1,700 acre irrigation project on Indian reservation land. Land were formerly served by water pump from Coulee (FDR) – upper end of reservoir.

"1992 Estimated Cost of Producing Red Delicious Apples in Central Washington" (EB 1720), and "1992 Enterprise Budgets for Alfalfa Hay, Potatoes, Winter Wheat, Grain Corn, Silage Corn, and Sweet Corn Under Center Pivot Irrigation, Columbia Basin, Washington" (EB 1667), issued by the Washington State University, Cooperative Extension Service.

"Feasibility of Irrigation Canal Along The Columbia River in Oregon," sponsored by John Day Pool Irrigators, Oregon Economic Development, Bonneville Power Administration, Umatilla Electric Cooperative Association, and Pacific Power. Engineering Report by IRZ Consulting & PACAM Engineering, Inc., Hermiston, Oregon, November 1992.

"John Day Reservoir, Washington Shore, Irrigation Pumping Stations Evaluation," by Bovay Northwest, Inc., for Corps of Engineers, Walla Walla District, February 5, 1993.

"Effects of the Columbia River Pool Draw–Down on Selected Pumping Stations in Washington," sponsored by Benton County PUD, Kennewick, Washington. Engineering Report by PACAM Engineering, Inc., and IRZ Consulting, Hermiston, Oregon, August 1991.

"Effects of the Columbia River Pool Draw–Down on Irrigated Agriculture in Oregon," sponsored by Umatilla Electric Cooperative Association, Hermiston, Oregon. Engineering Report by PACAM Engineering, Inc., and IRZ Consulting, Hermiston, Oregon, revision August 1991.

"Columbia River Salmon Mitigation Analysis System Configuration Study, Phase I, Interim Status Report, Technical Appendix B, John Day Reservoir Minimum Operating Pool," prepared in response to Northwest Power Planning Council Columbia River Fish and Wildlife Program, US Army Corps of Engineers, Portland District November 1992.

"Investigation of Pumping Facilities, Lower Snake River, 1991," US Army Corps of Engineers, Walla Walla District, by Anderson Perry & Associates, Edward Sigurdson, PE, PLS, Consulting Engineers, La Grande, Oregon, Walla Walla, Washington, and Lewiston, Idaho.

"1992 Estimated Cost of Producing Red Delicious Apples in Central Washington" (EB 1720), issued by the Washington State University, Cooperative Extension Service.

"1992 Enterprise Budgets for Alfalfa Hay, Potatoes, Winter Wheat, Grain Corn, Silage Corn, and Sweet Corn Under Center Pivot Irrigation, Columbia Basin, Washington" (EB 1667), issued by the Washington State University, Cooperative Extension Service.

Salmon Recovery in the Pacific Northwest, A Summary of Agricultural and Other Economic Effects, U.S. Department of Agriculture, Economic Research Service, Bulletin Number 699, June 1994.

The Role of Electricity in Pacific Northwest Irrigated Agriculture, 1979–1987, Volume 1, February 1989, by Northwest Economic Associated, Submitted to Bonneville Power Administration.

Impacts of Energy Cost Increases on Irrigated Land Values, by Norman Whittlesey and Jon Herrel, Western Journal of Agricultural Economics, Copyright 1987.

Demand Response to Increasing Electricity Prices by Pacific Northwest Irrigated Agriculture, College of Agriculture Research Center, Bulletin 0897, Washington State University, 1981.

TECHNICAL

EXHIBIT A

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor

SOS5b						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	0.00	0.439957	0.00	0.722421	0.00
2006	12	0.00	0.408312	0.00	0.701380	0.00
2007	13	0.00	0.378944	0.00	0.680951	0.00
2008	14	0.00	0.351688	0.00	0.661118	0.00
2009	15	0.00	0.326393	0.00	0.641862	0.00
2010	16	30,100.00	0.302917	9,117.80	0.623167	18757.32
2011	17	1,800.00	0.281129	506.03	0.605016	1089.03
2012	18	1,800.00	0.260909	469.64	0.587395	1057.31
2013	19	1,800.00	0.242143	435.86	0.570286	1026.51
2014	20	1,800.00	0.224727	404.51	0.553676	996.62
2015	21	1,800.00	0.208563	375.41	0.537549	967.59
2016	22	1,800.00	0.193562	348.41	0.521893	939.41
2017	23	1,800.00	0.179640	323.35	0.506692	912.05
2018	24	1,800.00	0.166719	300.09	0.491934	885.48
2019	25	1,800.00	0.154728	278.51	0.477606	859.69
2020	26	1,800.00	0.143599	258.48	0.463695	834.65

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2021	27	1,800.00	0.133270	239.89	0.450189	810.34
2022	28	1,800.00	0.123685	222.63	0.437077	786.74
2023	29	1,800.00	0.114789	206.62	0.424346	763.82
2024	30	1,800.00	0.106532	191.76	0.411987	741.58
2025	31	1,800.00	0.098870	177.97	0.399987	719.98
2026	32	1,800.00	0.091759	165.17	0.388337	699.01
2027	33	1,800.00	0.085159	153.29	0.377026	678.65
2028	34	1,800.00	0.079034	142.26	0.366045	658.88
2029	35	1,800.00	0.073349	132.03	0.355383	639.69
2030	36	30,100.00	0.068073	2,049.01	0.345032	10385.48
2031	37	1,800.00	0.063177	113.72	0.334983	602.97
2032	38	1,800.00	0.058633	105.54	0.325226	585.41
2033	39	1,800.00	0.054416	97.95	0.315754	568.36
2034	40	1,800.00	0.050502	90.90	0.306557	551.80
2035	41	1,800.00	0.046870	84.37	0.297628	535.73
2036	42	1,800.00	0.043499	78.30	0.288959	520.13
2037	43	1,800.00	0.040370	72.67	0.280543	504.98
2038	44	1,800.00	0.037466	67.44	0.272372	490.27
2039	45	1,800.00	0.034771	62.59	0.264439	475.99
2040	46	1,800.00	0.032270	58.09	0.256737	462.13
2041	47	1,800.00	0.029949	53.91	0.249259	448.67
2042	48	1,800.00	0.027795	50.03	0.241999	435.60
2043	49	1,800.00	0.025796	46.43	0.234950	422.91
2044	50	1,800.00	0.023941	43.09	0.228107	410.59
2045	51	1,800.00	0.022219	39.99	0.221463	398.63
2046	52	1,800.00	0.020621	37.12	0.215013	387.02
2047	53	1,800.00	0.019137	34.45	0.208750	375.75
2048	54	1,800.00	0.017761	31.97	0.202670	364.81

Table A-1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS5b – CONT

Implementation year = 2010
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	1,800.00	0.016484	29.67	0.196767	354.18
2050	56	30,100.00	0.015298	460.47	0.191036	5750.19
2051	57	1,800.00	0.014198	25.56	0.185472	333.85
2052	58	1,800.00	0.013176	23.72	0.180070	324.13
2053	59	1,800.00	0.012229	22.01	0.174825	314.69
2054	60	1,800.00	0.011349	20.43	0.169733	305.52
2055	61	1,800.00	0.010533	18.96	0.164789	296.62
2056	62	1,800.00	0.009775	17.60	0.159990	287.98
2057	63	1,800.00	0.009072	16.33	0.155330	279.59
2058	64	1,800.00	0.008420	15.16	0.150806	271.45
2059	65	1,800.00	0.007814	14.07	0.146413	263.54
2060	66	1,800.00	0.007252	13.05	0.142149	255.87
2061	67	1,800.00	0.006730	12.11	0.138009	248.42
2062	68	1,800.00	0.006246	11.24	0.133989	241.18
2063	69	1,800.00	0.005797	10.43	0.130086	234.16
2064	70	1,800.00	0.005380	9.68	0.126297	227.34
2065	71	1,800.00	0.004993	8.99	0.122619	220.71
2066	72	1,800.00	0.004634	8.34	0.119047	214.29
2067	73	1,800.00	0.004301	7.74	0.115580	208.04
2068	74	1,800.00	0.003991	7.18	0.112214	201.98
2069	75	1,800.00	0.003704	6.67	0.108945	196.10
2070	76	30,100.00	0.003438	103.48	0.105772	3183.74
2071	77	1,800.00	0.003191	5.74	0.102691	184.84
2072	78	1,800.00	0.002961	5.33	0.099700	179.46
2073	79	1,800.00	0.002748	4.95	0.096796	174.23
2074	80	1,800.00	0.002550	4.59	0.093977	169.16
2075	81	1,800.00	0.002367	4.26	0.091240	164.23
2076	82	1,800.00	0.002197	3.95	0.088582	159.45

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2077	83	1,800.00	0.002039	3.67	0.086002	154.80
2078	84	1,800.00	0.001892	3.41	0.083497	150.30
2079	85	1,800.00	0.001756	3.16	0.081065	145.92
2080	86	1,800.00	0.001630	2.93	0.078704	141.67
2081	87	1,800.00	0.001513	2.72	0.076412	137.54
2082	88	1,800.00	0.001404	2.53	0.074186	133.54
2083	89	1,800.00	0.001303	2.34	0.072026	129.65
2084	90	1,800.00	0.001209	2.18	0.069928	125.87
2085	91	1,800.00	0.001122	2.02	0.067891	122.20
2086	92	1,800.00	0.001041	1.87	0.065914	118.64
2087	93	1,800.00	0.000966	1.74	0.063994	115.19
2088	94	1,800.00	0.000897	1.61	0.062130	111.83
2089	95	1,800.00	0.000832	1.50	0.060320	108.58
2090	96	30,100.00	0.000773	23.25	0.058563	1762.76
2091	97	1,800.00	0.000717	1.29	0.056858	102.34
2092	98	1,800.00	0.000665	1.20	0.055202	99.36
2093	99	1,800.00	0.000618	1.11	0.053594	96.47
2094	100	1,800.00	0.000573	1.03	0.052033	93.66
			Sum of PW	18,618.54	Sum of PW	72,846.80
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				----------		----------
			An. Equiv =	1,443.765	An. Equiv =	2,305.358

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS5c						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	30,138.00	0.638993	19,257.98	0.837484	25240.10
2001	7	1,838.00	0.593033	1,090.00	0.813092	1494.46
2002	8	1,838.00	0.550379	1,011.60	0.789409	1450.93
2003	9	1,838.00	0.510792	938.84	0.766417	1408.67
2004	10	1,838.00	0.474053	871.31	0.744094	1367.64
2005	11	1,838.00	0.439957	808.64	0.722421	1327.81
2006	12	1,838.00	0.408312	750.48	0.701380	1289.14
2007	13	1,838.00	0.378944	696.50	0.680951	1251.59
2008	14	1,838.00	0.351688	646.40	0.661118	1215.13
2009	15	1,838.00	0.326393	599.91	0.641862	1179.74
2010	16	1,838.00	0.302917	556.76	0.623167	1145.38
2011	17	1,838.00	0.281129	516.72	0.605016	1112.02
2012	18	1,838.00	0.260909	479.55	0.587395	1079.63
2013	19	1,838.00	0.242143	445.06	0.570286	1048.19
2014	20	1,838.00	0.224727	413.05	0.553676	1017.66
2015	21	1,838.00	0.208563	383.34	0.537549	988.02
2016	22	1,838.00	0.193562	355.77	0.521893	959.24
2017	23	1,838.00	0.179640	330.18	0.506692	931.30
2018	24	1,838.00	0.166719	306.43	0.491934	904.17
2019	25	1,838.00	0.154728	284.39	0.477606	877.84
2020	26	30,138.00	0.143599	4,327.78	0.463695	13974.83
2021	27	1,838.00	0.133270	244.95	0.450189	827.45
2022	28	1,838.00	0.123685	227.33	0.437077	803.35

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS5c – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2023	29	1,838.00	0.114789	210.98	0.424346	779.95
2024	30	1,838.00	0.106532	195.81	0.411987	757.23
2025	31	1,838.00	0.098870	181.72	0.399987	735.18
2026	32	1,838.00	0.091759	168.65	0.388337	713.76
2027	33	1,838.00	0.085159	156.52	0.377026	692.97
2028	34	1,838.00	0.079034	145.26	0.366045	672.79
2029	35	1,838.00	0.073349	134.82	0.355383	653.19
2030	36	1,838.00	0.068073	125.12	0.345032	634.17
2031	37	1,838.00	0.063177	116.12	0.334983	615.70
2032	38	1,838.00	0.058633	107.77	0.325226	597.77
2033	39	1,838.00	0.054416	100.02	0.315754	580.36
2034	40	1,838.00	0.050502	92.82	0.306557	563.45
2035	41	1,838.00	0.046870	86.15	0.297628	547.04
2036	42	1,838.00	0.043499	79.95	0.288959	531.11
2037	43	1,838.00	0.040370	74.20	0.280543	515.64
2038	44	1,838.00	0.037466	68.86	0.272372	500.62
2039	45	1,838.00	0.034771	63.91	0.264439	486.04
2040	46	30,138.00	0.032270	972.57	0.256737	7737.53
2041	47	1,838.00	0.029949	55.05	0.249259	458.14
2042	48	1,838.00	0.027795	51.09	0.241999	444.79
2043	49	1,838.00	0.025796	47.41	0.234950	431.84
2044	50	1,838.00	0.023941	44.00	0.228107	419.26
2045	51	1,838.00	0.022219	40.84	0.221463	407.05
2046	52	1,838.00	0.020621	37.90	0.215013	395.19
2047	53	1,838.00	0.019137	35.17	0.208750	383.68
2048	54	1,838.00	0.017761	32.64	0.202670	372.51
2049	55	1,838.00	0.016484	30.30	0.196767	361.66
2050	56	1,838.00	0.015298	28.12	0.191036	351.12

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS5c – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2051	57	1,838.00	0.014198	26.10	0.185472	340.90
2052	58	1,838.00	0.013176	24.22	0.180070	330.97
2053	59	1,838.00	0.012229	22.48	0.174825	321.33
2054	60	1,838.00	0.011349	20.86	0.169733	311.97
2055	61	1,838.00	0.010533	19.36	0.164789	302.88
2056	62	1,838.00	0.009775	17.97	0.159990	294.06
2057	63	1,838.00	0.009072	16.67	0.155330	285.50
2058	64	1,838.00	0.008420	15.48	0.150806	277.18
2059	65	1,838.00	0.007814	14.36	0.146413	269.11
2060	66	30,138.00	0.007252	218.56	0.142149	4284.08
2061	67	1,838.00	0.006730	12.37	0.138009	253.66
2062	68	1,838.00	0.006246	11.48	0.133989	246.27
2063	69	1,838.00	0.005797	10.65	0.130086	239.10
2064	70	1,838.00	0.005380	9.89	0.126297	232.13
2065	71	1,838.00	0.004993	9.18	0.122619	225.37
2066	72	1,838.00	0.004634	8.52	0.119047	218.81
2067	73	1,838.00	0.004301	7.90	0.115580	212.44
2068	74	1,838.00	0.003991	7.34	0.112214	206.25
2069	75	1,838.00	0.003704	6.81	0.108945	200.24
2070	76	1,838.00	0.003438	6.32	0.105772	194.41
2071	77	1,838.00	0.003191	5.86	0.102691	188.75
2072	78	1,838.00	0.002961	5.44	0.099700	183.25
2073	79	1,838.00	0.002748	5.05	0.096796	177.91
2074	80	1,838.00	0.002550	4.69	0.093977	172.73
2075	81	1,838.00	0.002367	4.35	0.091240	167.70
2076	82	1,838.00	0.002197	4.04	0.088582	162.81
2077	83	1,838.00	0.002039	3.75	0.086002	158.07
2078	84	1,838.00	0.001892	3.48	0.083497	153.47

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS5c – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2079	85	1,838.00	0.001756	3.23	0.081065	149.00
2080	86	30,138.00	0.001630	49.12	0.078704	2371.99
2081	87	1,838.00	0.001513	2.78	0.076412	140.45
2082	88	1,838.00	0.001404	2.58	0.074186	136.35
2083	89	1,838.00	0.001303	2.39	0.072026	132.38
2084	90	1,838.00	0.001209	2.22	0.069928	128.53
2085	91	1,838.00	0.001122	2.06	0.067891	124.78
2086	92	1,838.00	0.001041	1.91	0.065914	121.15
2087	93	1,838.00	0.000966	1.78	0.063994	117.62
2088	94	1,838.00	0.000897	1.65	0.062130	114.19
2089	95	1,838.00	0.000832	1.53	0.060320	110.87
2090	96	1,838.00	0.000773	1.42	0.058563	107.64
2091	97	1,838.00	0.000717	1.32	0.056858	104.50
2092	98	1,838.00	0.000665	1.22	0.055202	101.46
2093	99	1,838.00	0.000618	1.14	0.053594	98.51
2094	100	1,838.00	0.000573	1.05	0.052033	95.64
			Sum of PW	39,627.29	Sum of PW	100,000.44
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	3,072.876	An. Equiv =	3,164.680

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS6b						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	15,889.00	0.439957	6,990.47	0.722421	11478.55
2006	12	889.00	0.408312	362.99	0.701380	623.53
2007	13	889.00	0.378944	336.88	0.680951	605.37
2008	14	889.00	0.351688	312.65	0.661118	587.73
2009	15	889.00	0.326393	290.16	0.641862	570.62
2010	16	889.00	0.302917	269.29	0.623167	554.00
2011	17	889.00	0.281129	249.92	0.605016	537.86
2012	18	889.00	0.260909	231.95	0.587395	522.19
2013	19	889.00	0.242143	215.27	0.570286	506.98
2014	20	889.00	0.224727	199.78	0.553676	492.22
2015	21	889.00	0.208563	185.41	0.537549	477.88
2016	22	889.00	0.193562	172.08	0.521893	463.96
2017	23	889.00	0.179640	159.70	0.506692	450.45
2018	24	889.00	0.166719	148.21	0.491934	437.33
2019	25	889.00	0.154728	137.55	0.477606	424.59
2020	26	889.00	0.143599	127.66	0.463695	412.22
2021	27	889.00	0.133270	118.48	0.450189	400.22
2022	28	889.00	0.123685	109.96	0.437077	388.56

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS6b – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2023	29	889.00	0.114789	102.05	0.424346	377.24
2024	30	889.00	0.106532	94.71	0.411987	366.26
2025	31	15,889.00	0.098870	1,570.94	0.399987	6355.40
2026	32	889.00	0.091759	81.57	0.388337	345.23
2027	33	889.00	0.085159	75.71	0.377026	335.18
2028	34	889.00	0.079034	70.26	0.366045	325.41
2029	35	889.00	0.073349	65.21	0.355383	315.94
2030	36	889.00	0.068073	60.52	0.345032	306.73
2031	37	889.00	0.063177	56.16	0.334983	297.80
2032	38	889.00	0.058633	52.12	0.325226	289.13
2033	39	889.00	0.054416	48.38	0.315754	280.70
2034	40	889.00	0.050502	44.90	0.306557	272.53
2035	41	889.00	0.046870	41.67	0.297628	264.59
2036	42	889.00	0.043499	38.67	0.288959	256.88
2037	43	889.00	0.040370	35.89	0.280543	249.40
2038	44	889.00	0.037466	33.31	0.272372	242.14
2039	45	889.00	0.034771	30.91	0.264439	235.09
2040	46	889.00	0.032270	28.69	0.256737	228.24
2041	47	889.00	0.029949	26.63	0.249259	221.59
2042	48	889.00	0.027795	24.71	0.241999	215.14
2043	49	889.00	0.025796	22.93	0.234950	208.87
2044	50	889.00	0.023941	21.28	0.228107	202.79
2045	51	15,889.00	0.022219	353.03	0.221463	3518.83
2046	52	889.00	0.020621	18.33	0.215013	191.15
2047	53	889.00	0.019137	17.01	0.208750	185.58
2048	54	889.00	0.017761	15.79	0.202670	180.17
2049	55	889.00	0.016484	14.65	0.196767	174.93
2050	56	889.00	0.015298	13.60	0.191036	169.83

Table A-1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS6b – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2051	57	889.00	0.014198	12.62	0.185472	164.88
2052	58	889.00	0.013176	11.71	0.180070	160.08
2053	59	889.00	0.012229	10.87	0.174825	155.42
2054	60	889.00	0.011349	10.09	0.169733	150.89
2055	61	889.00	0.010533	9.36	0.164789	146.50
2056	62	889.00	0.009775	8.69	0.159990	142.23
2057	63	889.00	0.009072	8.07	0.155330	138.09
2058	64	889.00	0.008420	7.49	0.150806	134.07
2059	65	889.00	0.007814	6.95	0.146413	130.16
2060	66	889.00	0.007252	6.45	0.142149	126.37
2061	67	889.00	0.006730	5.98	0.138009	122.69
2062	68	889.00	0.006246	5.55	0.133989	119.12
2063	69	889.00	0.005797	5.15	0.130086	115.65
2064	70	889.00	0.005380	4.78	0.126297	112.28
2065	71	15,889.00	0.004993	79.34	0.122619	1948.29
2066	72	889.00	0.004634	4.12	0.119047	105.83
2067	73	889.00	0.004301	3.82	0.115580	102.75
2068	74	889.00	0.003991	3.55	0.112214	99.76
2069	75	889.00	0.003704	3.29	0.108945	96.85
2070	76	889.00	0.003438	3.06	0.105772	94.03
2071	77	889.00	0.003191	2.84	0.102691	91.29
2072	78	889.00	0.002961	2.63	0.099700	88.63
2073	79	889.00	0.002748	2.44	0.096796	86.05
2074	80	889.00	0.002550	2.27	0.093977	83.55
2075	81	889.00	0.002367	2.10	0.091240	81.11
2076	82	889.00	0.002197	1.95	0.088582	78.75
2077	83	889.00	0.002039	1.81	0.086002	76.46
2078	84	889.00	0.001892	1.68	0.083497	74.23

Table A-1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS6b – CONT

Implementation year = 2005
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2079	85	889.00	0.001756	1.56	0.081065	72.07
2080	86	889.00	0.001630	1.45	0.078704	69.97
2081	87	889.00	0.001513	1.34	0.076412	67.93
2082	88	889.00	0.001404	1.25	0.074186	65.95
2083	89	889.00	0.001303	1.16	0.072026	64.03
2084	90	889.00	0.001209	1.07	0.069928	62.17
2085	91	15,889.00	0.001122	17.83	0.067891	1078.72
2086	92	889.00	0.001041	0.93	0.065914	58.60
2087	93	889.00	0.000966	0.86	0.063994	56.89
2088	94	889.00	0.000897	0.80	0.062130	55.23
2089	95	889.00	0.000832	0.74	0.060320	53.62
2090	96	889.00	0.000773	0.69	0.058563	52.06
2091	97	889.00	0.000717	0.64	0.056858	50.55
2092	98	889.00	0.000665	0.59	0.055202	49.07
2093	99	889.00	0.000618	0.55	0.053594	47.64
2094	100	889.00	0.000573	0.51	0.052033	46.26
			Sum of PW	13,938.68	Sum of PW	43,523.80
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	1,080.868	An. Equiv =	1,377.383

Table A-1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS9a

Implementation year = 2005
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	15,890.00	0.439957	6,990.91	0.722421	11479.27
2006	12	890.00	0.408312	363.40	0.701380	624.23
2007	13	890.00	0.378944	337.26	0.680951	606.05
2008	14	890.00	0.351688	313.00	0.661118	588.39
2009	15	890.00	0.326393	290.49	0.641862	571.26
2010	16	890.00	0.302917	269.60	0.623167	554.62
2011	17	890.00	0.281129	250.21	0.605016	538.46
2012	18	890.00	0.260909	232.21	0.587395	522.78
2013	19	890.00	0.242143	215.51	0.570286	507.55
2014	20	890.00	0.224727	200.01	0.553676	492.77
2015	21	890.00	0.208563	185.62	0.537549	478.42
2016	22	890.00	0.193562	172.27	0.521893	464.48
2017	23	890.00	0.179640	159.88	0.506692	450.96
2018	24	890.00	0.166719	148.38	0.491934	437.82
2019	25	890.00	0.154728	137.71	0.477606	425.07
2020	26	890.00	0.143599	127.80	0.463695	412.69
2021	27	890.00	0.133270	118.61	0.450189	400.67
2022	28	890.00	0.123685	110.08	0.437077	389.00

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2023	29	890.00	0.114789	102.16	0.424346	377.67
2024	30	890.00	0.106532	94.81	0.411987	366.67
2025	31	15,890.00	0.098870	1,571.04	0.399987	6355.80
2026	32	890.00	0.091759	81.67	0.388337	345.62
2027	33	890.00	0.085159	75.79	0.377026	335.55
2028	34	890.00	0.079034	70.34	0.366045	325.78
2029	35	890.00	0.073349	65.28	0.355383	316.29
2030	36	890.00	0.068073	60.59	0.345032	307.08
2031	37	890.00	0.063177	56.23	0.334983	298.13
2032	38	890.00	0.058633	52.18	0.325226	289.45
2033	39	890.00	0.054416	48.43	0.315754	281.02
2034	40	890.00	0.050502	44.95	0.306557	272.84
2035	41	890.00	0.046870	41.71	0.297628	264.89
2036	42	890.00	0.043499	38.71	0.288959	257.17
2037	43	890.00	0.040370	35.93	0.280543	249.68
2038	44	890.00	0.037466	33.34	0.272372	242.41
2039	45	890.00	0.034771	30.95	0.264439	235.35
2040	46	890.00	0.032270	28.72	0.256737	228.50
2041	47	890.00	0.029949	26.65	0.249259	221.84
2042	48	890.00	0.027795	24.74	0.241999	215.38
2043	49	890.00	0.025796	22.96	0.234950	209.11
2044	50	890.00	0.023941	21.31	0.228107	203.02
2045	51	15,890.00	0.022219	353.06	0.221463	3519.05
2046	52	890.00	0.020621	18.35	0.215013	191.36
2047	53	890.00	0.019137	17.03	0.208750	185.79
2048	54	890.00	0.017761	15.81	0.202670	180.38
2049	55	890.00	0.016484	14.67	0.196767	175.12

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2050	56	890.00	0.015298	13.62	0.191036	170.02
2051	57	890.00	0.014198	12.64	0.185472	165.07
2052	58	890.00	0.013176	11.73	0.180070	160.26
2053	59	890.00	0.012229	10.88	0.174825	155.59
2054	60	890.00	0.011349	10.10	0.169733	151.06
2055	61	890.00	0.010533	9.37	0.164789	146.66
2056	62	890.00	0.009775	8.70	0.159990	142.39
2057	63	890.00	0.009072	8.07	0.155330	138.24
2058	64	890.00	0.008420	7.49	0.150806	134.22
2059	65	890.00	0.007814	6.95	0.146413	130.31
2060	66	890.00	0.007252	6.45	0.142149	126.51
2061	67	890.00	0.006730	5.99	0.138009	122.83
2062	68	890.00	0.006246	5.56	0.133989	119.25
2063	69	890.00	0.005797	5.16	0.130086	115.78
2064	70	890.00	0.005380	4.79	0.126297	112.40
2065	71	15,890.00	0.004993	79.34	0.122619	1948.41
2066	72	890.00	0.004634	4.12	0.119047	105.95
2067	73	890.00	0.004301	3.83	0.115580	102.87
2068	74	890.00	0.003991	3.55	0.112214	99.87
2069	75	890.00	0.003704	3.30	0.108945	96.96
2070	76	890.00	0.003438	3.06	0.105772	94.14
2071	77	890.00	0.003191	2.84	0.102691	91.40
2072	78	890.00	0.002961	2.64	0.099700	88.73
2073	79	890.00	0.002748	2.45	0.096796	86.15
2074	80	890.00	0.002550	2.27	0.093977	83.64
2075	81	890.00	0.002367	2.11	0.091240	81.20
2076	82	890.00	0.002197	1.96	0.088582	78.84

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2077	83	890.00	0.002039	1.81	0.086002	76.54
2078	84	890.00	0.001892	1.68	0.083497	74.31
2079	85	890.00	0.001756	1.56	0.081065	72.15
2080	86	890.00	0.001630	1.45	0.078704	70.05
2081	87	890.00	0.001513	1.35	0.076412	68.01
2082	88	890.00	0.001404	1.25	0.074186	66.03
2083	89	890.00	0.001303	1.16	0.072026	64.10
2084	90	890.00	0.001209	1.08	0.069928	62.24
2085	91	15,890.00	0.001122	17.83	0.067891	1078.79
2086	92	890.00	0.001041	0.93	0.065914	58.66
2087	93	890.00	0.000966	0.86	0.063994	56.95
2088	94	890.00	0.000897	0.80	0.062130	55.30
2089	95	890.00	0.000832	0.74	0.060320	53.69
2090	96	890.00	0.000773	0.69	0.058563	52.12
2091	97	890.00	0.000717	0.64	0.056858	50.60
2092	98	890.00	0.000665	0.59	0.055202	49.13
2093	99	890.00	0.000618	0.55	0.053594	47.70
2094	100	890.00	0.000573	0.51	0.052033	46.31
			Sum of PW	13,944.79	Sum of PW	43,546.87
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				----------		----------
			An. Equiv =	1,081.341	An. Equiv =	1,378.113

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS9c						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	16,910.00	0.439957	7,439.67	0.722421	12216.14
2006	12	890.00	0.408312	363.40	0.701380	624.23
2007	13	890.00	0.378944	337.26	0.680951	606.05
2008	14	890.00	0.351688	313.00	0.661118	588.39
2009	15	890.00	0.326393	290.49	0.641862	571.26
2010	16	890.00	0.302917	269.60	0.623167	554.62
2011	17	890.00	0.281129	250.21	0.605016	538.46
2012	18	890.00	0.260909	232.21	0.587395	522.78
2013	19	890.00	0.242143	215.51	0.570286	507.55
2014	20	890.00	0.224727	200.01	0.553676	492.77
2015	21	890.00	0.208563	185.62	0.537549	478.42
2016	22	890.00	0.193562	172.27	0.521893	464.48
2017	23	890.00	0.179640	159.88	0.506692	450.96
2018	24	890.00	0.166719	148.38	0.491934	437.82
2019	25	890.00	0.154728	137.71	0.477606	425.07
2020	26	890.00	0.143599	127.80	0.463695	412.69
2021	27	890.00	0.133270	118.61	0.450189	400.67

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS9c – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	890.00	0.123685	110.08	0.437077	389.00
2023	29	890.00	0.114789	102.16	0.424346	377.67
2024	30	890.00	0.106532	94.81	0.411987	366.67
2025	31	16,910.00	0.098870	1,671.89	0.399987	6763.78
2026	32	890.00	0.091759	81.67	0.388337	345.62
2027	33	890.00	0.085159	75.79	0.377026	335.55
2028	34	890.00	0.079034	70.34	0.366045	325.78
2029	35	890.00	0.073349	65.28	0.355383	316.29
2030	36	890.00	0.068073	60.59	0.345032	307.08
2031	37	890.00	0.063177	56.23	0.334983	298.13
2032	38	890.00	0.058633	52.18	0.325226	289.45
2033	39	890.00	0.054416	48.43	0.315754	281.02
2034	40	890.00	0.050502	44.95	0.306557	272.84
2035	41	890.00	0.046870	41.71	0.297628	264.89
2036	42	890.00	0.043499	38.71	0.288959	257.17
2037	43	890.00	0.040370	35.93	0.280543	249.68
2038	44	890.00	0.037466	33.34	0.272372	242.41
2039	45	890.00	0.034771	30.95	0.264439	235.35
2040	46	890.00	0.032270	28.72	0.256737	228.50
2041	47	890.00	0.029949	26.65	0.249259	221.84
2042	48	890.00	0.027795	24.74	0.241999	215.38
2043	49	890.00	0.025796	22.96	0.234950	209.11
2044	50	890.00	0.023941	21.31	0.228107	203.02
2045	51	16,910.00	0.022219	375.72	0.221463	3744.94
2046	52	890.00	0.020621	18.35	0.215013	191.36
2047	53	890.00	0.019137	17.03	0.208750	185.79
2048	54	890.00	0.017761	15.81	0.202670	180.38

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS9c – CONT

Implementation year = 2005
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2049	55	890.00	0.016484	14.67	0.196767	175.12
2050	56	890.00	0.015298	13.62	0.191036	170.02
2051	57	890.00	0.014198	12.64	0.185472	165.07
2052	58	890.00	0.013176	11.73	0.180070	160.26
2053	59	890.00	0.012229	10.88	0.174825	155.59
2054	60	890.00	0.011349	10.10	0.169733	151.06
2055	61	890.00	0.010533	9.37	0.164789	146.66
2056	62	890.00	0.009775	8.70	0.159990	142.39
2057	63	890.00	0.009072	8.07	0.155330	138.24
2058	64	890.00	0.008420	7.49	0.150806	134.22
2059	65	890.00	0.007814	6.95	0.146413	130.31
2060	66	890.00	0.007252	6.45	0.142149	126.51
2061	67	890.00	0.006730	5.99	0.138009	122.83
2062	68	890.00	0.006246	5.56	0.133989	119.25
2063	69	890.00	0.005797	5.16	0.130086	115.78
2064	70	890.00	0.005380	4.79	0.126297	112.40
2065	71	16,910.00	0.004993	84.43	0.122619	2073.48
2066	72	890.00	0.004634	4.12	0.119047	105.95
2067	73	890.00	0.004301	3.83	0.115580	102.87
2068	74	890.00	0.003991	3.55	0.112214	99.87
2069	75	890.00	0.003704	3.30	0.108945	96.96
2070	76	890.00	0.003438	3.06	0.105772	94.14
2071	77	890.00	0.003191	2.84	0.102691	91.40
2072	78	890.00	0.002961	2.64	0.099700	88.73
2073	79	890.00	0.002748	2.45	0.096796	86.15
2074	80	890.00	0.002550	2.27	0.093977	83.64
2075	81	890.00	0.002367	2.11	0.091240	81.20

Table A–1. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – Ice Harbor – CONT

SOS9c – CONT

Implementation year = 2005
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	890.00	0.002197	1.96	0.088582	78.84
2077	83	890.00	0.002039	1.81	0.086002	76.54
2078	84	890.00	0.001892	1.68	0.083497	74.31
2079	85	890.00	0.001756	1.56	0.081065	72.15
2080	86	890.00	0.001630	1.45	0.078704	70.05
2081	87	890.00	0.001513	1.35	0.076412	68.01
2082	88	890.00	0.001404	1.25	0.074186	66.03
2083	89	890.00	0.001303	1.16	0.072026	64.10
2084	90	890.00	0.001209	1.08	0.069928	62.24
2085	91	16,910.00	0.001122	18.97	0.067891	1148.04
2086	92	890.00	0.001041	0.93	0.065914	58.66
2087	93	890.00	0.000966	0.86	0.063994	56.95
2088	94	890.00	0.000897	0.80	0.062130	55.30
2089	95	890.00	0.000832	0.74	0.060320	53.69
2090	96	890.00	0.000773	0.69	0.058563	52.12
2091	97	890.00	0.000717	0.64	0.056858	50.60
2092	98	890.00	0.000665	0.59	0.055202	49.13
2093	99	890.00	0.000618	0.55	0.053594	47.70
2094	100	890.00	0.000573	0.51	0.052033	46.31
			Sum of PW	14,523.30	Sum of PW	45,111.94
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				----------		----------
			An. Equiv =	1,126.201	An. Equiv =	1,427.642

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day

SOS5b						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	0.00	0.439957	0.00	0.722421	0.00
2006	12	0.00	0.408312	0.00	0.701380	0.00
2007	13	0.00	0.378944	0.00	0.680951	0.00
2008	14	0.00	0.351688	0.00	0.661118	0.00
2009	15	0.00	0.326393	0.00	0.641862	0.00
2010	16	15,004.00	0.302917	4,544.97	0.623167	9350.00
2011	17	664.00	0.281129	186.67	0.605016	401.73
2012	18	664.00	0.260909	173.24	0.587395	390.03
2013	19	664.00	0.242143	160.78	0.570286	378.67
2014	20	664.00	0.224727	149.22	0.553676	367.64
2015	21	664.00	0.208563	138.49	0.537549	356.93
2016	22	664.00	0.193562	128.53	0.521893	346.54
2017	23	664.00	0.179640	119.28	0.506692	336.44
2018	24	664.00	0.166719	110.70	0.491934	326.64
2019	25	664.00	0.154728	102.74	0.477606	317.13
2020	26	664.00	0.143599	95.35	0.463695	307.89
2021	27	664.00	0.133270	88.49	0.450189	298.93
2022	28	664.00	0.123685	82.13	0.437077	290.22

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS5b – CONT

Implementation year = 2010
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2023	29	664.00	0.114789	76.22	0.424346	281.77
2024	30	664.00	0.106532	70.74	0.411987	273.56
2025	31	664.00	0.098870	65.65	0.399987	265.59
2026	32	664.00	0.091759	60.93	0.388337	257.86
2027	33	664.00	0.085159	56.55	0.377026	250.35
2028	34	664.00	0.079034	52.48	0.366045	243.05
2029	35	664.00	0.073349	48.70	0.355383	235.97
2030	36	15,004.00	0.068073	1,021.37	0.345032	5176.87
2031	37	664.00	0.063177	41.95	0.334983	222.43
2032	38	664.00	0.058633	38.93	0.325226	215.95
2033	39	664.00	0.054416	36.13	0.315754	209.66
2034	40	664.00	0.050502	33.53	0.306557	203.55
2035	41	664.00	0.046870	31.12	0.297628	197.62
2036	42	664.00	0.043499	28.88	0.288959	191.87
2037	43	664.00	0.040370	26.81	0.280543	186.28
2038	44	664.00	0.037466	24.88	0.272372	180.85
2039	45	664.00	0.034771	23.09	0.264439	175.59
2040	46	664.00	0.032270	21.43	0.256737	170.47
2041	47	664.00	0.029949	19.89	0.249259	165.51
2042	48	664.00	0.027795	18.46	0.241999	160.69
2043	49	664.00	0.025796	17.13	0.234950	156.01
2044	50	664.00	0.023941	15.90	0.228107	151.46
2045	51	664.00	0.022219	14.75	0.221463	147.05
2046	52	664.00	0.020621	13.69	0.215013	142.77
2047	53	664.00	0.019137	12.71	0.208750	138.61
2048	54	664.00	0.017761	11.79	0.202670	134.57
2049	55	664.00	0.016484	10.95	0.196767	130.65

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2050	56	15,004.00	0.015298	229.53	0.191036	2866.31
2051	57	664.00	0.014198	9.43	0.185472	123.15
2052	58	664.00	0.013176	8.75	0.180070	119.57
2053	59	664.00	0.012229	8.12	0.174825	116.08
2054	60	664.00	0.011349	7.54	0.169733	112.70
2055	61	664.00	0.010533	6.99	0.164789	109.42
2056	62	664.00	0.009775	6.49	0.159990	106.23
2057	63	664.00	0.009072	6.02	0.155330	103.14
2058	64	664.00	0.008420	5.59	0.150806	100.13
2059	65	664.00	0.007814	5.19	0.146413	97.22
2060	66	664.00	0.007252	4.82	0.142149	94.39
2061	67	664.00	0.006730	4.47	0.138009	91.64
2062	68	664.00	0.006246	4.15	0.133989	88.97
2063	69	664.00	0.005797	3.85	0.130086	86.38
2064	70	664.00	0.005380	3.57	0.126297	83.86
2065	71	664.00	0.004993	3.32	0.122619	81.42
2066	72	664.00	0.004634	3.08	0.119047	79.05
2067	73	664.00	0.004301	2.86	0.115580	76.75
2068	74	664.00	0.003991	2.65	0.112214	74.51
2069	75	664.00	0.003704	2.46	0.108945	72.34
2070	76	15,004.00	0.003438	51.58	0.105772	1587.00
2071	77	664.00	0.003191	2.12	0.102691	68.19
2072	78	664.00	0.002961	1.97	0.099700	66.20
2073	79	664.00	0.002748	1.82	0.096796	64.27
2074	80	664.00	0.002550	1.69	0.093977	62.40
2075	81	664.00	0.002367	1.57	0.091240	60.58
2076	82	664.00	0.002197	1.46	0.088582	58.82

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS5b – CONT

Implementation year = 2010
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2077	83	664.00	0.002039	1.35	0.086002	57.11
2078	84	664.00	0.001892	1.26	0.083497	55.44
2079	85	664.00	0.001756	1.17	0.081065	53.83
2080	86	664.00	0.001630	1.08	0.078704	52.26
2081	87	664.00	0.001513	1.00	0.076412	50.74
2082	88	664.00	0.001404	0.93	0.074186	49.26
2083	89	664.00	0.001303	0.87	0.072026	47.83
2084	90	664.00	0.001209	0.80	0.069928	46.43
2085	91	664.00	0.001122	0.75	0.067891	45.08
2086	92	664.00	0.001041	0.69	0.065914	43.77
2087	93	664.00	0.000966	0.64	0.063994	42.49
2088	94	664.00	0.000897	0.60	0.062130	41.25
2089	95	664.00	0.000832	0.55	0.060320	40.05
2090	96	15,004.00	0.000773	11.59	0.058563	878.69
2091	97	664.00	0.000717	0.48	0.056858	37.75
2092	98	664.00	0.000665	0.44	0.055202	36.65
2093	99	664.00	0.000618	0.41	0.053594	35.59
2094	100	664.00	0.000573	0.38	0.052033	34.55
			Sum of PW	8,391.29	Sum of PW	32,034.89
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	650.698	An. Equiv =	1,013.798

Table A-2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS5c & 6d						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	15,004.00	0.638993	9,587.46	0.837484	12565.61
2001	7	664.00	0.593033	393.77	0.813092	539.89
2002	8	664.00	0.550379	365.45	0.789409	524.17
2003	9	664.00	0.510792	339.17	0.766417	508.90
2004	10	664.00	0.474053	314.77	0.744094	494.08
2005	11	664.00	0.439957	292.13	0.722421	479.69
2006	12	664.00	0.408312	271.12	0.701380	465.72
2007	13	664.00	0.378944	251.62	0.680951	452.15
2008	14	664.00	0.351688	233.52	0.661118	438.98
2009	15	664.00	0.326393	216.72	0.641862	426.20
2010	16	664.00	0.302917	201.14	0.623167	413.78
2011	17	664.00	0.281129	186.67	0.605016	401.73
2012	18	664.00	0.260909	173.24	0.587395	390.03
2013	19	664.00	0.242143	160.78	0.570286	378.67
2014	20	664.00	0.224727	149.22	0.553676	367.64
2015	21	664.00	0.208563	138.49	0.537549	356.93
2016	22	664.00	0.193562	128.53	0.521893	346.54
2017	23	664.00	0.179640	119.28	0.506692	336.44
2018	24	664.00	0.166719	110.70	0.491934	326.64
2019	25	664.00	0.154728	102.74	0.477606	317.13
2020	26	15,004.00	0.143599	2,154.56	0.463695	6957.28
2021	27	664.00	0.133270	88.49	0.450189	298.93

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS5c & 6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	664.00	0.123685	82.13	0.437077	290.22
2023	29	664.00	0.114789	76.22	0.424346	281.77
2024	30	664.00	0.106532	70.74	0.411987	273.56
2025	31	664.00	0.098870	65.65	0.399987	265.59
2026	32	664.00	0.091759	60.93	0.388337	257.86
2027	33	664.00	0.085159	56.55	0.377026	250.35
2028	34	664.00	0.079034	52.48	0.366045	243.05
2029	35	664.00	0.073349	48.70	0.355383	235.97
2030	36	664.00	0.068073	45.20	0.345032	229.10
2031	37	664.00	0.063177	41.95	0.334983	222.43
2032	38	664.00	0.058633	38.93	0.325226	215.95
2033	39	664.00	0.054416	36.13	0.315754	209.66
2034	40	664.00	0.050502	33.53	0.306557	203.55
2035	41	664.00	0.046870	31.12	0.297628	197.62
2036	42	664.00	0.043499	28.88	0.288959	191.87
2037	43	664.00	0.040370	26.81	0.280543	186.28
2038	44	664.00	0.037466	24.88	0.272372	180.85
2039	45	664.00	0.034771	23.09	0.264439	175.59
2040	46	15,004.00	0.032270	484.19	0.256737	3852.07
2041	47	664.00	0.029949	19.89	0.249259	165.51
2042	48	664.00	0.027795	18.46	0.241999	160.69
2043	49	664.00	0.025796	17.13	0.234950	156.01
2044	50	664.00	0.023941	15.90	0.228107	151.46
2045	51	664.00	0.022219	14.75	0.221463	147.05
2046	52	664.00	0.020621	13.69	0.215013	142.77
2047	53	664.00	0.019137	12.71	0.208750	138.61
2048	54	664.00	0.017761	11.79	0.202670	134.57

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS5c & 6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	**B**	**C**	**D**	**E**	**F**	**G**
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2049	55	664.00	0.016484	10.95	0.196767	130.65
2050	56	664.00	0.015298	10.16	0.191036	126.85
2051	57	664.00	0.014198	9.43	0.185472	123.15
2052	58	664.00	0.013176	8.75	0.180070	119.57
2053	59	664.00	0.012229	8.12	0.174825	116.08
2054	60	664.00	0.011349	7.54	0.169733	112.70
2055	61	664.00	0.010533	6.99	0.164789	109.42
2056	62	664.00	0.009775	6.49	0.159990	106.23
2057	63	664.00	0.009072	6.02	0.155330	103.14
2058	64	664.00	0.008420	5.59	0.150806	100.13
2059	65	664.00	0.007814	5.19	0.146413	97.22
2060	66	15,004.00	0.007252	108.81	0.142149	2132.80
2061	67	664.00	0.006730	4.47	0.138009	91.64
2062	68	664.00	0.006246	4.15	0.133989	88.97
2063	69	664.00	0.005797	3.85	0.130086	86.38
2064	70	664.00	0.005380	3.57	0.126297	83.86
2065	71	664.00	0.004993	3.32	0.122619	81.42
2066	72	664.00	0.004634	3.08	0.119047	79.05
2067	73	664.00	0.004301	2.86	0.115580	76.75
2068	74	664.00	0.003991	2.65	0.112214	74.51
2069	75	664.00	0.003704	2.46	0.108945	72.34
2070	76	664.00	0.003438	2.28	0.105772	70.23
2071	77	664.00	0.003191	2.12	0.102691	68.19
2072	78	664.00	0.002961	1.97	0.099700	66.20
2073	79	664.00	0.002748	1.82	0.096796	64.27
2074	80	664.00	0.002550	1.69	0.093977	62.40
2075	81	664.00	0.002367	1.57	0.091240	60.58

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS5c & 6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2076	82	664.00	0.002197	1.46	0.088582	58.82
2077	83	664.00	0.002039	1.35	0.086002	57.11
2078	84	664.00	0.001892	1.26	0.083497	55.44
2079	85	664.00	0.001756	1.17	0.081065	53.83
2080	86	15,004.00	0.001630	24.45	0.078704	1180.88
2081	87	664.00	0.001513	1.00	0.076412	50.74
2082	88	664.00	0.001404	0.93	0.074186	49.26
2083	89	664.00	0.001303	0.87	0.072026	47.83
2084	90	664.00	0.001209	0.80	0.069928	46.43
2085	91	664.00	0.001122	0.75	0.067891	45.08
2086	92	664.00	0.001041	0.69	0.065914	43.77
2087	93	664.00	0.000966	0.64	0.063994	42.49
2088	94	664.00	0.000897	0.60	0.062130	41.25
2089	95	664.00	0.000832	0.55	0.060320	40.05
2090	96	664.00	0.000773	0.51	0.058563	38.89
2091	97	664.00	0.000717	0.48	0.056858	37.75
2092	98	664.00	0.000665	0.44	0.055202	36.65
2093	99	664.00	0.000618	0.41	0.053594	35.59
2094	100	664.00	0.000573	0.38	0.052033	34.55
			Sum of PW	17,706.60	Sum of PW	43,448.29
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	1,373.049	An. Equiv =	1,374.994

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS6b						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	15,004.00	0.439957	6,601.11	0.722421	10839.21
2006	12	664.00	0.408312	271.12	0.701380	465.72
2007	13	664.00	0.378944	251.62	0.680951	452.15
2008	14	664.00	0.351688	233.52	0.661118	438.98
2009	15	664.00	0.326393	216.72	0.641862	426.20
2010	16	664.00	0.302917	201.14	0.623167	413.78
2011	17	664.00	0.281129	186.67	0.605016	401.73
2012	18	664.00	0.260909	173.24	0.587395	390.03
2013	19	664.00	0.242143	160.78	0.570286	378.67
2014	20	664.00	0.224727	149.22	0.553676	367.64
2015	21	664.00	0.208563	138.49	0.537549	356.93
2016	22	664.00	0.193562	128.53	0.521893	346.54
2017	23	664.00	0.179640	119.28	0.506692	336.44
2018	24	664.00	0.166719	110.70	0.491934	326.64
2019	25	664.00	0.154728	102.74	0.477606	317.13
2020	26	664.00	0.143599	95.35	0.463695	307.89
2021	27	664.00	0.133270	88.49	0.450189	298.93

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS6b – CONT

Implementation year = 2005
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2022	28	664.00	0.123685	82.13	0.437077	290.22
2023	29	664.00	0.114789	76.22	0.424346	281.77
2024	30	664.00	0.106532	70.74	0.411987	273.56
2025	31	15,004.00	0.098870	1,483.44	0.399987	6001.41
2026	32	664.00	0.091759	60.93	0.388337	257.86
2027	33	664.00	0.085159	56.55	0.377026	250.35
2028	34	664.00	0.079034	52.48	0.366045	243.05
2029	35	664.00	0.073349	48.70	0.355383	235.97
2030	36	664.00	0.068073	45.20	0.345032	229.10
2031	37	664.00	0.063177	41.95	0.334983	222.43
2032	38	664.00	0.058633	38.93	0.325226	215.95
2033	39	664.00	0.054416	36.13	0.315754	209.66
2034	40	664.00	0.050502	33.53	0.306557	203.55
2035	41	664.00	0.046870	31.12	0.297628	197.62
2036	42	664.00	0.043499	28.88	0.288959	191.87
2037	43	664.00	0.040370	26.81	0.280543	186.28
2038	44	664.00	0.037466	24.88	0.272372	180.85
2039	45	664.00	0.034771	23.09	0.264439	175.59
2040	46	664.00	0.032270	21.43	0.256737	170.47
2041	47	664.00	0.029949	19.89	0.249259	165.51
2042	48	664.00	0.027795	18.46	0.241999	160.69
2043	49	664.00	0.025796	17.13	0.234950	156.01
2044	50	664.00	0.023941	15.90	0.228107	151.46
2045	51	15,004.00	0.022219	333.37	0.221463	3322.83
2046	52	664.00	0.020621	13.69	0.215013	142.77
2047	53	664.00	0.019137	12.71	0.208750	138.61
2048	54	664.00	0.017761	11.79	0.202670	134.57

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS6b – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	664.00	0.016484	10.95	0.196767	130.65
2050	56	664.00	0.015298	10.16	0.191036	126.85
2051	57	664.00	0.014198	9.43	0.185472	123.15
2052	58	664.00	0.013176	8.75	0.180070	119.57
2053	59	664.00	0.012229	8.12	0.174825	116.08
2054	60	664.00	0.011349	7.54	0.169733	112.70
2055	61	664.00	0.010533	6.99	0.164789	109.42
2056	62	664.00	0.009775	6.49	0.159990	106.23
2057	63	664.00	0.009072	6.02	0.155330	103.14
2058	64	664.00	0.008420	5.59	0.150806	100.13
2059	65	664.00	0.007814	5.19	0.146413	97.22
2060	66	664.00	0.007252	4.82	0.142149	94.39
2061	67	664.00	0.006730	4.47	0.138009	91.64
2062	68	664.00	0.006246	4.15	0.133989	88.97
2063	69	664.00	0.005797	3.85	0.130086	86.38
2064	70	664.00	0.005380	3.57	0.126297	83.86
2065	71	15,004.00	0.004993	74.92	0.122619	1839.77
2066	72	664.00	0.004634	3.08	0.119047	79.05
2067	73	664.00	0.004301	2.86	0.115580	76.75
2068	74	664.00	0.003991	2.65	0.112214	74.51
2069	75	664.00	0.003704	2.46	0.108945	72.34
2070	76	664.00	0.003438	2.28	0.105772	70.23
2071	77	664.00	0.003191	2.12	0.102691	68.19
2072	78	664.00	0.002961	1.97	0.099700	66.20
2073	79	664.00	0.002748	1.82	0.096796	64.27
2074	80	664.00	0.002550	1.69	0.093977	62.40
2075	81	664.00	0.002367	1.57	0.091240	60.58

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS6b – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	664.00	0.002197	1.46	0.088582	58.82
2077	83	664.00	0.002039	1.35	0.086002	57.11
2078	84	664.00	0.001892	1.26	0.083497	55.44
2079	85	664.00	0.001756	1.17	0.081065	53.83
2080	86	664.00	0.001630	1.08	0.078704	52.26
2081	87	664.00	0.001513	1.00	0.076412	50.74
2082	88	664.00	0.001404	0.93	0.074186	49.26
2083	89	664.00	0.001303	0.87	0.072026	47.83
2084	90	664.00	0.001209	0.80	0.069928	46.43
2085	91	15,004.00	0.001122	16.84	0.067891	1018.64
2086	92	664.00	0.001041	0.69	0.065914	43.77
2087	93	664.00	0.000966	0.64	0.063994	42.49
2088	94	664.00	0.000897	0.60	0.062130	41.25
2089	95	664.00	0.000832	0.55	0.060320	40.05
2090	96	664.00	0.000773	0.51	0.058563	38.89
2091	97	664.00	0.000717	0.48	0.056858	37.75
2092	98	664.00	0.000665	0.44	0.055202	36.65
2093	99	664.00	0.000618	0.41	0.053594	35.59
2094	100	664.00	0.000573	0.38	0.052033	34.55
			Sum of PW	12,189.74	Sum of PW	37,320.65
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				----------		----------
			An. Equiv =	945.247	An. Equiv =	1,181.074

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS9a						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	11,368.00	0.439957	5,001.43	0.722421	8212.49
2006	12	578.00	0.408312	236.00	0.701380	405.40
2007	13	578.00	0.378944	219.03	0.680951	393.59
2008	14	578.00	0.351688	203.28	0.661118	382.13
2009	15	578.00	0.326393	188.66	0.641862	371.00
2010	16	578.00	0.302917	175.09	0.623167	360.19
2011	17	578.00	0.281129	162.49	0.605016	349.70
2012	18	578.00	0.260909	150.81	0.587395	339.51
2013	19	578.00	0.242143	139.96	0.570286	329.63
2014	20	578.00	0.224727	129.89	0.553676	320.02
2015	21	578.00	0.208563	120.55	0.537549	310.70
2016	22	578.00	0.193562	111.88	0.521893	301.65
2017	23	578.00	0.179640	103.83	0.506692	292.87
2018	24	578.00	0.166719	96.36	0.491934	284.34
2019	25	578.00	0.154728	89.43	0.477606	276.06
2020	26	578.00	0.143599	83.00	0.463695	268.02
2021	27	578.00	0.133270	77.03	0.450189	260.21

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	578.00	0.123685	71.49	0.437077	252.63
2023	29	578.00	0.114789	66.35	0.424346	245.27
2024	30	578.00	0.106532	61.58	0.411987	238.13
2025	31	11,368.00	0.098870	1,123.95	0.399987	4547.05
2026	32	578.00	0.091759	53.04	0.388337	224.46
2027	33	578.00	0.085159	49.22	0.377026	217.92
2028	34	578.00	0.079034	45.68	0.366045	211.57
2029	35	578.00	0.073349	42.40	0.355383	205.41
2030	36	578.00	0.068073	39.35	0.345032	199.43
2031	37	578.00	0.063177	36.52	0.334983	193.62
2032	38	578.00	0.058633	33.89	0.325226	187.98
2033	39	578.00	0.054416	31.45	0.315754	182.51
2034	40	578.00	0.050502	29.19	0.306557	177.19
2035	41	578.00	0.046870	27.09	0.297628	172.03
2036	42	578.00	0.043499	25.14	0.288959	167.02
2037	43	578.00	0.040370	23.33	0.280543	162.15
2038	44	578.00	0.037466	21.66	0.272372	157.43
2039	45	578.00	0.034771	20.10	0.264439	152.85
2040	46	578.00	0.032270	18.65	0.256737	148.39
2041	47	578.00	0.029949	17.31	0.249259	144.07
2042	48	578.00	0.027795	16.07	0.241999	139.88
2043	49	578.00	0.025796	14.91	0.234950	135.80
2044	50	578.00	0.023941	13.84	0.228107	131.85
2045	51	11,368.00	0.022219	252.58	0.221463	2517.59
2046	52	578.00	0.020621	11.92	0.215013	124.28
2047	53	578.00	0.019137	11.06	0.208750	120.66
2048	54	578.00	0.017761	10.27	0.202670	117.14

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	578.00	0.016484	9.53	0.196767	113.73
2050	56	578.00	0.015298	8.84	0.191036	110.42
2051	57	578.00	0.014198	8.21	0.185472	107.20
2052	58	578.00	0.013176	7.62	0.180070	104.08
2053	59	578.00	0.012229	7.07	0.174825	101.05
2054	60	578.00	0.011349	6.56	0.169733	98.11
2055	61	578.00	0.010533	6.09	0.164789	95.25
2056	62	578.00	0.009775	5.65	0.159990	92.47
2057	63	578.00	0.009072	5.24	0.155330	89.78
2058	64	578.00	0.008420	4.87	0.150806	87.17
2059	65	578.00	0.007814	4.52	0.146413	84.63
2060	66	578.00	0.007252	4.19	0.142149	82.16
2061	67	578.00	0.006730	3.89	0.138009	79.77
2062	68	578.00	0.006246	3.61	0.133989	77.45
2063	69	578.00	0.005797	3.35	0.130086	75.19
2064	70	578.00	0.005380	3.11	0.126297	73.00
2065	71	11,368.00	0.004993	56.76	0.122619	1393.93
2066	72	578.00	0.004634	2.68	0.119047	68.81
2067	73	578.00	0.004301	2.49	0.115580	66.81
2068	74	578.00	0.003991	2.31	0.112214	64.86
2069	75	578.00	0.003704	2.14	0.108945	62.97
2070	76	578.00	0.003438	1.99	0.105772	61.14
2071	77	578.00	0.003191	1.84	0.102691	59.36
2072	78	578.00	0.002961	1.71	0.099700	57.63
2073	79	578.00	0.002748	1.59	0.096796	55.95
2074	80	578.00	0.002550	1.47	0.093977	54.32
2075	81	578.00	0.002367	1.37	0.091240	52.74

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2076	82	578.00	0.002197	1.27	0.088582	51.20
2077	83	578.00	0.002039	1.18	0.086002	49.71
2078	84	578.00	0.001892	1.09	0.083497	48.26
2079	85	578.00	0.001756	1.01	0.081065	46.86
2080	86	578.00	0.001630	0.94	0.078704	45.49
2081	87	578.00	0.001513	0.87	0.076412	44.17
2082	88	578.00	0.001404	0.81	0.074186	42.88
2083	89	578.00	0.001303	0.75	0.072026	41.63
2084	90	578.00	0.001209	0.70	0.069928	40.42
2085	91	11,368.00	0.001122	12.76	0.067891	771.79
2086	92	578.00	0.001041	0.60	0.065914	38.10
2087	93	578.00	0.000966	0.56	0.063994	36.99
2088	94	578.00	0.000897	0.52	0.062130	35.91
2089	95	578.00	0.000832	0.48	0.060320	34.87
2090	96	578.00	0.000773	0.45	0.058563	33.85
2091	97	578.00	0.000717	0.41	0.056858	32.86
2092	98	578.00	0.000665	0.38	0.055202	31.91
2093	99	578.00	0.000618	0.36	0.053594	30.98
2094	100	578.00	0.000573	0.33	0.052033	30.07
			Sum of PW	9,650.91	Sum of PW	29,889.69
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	748.374	An. Equiv =	945.909

Table A-2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS9c						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	15,048.00	0.439957	6,620.47	0.722421	10871.00
2006	12	708.00	0.408312	289.09	0.701380	496.58
2007	13	708.00	0.378944	268.29	0.680951	482.11
2008	14	708.00	0.351688	249.00	0.661118	468.07
2009	15	708.00	0.326393	231.09	0.641862	454.44
2010	16	708.00	0.302917	214.47	0.623167	441.20
2011	17	708.00	0.281129	199.04	0.605016	428.35
2012	18	708.00	0.260909	184.72	0.587395	415.88
2013	19	708.00	0.242143	171.44	0.570286	403.76
2014	20	708.00	0.224727	159.11	0.553676	392.00
2015	21	708.00	0.208563	147.66	0.537549	380.58
2016	22	708.00	0.193562	137.04	0.521893	369.50
2017	23	708.00	0.179640	127.18	0.506692	358.74
2018	24	708.00	0.166719	118.04	0.491934	348.29
2019	25	708.00	0.154728	109.55	0.477606	338.14
2020	26	708.00	0.143599	101.67	0.463695	328.30
2021	27	708.00	0.133270	94.36	0.450189	318.73

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS9c – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	708.00	0.123685	87.57	0.437077	309.45
2023	29	708.00	0.114789	81.27	0.424346	300.44
2024	30	708.00	0.106532	75.42	0.411987	291.69
2025	31	15,048.00	0.098870	1,487.80	0.399987	6019.01
2026	32	708.00	0.091759	64.97	0.388337	274.94
2027	33	708.00	0.085159	60.29	0.377026	266.93
2028	34	708.00	0.079034	55.96	0.366045	259.16
2029	35	708.00	0.073349	51.93	0.355383	251.61
2030	36	708.00	0.068073	48.20	0.345032	244.28
2031	37	708.00	0.063177	44.73	0.334983	237.17
2032	38	708.00	0.058633	41.51	0.325226	230.26
2033	39	708.00	0.054416	38.53	0.315754	223.55
2034	40	708.00	0.050502	35.76	0.306557	217.04
2035	41	708.00	0.046870	33.18	0.297628	210.72
2036	42	708.00	0.043499	30.80	0.288959	204.58
2037	43	708.00	0.040370	28.58	0.280543	198.62
2038	44	708.00	0.037466	26.53	0.272372	192.84
2039	45	708.00	0.034771	24.62	0.264439	187.22
2040	46	708.00	0.032270	22.85	0.256737	181.77
2041	47	708.00	0.029949	21.20	0.249259	176.48
2042	48	708.00	0.027795	19.68	0.241999	171.34
2043	49	708.00	0.025796	18.26	0.234950	166.34
2044	50	708.00	0.023941	16.95	0.228107	161.50
2045	51	15,048.00	0.022219	334.35	0.221463	3332.58
2046	52	708.00	0.020621	14.60	0.215013	152.23
2047	53	708.00	0.019137	13.55	0.208750	147.80
2048	54	708.00	0.017761	12.57	0.202670	143.49

Table A-2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS9c – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	708.00	0.016484	11.67	0.196767	139.31
2050	56	708.00	0.015298	10.83	0.191036	135.25
2051	57	708.00	0.014198	10.05	0.185472	131.31
2052	58	708.00	0.013176	9.33	0.180070	127.49
2053	59	708.00	0.012229	8.66	0.174825	123.78
2054	60	708.00	0.011349	8.04	0.169733	120.17
2055	61	708.00	0.010533	7.46	0.164789	116.67
2056	62	708.00	0.009775	6.92	0.159990	113.27
2057	63	708.00	0.009072	6.42	0.155330	109.97
2058	64	708.00	0.008420	5.96	0.150806	106.77
2059	65	708.00	0.007814	5.53	0.146413	103.66
2060	66	708.00	0.007252	5.13	0.142149	100.64
2061	67	708.00	0.006730	4.77	0.138009	97.71
2062	68	708.00	0.006246	4.42	0.133989	94.86
2063	69	708.00	0.005797	4.10	0.130086	92.10
2064	70	708.00	0.005380	3.81	0.126297	89.42
2065	71	15,048.00	0.004993	75.14	0.122619	1845.17
2066	72	708.00	0.004634	3.28	0.119047	84.29
2067	73	708.00	0.004301	3.04	0.115580	81.83
2068	74	708.00	0.003991	2.83	0.112214	79.45
2069	75	708.00	0.003704	2.62	0.108945	77.13
2070	76	708.00	0.003438	2.43	0.105772	74.89
2071	77	708.00	0.003191	2.26	0.102691	72.71
2072	78	708.00	0.002961	2.10	0.099700	70.59
2073	79	708.00	0.002748	1.95	0.096796	68.53
2074	80	708.00	0.002550	1.81	0.093977	66.54
2075	81	708.00	0.002367	1.68	0.091240	64.60

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

SOS9c – CONT

Implementation year = 2005
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	708.00	0.002197	1.56	0.088582	62.72
2077	83	708.00	0.002039	1.44	0.086002	60.89
2078	84	708.00	0.001892	1.34	0.083497	59.12
2079	85	708.00	0.001756	1.24	0.081065	57.39
2080	86	708.00	0.001630	1.15	0.078704	55.72
2081	87	708.00	0.001513	1.07	0.076412	54.10
2082	88	708.00	0.001404	0.99	0.074186	52.52
2083	89	708.00	0.001303	0.92	0.072026	50.99
2084	90	708.00	0.001209	0.86	0.069928	49.51
2085	91	15,048.00	0.001122	16.89	0.067891	1021.62
2086	92	708.00	0.001041	0.74	0.065914	46.67
2087	93	708.00	0.000966	0.68	0.063994	45.31
2088	94	708.00	0.000897	0.64	0.062130	43.99
2089	95	708.00	0.000832	0.59	0.060320	42.71
2090	96	708.00	0.000773	0.55	0.058563	41.46
2091	97	708.00	0.000717	0.51	0.056858	40.26
2092	98	708.00	0.000665	0.47	0.055202	39.08
2093	99	708.00	0.000618	0.44	0.053594	37.94
2094	100	708.00	0.000573	0.41	0.052033	36.84
			Sum of PW	12,458.55	Sum of PW	38,335.67
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	966.092	An. Equiv =	1,213.196

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

Pref. Alt						
Implementation year = 1998 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	15,091.00	0.741875	11,195.64	0.888487	13408.16
1999	5	751.00	0.688515	517.08	0.862609	647.82
2000	6	751.00	0.638993	479.88	0.837484	628.95
2001	7	751.00	0.593033	445.37	0.813092	610.63
2002	8	751.00	0.550379	413.33	0.789409	592.85
2003	9	751.00	0.510792	383.61	0.766417	575.58
2004	10	751.00	0.474053	356.01	0.744094	558.81
2005	11	751.00	0.439957	330.41	0.722421	542.54
2006	12	751.00	0.408312	306.64	0.701380	526.74
2007	13	751.00	0.378944	284.59	0.680951	511.39
2008	14	751.00	0.351688	264.12	0.661118	496.50
2009	15	751.00	0.326393	245.12	0.641862	482.04
2010	16	751.00	0.302917	227.49	0.623167	468.00
2011	17	751.00	0.281129	211.13	0.605016	454.37
2012	18	751.00	0.260909	195.94	0.587395	441.13
2013	19	751.00	0.242143	181.85	0.570286	428.28
2014	20	751.00	0.224727	168.77	0.553676	415.81
2015	21	751.00	0.208563	156.63	0.537549	403.70
2016	22	751.00	0.193562	145.36	0.521893	391.94
2017	23	751.00	0.179640	134.91	0.506692	380.53
2018	24	15,091.00	0.166719	2,515.96	0.491934	7423.77
2019	25	751.00	0.154728	116.20	0.477606	358.68
2020	26	751.00	0.143599	107.84	0.463695	348.23
2021	27	751.00	0.133270	100.09	0.450189	338.09

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

Pref. Alt – CONT						
Implementation year = 1998 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	751.00	0.123685	92.89	0.437077	328.24
2023	29	751.00	0.114789	86.21	0.424346	318.68
2024	30	751.00	0.106532	80.01	0.411987	309.40
2025	31	751.00	0.098870	74.25	0.399987	300.39
2026	32	751.00	0.091759	68.91	0.388337	291.64
2027	33	751.00	0.085159	63.95	0.377026	283.15
2028	34	751.00	0.079034	59.35	0.366045	274.90
2029	35	751.00	0.073349	55.09	0.355383	266.89
2030	36	751.00	0.068073	51.12	0.345032	259.12
2031	37	751.00	0.063177	47.45	0.334983	251.57
2032	38	751.00	0.058633	44.03	0.325226	244.24
2033	39	751.00	0.054416	40.87	0.315754	237.13
2034	40	751.00	0.050502	37.93	0.306557	230.22
2035	41	751.00	0.046870	35.20	0.297628	223.52
2036	42	751.00	0.043499	32.67	0.288959	217.01
2037	43	751.00	0.040370	30.32	0.280543	210.69
2038	44	15,091.00	0.037466	565.40	0.272372	4110.36
2039	45	751.00	0.034771	26.11	0.264439	198.59
2040	46	751.00	0.032270	24.24	0.256737	192.81
2041	47	751.00	0.029949	22.49	0.249259	187.19
2042	48	751.00	0.027795	20.87	0.241999	181.74
2043	49	751.00	0.025796	19.37	0.234950	176.45
2044	50	751.00	0.023941	17.98	0.228107	171.31
2045	51	751.00	0.022219	16.69	0.221463	166.32
2046	52	751.00	0.020621	15.49	0.215013	161.47
2047	53	751.00	0.019137	14.37	0.208750	156.77
2048	54	751.00	0.017761	13.34	0.202670	152.21

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

Pref. Alt – CONT						
Implementation year = 1998 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	751.00	0.016484	12.38	0.196767	147.77
2050	56	751.00	0.015298	11.49	0.191036	143.47
2051	57	751.00	0.014198	10.66	0.185472	139.29
2052	58	751.00	0.013176	9.90	0.180070	135.23
2053	59	751.00	0.012229	9.18	0.174825	131.29
2054	60	751.00	0.011349	8.52	0.169733	127.47
2055	61	751.00	0.010533	7.91	0.164789	123.76
2056	62	751.00	0.009775	7.34	0.159990	120.15
2057	63	751.00	0.009072	6.81	0.155330	116.65
2058	64	15,091.00	0.008420	127.06	0.150806	2275.81
2059	65	751.00	0.007814	5.87	0.146413	109.96
2060	66	751.00	0.007252	5.45	0.142149	106.75
2061	67	751.00	0.006730	5.05	0.138009	103.64
2062	68	751.00	0.006246	4.69	0.133989	100.63
2063	69	751.00	0.005797	4.35	0.130086	97.69
2064	70	751.00	0.005380	4.04	0.126297	94.85
2065	71	751.00	0.004993	3.75	0.122619	92.09
2066	72	751.00	0.004634	3.48	0.119047	89.40
2067	73	751.00	0.004301	3.23	0.115580	86.80
2068	74	751.00	0.003991	3.00	0.112214	84.27
2069	75	751.00	0.003704	2.78	0.108945	81.82
2070	76	751.00	0.003438	2.58	0.105772	79.43
2071	77	751.00	0.003191	2.40	0.102691	77.12
2072	78	751.00	0.002961	2.22	0.099700	74.87
2073	79	751.00	0.002748	2.06	0.096796	72.69
2074	80	751.00	0.002550	1.92	0.093977	70.58
2075	81	751.00	0.002367	1.78	0.091240	68.52

Table A–2. Annual Equivalent Increased Pumping Cost – Agr. Pumpers – John Day – CONT

Pref. Alt – CONT						
Implementation year = 1998 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	751.00	0.002197	1.65	0.088582	66.53
2077	83	751.00	0.002039	1.53	0.086002	64.59
2078	84	15,091.00	0.001892	28.55	0.083497	1260.06
2079	85	751.00	0.001756	1.32	0.081065	60.88
2080	86	751.00	0.001630	1.22	0.078704	59.11
2081	87	751.00	0.001513	1.14	0.076412	57.39
2082	88	751.00	0.001404	1.05	0.074186	55.71
2083	89	751.00	0.001303	0.98	0.072026	54.09
2084	90	751.00	0.001209	0.91	0.069928	52.52
2085	91	751.00	0.001122	0.84	0.067891	50.99
2086	92	751.00	0.001041	0.78	0.065914	49.50
2087	93	751.00	0.000966	0.73	0.063994	48.06
2088	94	751.00	0.000897	0.67	0.062130	46.66
2089	95	751.00	0.000832	0.63	0.060320	45.30
2090	96	751.00	0.000773	0.58	0.058563	43.98
2091	97	751.00	0.000717	0.54	0.056858	42.70
2092	98	751.00	0.000665	0.50	0.055202	41.46
2093	99	751.00	0.000618	0.46	0.053594	40.25
2094	100	751.00	0.000573	0.43	0.052033	39.08
			Sum of PW	21,454.98	Sum of PW	48,667.44
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	1,663.715	An. Equiv =	1,540.162

Table A-3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake

SOS5b						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	0.00	0.439957	0.00	0.722421	0.00
2006	12	0.00	0.408312	0.00	0.701380	0.00
2007	13	0.00	0.378944	0.00	0.680951	0.00
2008	14	0.00	0.351688	0.00	0.661118	0.00
2009	15	0.00	0.326393	0.00	0.641862	0.00
2010	16	6,885.00	0.302917	2,085.58	0.623167	4290.50
2011	17	337.00	0.281129	94.74	0.605016	203.89
2012	18	337.00	0.260909	87.93	0.587395	197.95
2013	19	337.00	0.242143	81.60	0.570286	192.19
2014	20	337.00	0.224727	75.73	0.553676	186.59
2015	21	337.00	0.208563	70.29	0.537549	181.15
2016	22	337.00	0.193562	65.23	0.521893	175.88
2017	23	337.00	0.179640	60.54	0.506692	170.76
2018	24	337.00	0.166719	56.18	0.491934	165.78
2019	25	337.00	0.154728	52.14	0.477606	160.95
2020	26	337.00	0.143599	48.39	0.463695	156.27
2021	27	337.00	0.133270	44.91	0.450189	151.71

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	337.00	0.123685	41.68	0.437077	147.29
2023	29	337.00	0.114789	38.68	0.424346	143.00
2024	30	337.00	0.106532	35.90	0.411987	138.84
2025	31	337.00	0.098870	33.32	0.399987	134.80
2026	32	337.00	0.091759	30.92	0.388337	130.87
2027	33	337.00	0.085159	28.70	0.377026	127.06
2028	34	337.00	0.079034	26.63	0.366045	123.36
2029	35	337.00	0.073349	24.72	0.355383	119.76
2030	36	6,885.00	0.068073	468.69	0.345032	2375.55
2031	37	337.00	0.063177	21.29	0.334983	112.89
2032	38	337.00	0.058633	19.76	0.325226	109.60
2033	39	337.00	0.054416	18.34	0.315754	106.41
2034	40	337.00	0.050502	17.02	0.306557	103.31
2035	41	337.00	0.046870	15.80	0.297628	100.30
2036	42	337.00	0.043499	14.66	0.288959	97.38
2037	43	337.00	0.040370	13.60	0.280543	94.54
2038	44	337.00	0.037466	12.63	0.272372	91.79
2039	45	337.00	0.034771	11.72	0.264439	89.12
2040	46	337.00	0.032270	10.88	0.256737	86.52
2041	47	337.00	0.029949	10.09	0.249259	84.00
2042	48	337.00	0.027795	9.37	0.241999	81.55
2043	49	337.00	0.025796	8.69	0.234950	79.18
2044	50	337.00	0.023941	8.07	0.228107	76.87
2045	51	337.00	0.022219	7.49	0.221463	74.63
2046	52	337.00	0.020621	6.95	0.215013	72.46
2047	53	337.00	0.019137	6.45	0.208750	70.35
2048	54	337.00	0.017761	5.99	0.202670	68.30

Table A-3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	337.00	0.016484	5.55	0.196767	66.31
2050	56	6,885.00	0.015298	105.33	0.191036	1315.28
2051	57	337.00	0.014198	4.78	0.185472	62.50
2052	58	337.00	0.013176	4.44	0.180070	60.68
2053	59	337.00	0.012229	4.12	0.174825	58.92
2054	60	337.00	0.011349	3.82	0.169733	57.20
2055	61	337.00	0.010533	3.55	0.164789	55.53
2056	62	337.00	0.009775	3.29	0.159990	53.92
2057	63	337.00	0.009072	3.06	0.155330	52.35
2058	64	337.00	0.008420	2.84	0.150806	50.82
2059	65	337.00	0.007814	2.63	0.146413	49.34
2060	66	337.00	0.007252	2.44	0.142149	47.90
2061	67	337.00	0.006730	2.27	0.138009	46.51
2062	68	337.00	0.006246	2.11	0.133989	45.15
2063	69	337.00	0.005797	1.95	0.130086	43.84
2064	70	337.00	0.005380	1.81	0.126297	42.56
2065	71	337.00	0.004993	1.68	0.122619	41.32
2066	72	337.00	0.004634	1.56	0.119047	40.12
2067	73	337.00	0.004301	1.45	0.115580	38.95
2068	74	337.00	0.003991	1.35	0.112214	37.82
2069	75	337.00	0.003704	1.25	0.108945	36.71
2070	76	6,885.00	0.003438	23.67	0.105772	728.24
2071	77	337.00	0.003191	1.08	0.102691	34.61
2072	78	337.00	0.002961	1.00	0.099700	33.60
2073	79	337.00	0.002748	0.93	0.096796	32.62
2074	80	337.00	0.002550	0.86	0.093977	31.67
2075	81	337.00	0.002367	0.80	0.091240	30.75

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	337.00	0.002197	0.74	0.088582	29.85
2077	83	337.00	0.002039	0.69	0.086002	28.98
2078	84	337.00	0.001892	0.64	0.083497	28.14
2079	85	337.00	0.001756	0.59	0.081065	27.32
2080	86	337.00	0.001630	0.55	0.078704	26.52
2081	87	337.00	0.001513	0.51	0.076412	25.75
2082	88	337.00	0.001404	0.47	0.074186	25.00
2083	89	337.00	0.001303	0.44	0.072026	24.27
2084	90	337.00	0.001209	0.41	0.069928	23.57
2085	91	337.00	0.001122	0.38	0.067891	22.88
2086	92	337.00	0.001041	0.35	0.065914	22.21
2087	93	337.00	0.000966	0.33	0.063994	21.57
2088	94	337.00	0.000897	0.30	0.062130	20.94
2089	95	337.00	0.000832	0.28	0.060320	20.33
2090	96	6,885.00	0.000773	5.32	0.058563	403.21
2091	97	337.00	0.000717	0.24	0.056858	19.16
2092	98	337.00	0.000665	0.22	0.055202	18.60
2093	99	337.00	0.000618	0.21	0.053594	18.06
2094	100	337.00	0.000573	0.19	0.052033	17.54
			Sum of PW	3,973.78	Sum of PW	15,292.49
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	308.144	An. Equiv =	483.956

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS5c						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	6,924.00	0.638993	4,424.39	0.837484	5798.74
2001	7	376.00	0.593033	222.98	0.813092	305.72
2002	8	376.00	0.550379	206.94	0.789409	296.82
2003	9	376.00	0.510792	192.06	0.766417	288.17
2004	10	376.00	0.474053	178.24	0.744094	279.78
2005	11	376.00	0.439957	165.42	0.722421	271.63
2006	12	376.00	0.408312	153.53	0.701380	263.72
2007	13	376.00	0.378944	142.48	0.680951	256.04
2008	14	376.00	0.351688	132.23	0.661118	248.58
2009	15	376.00	0.326393	122.72	0.641862	241.34
2010	16	376.00	0.302917	113.90	0.623167	234.31
2011	17	376.00	0.281129	105.70	0.605016	227.49
2012	18	376.00	0.260909	98.10	0.587395	220.86
2013	19	376.00	0.242143	91.05	0.570286	214.43
2014	20	376.00	0.224727	84.50	0.553676	208.18
2015	21	376.00	0.208563	78.42	0.537549	202.12
2016	22	376.00	0.193562	72.78	0.521893	196.23
2017	23	376.00	0.179640	67.54	0.506692	190.52
2018	24	376.00	0.166719	62.69	0.491934	184.97
2019	25	376.00	0.154728	58.18	0.477606	179.58
2020	26	6,924.00	0.143599	994.28	0.463695	3210.62
2021	27	376.00	0.133270	50.11	0.450189	169.27

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS5c – CONT

Implementation year = 2000
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2022	28	376.00	0.123685	46.51	0.437077	164.34
2023	29	376.00	0.114789	43.16	0.424346	159.55
2024	30	376.00	0.106532	40.06	0.411987	154.91
2025	31	376.00	0.098870	37.18	0.399987	150.40
2026	32	376.00	0.091759	34.50	0.388337	146.01
2027	33	376.00	0.085159	32.02	0.377026	141.76
2028	34	376.00	0.079034	29.72	0.366045	137.63
2029	35	376.00	0.073349	27.58	0.355383	133.62
2030	36	376.00	0.068073	25.60	0.345032	129.73
2031	37	376.00	0.063177	23.75	0.334983	125.95
2032	38	376.00	0.058633	22.05	0.325226	122.29
2033	39	376.00	0.054416	20.46	0.315754	118.72
2034	40	376.00	0.050502	18.99	0.306557	115.27
2035	41	376.00	0.046870	17.62	0.297628	111.91
2036	42	376.00	0.043499	16.36	0.288959	108.65
2037	43	376.00	0.040370	15.18	0.280543	105.48
2038	44	376.00	0.037466	14.09	0.272372	102.41
2039	45	376.00	0.034771	13.07	0.264439	99.43
2040	46	6,924.00	0.032270	223.44	0.256737	1777.64
2041	47	376.00	0.029949	11.26	0.249259	93.72
2042	48	376.00	0.027795	10.45	0.241999	90.99
2043	49	376.00	0.025796	9.70	0.234950	88.34
2044	50	376.00	0.023941	9.00	0.228107	85.77
2045	51	376.00	0.022219	8.35	0.221463	83.27
2046	52	376.00	0.020621	7.75	0.215013	80.84
2047	53	376.00	0.019137	7.20	0.208750	78.49
2048	54	376.00	0.017761	6.68	0.202670	76.20

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS5c – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	376.00	0.016484	6.20	0.196767	73.98
2050	56	376.00	0.015298	5.75	0.191036	71.83
2051	57	376.00	0.014198	5.34	0.185472	69.74
2052	58	376.00	0.013176	4.95	0.180070	67.71
2053	59	376.00	0.012229	4.60	0.174825	65.73
2054	60	376.00	0.011349	4.27	0.169733	63.82
2055	61	376.00	0.010533	3.96	0.164789	61.96
2056	62	376.00	0.009775	3.68	0.159990	60.16
2057	63	376.00	0.009072	3.41	0.155330	58.40
2058	64	376.00	0.008420	3.17	0.150806	56.70
2059	65	376.00	0.007814	2.94	0.146413	55.05
2060	66	6,924.00	0.007252	50.21	0.142149	984.24
2061	67	376.00	0.006730	2.53	0.138009	51.89
2062	68	376.00	0.006246	2.35	0.133989	50.38
2063	69	376.00	0.005797	2.18	0.130086	48.91
2064	70	376.00	0.005380	2.02	0.126297	47.49
2065	71	376.00	0.004993	1.88	0.122619	46.10
2066	72	376.00	0.004634	1.74	0.119047	44.76
2067	73	376.00	0.004301	1.62	0.115580	43.46
2068	74	376.00	0.003991	1.50	0.112214	42.19
2069	75	376.00	0.003704	1.39	0.108945	40.96
2070	76	376.00	0.003438	1.29	0.105772	39.77
2071	77	376.00	0.003191	1.20	0.102691	38.61
2072	78	376.00	0.002961	1.11	0.099700	37.49
2073	79	376.00	0.002748	1.03	0.096796	36.40
2074	80	376.00	0.002550	0.96	0.093977	35.34
2075	81	376.00	0.002367	0.89	0.091240	34.31

Table A-3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS5c – CONT

Implementation year = 2000
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	376.00	0.002197	0.83	0.088582	33.31
2077	83	376.00	0.002039	0.77	0.086002	32.34
2078	84	376.00	0.001892	0.71	0.083497	31.40
2079	85	376.00	0.001756	0.66	0.081065	30.48
2080	86	6,924.00	0.001630	11.28	0.078704	544.95
2081	87	376.00	0.001513	0.57	0.076412	28.73
2082	88	376.00	0.001404	0.53	0.074186	27.89
2083	89	376.00	0.001303	0.49	0.072026	27.08
2084	90	376.00	0.001209	0.45	0.069928	26.29
2085	91	376.00	0.001122	0.42	0.067891	25.53
2086	92	376.00	0.001041	0.39	0.065914	24.78
2087	93	376.00	0.000966	0.36	0.063994	24.06
2088	94	376.00	0.000897	0.34	0.062130	23.36
2089	95	376.00	0.000832	0.31	0.060320	22.68
2090	96	376.00	0.000773	0.29	0.058563	22.02
2091	97	376.00	0.000717	0.27	0.056858	21.38
2092	98	376.00	0.000665	0.25	0.055202	20.76
2093	99	376.00	0.000618	0.23	0.053594	20.15
2094	100	376.00	0.000573	0.22	0.052033	19.56
			Sum of PW	8,731.51	Sum of PW	21,806.60
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	677.080	An. Equiv =	690.106

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS6b						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	4,664.00	0.439957	2,051.96	0.722421	3369.37
2006	12	226.00	0.408312	92.28	0.701380	158.51
2007	13	226.00	0.378944	85.64	0.680951	153.90
2008	14	226.00	0.351688	79.48	0.661118	149.41
2009	15	226.00	0.326393	73.76	0.641862	145.06
2010	16	226.00	0.302917	68.46	0.623167	140.84
2011	17	226.00	0.281129	63.54	0.605016	136.73
2012	18	226.00	0.260909	58.97	0.587395	132.75
2013	19	226.00	0.242143	54.72	0.570286	128.88
2014	20	226.00	0.224727	50.79	0.553676	125.13
2015	21	226.00	0.208563	47.14	0.537549	121.49
2016	22	226.00	0.193562	43.74	0.521893	117.95
2017	23	226.00	0.179640	40.60	0.506692	114.51
2018	24	226.00	0.166719	37.68	0.491934	111.18
2019	25	226.00	0.154728	34.97	0.477606	107.94
2020	26	226.00	0.143599	32.45	0.463695	104.80
2021	27	226.00	0.133270	30.12	0.450189	101.74

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS6b – CONT

Implementation year = 2005
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2022	28	226.00	0.123685	27.95	0.437077	98.78
2023	29	226.00	0.114789	25.94	0.424346	95.90
2024	30	226.00	0.106532	24.08	0.411987	93.11
2025	31	4,664.00	0.098870	461.13	0.399987	1865.54
2026	32	226.00	0.091759	20.74	0.388337	87.76
2027	33	226.00	0.085159	19.25	0.377026	85.21
2028	34	226.00	0.079034	17.86	0.366045	82.73
2029	35	226.00	0.073349	16.58	0.355383	80.32
2030	36	226.00	0.068073	15.38	0.345032	77.98
2031	37	226.00	0.063177	14.28	0.334983	75.71
2032	38	226.00	0.058633	13.25	0.325226	73.50
2033	39	226.00	0.054416	12.30	0.315754	71.36
2034	40	226.00	0.050502	11.41	0.306557	69.28
2035	41	226.00	0.046870	10.59	0.297628	67.26
2036	42	226.00	0.043499	9.83	0.288959	65.30
2037	43	226.00	0.040370	9.12	0.280543	63.40
2038	44	226.00	0.037466	8.47	0.272372	61.56
2039	45	226.00	0.034771	7.86	0.264439	59.76
2040	46	226.00	0.032270	7.29	0.256737	58.02
2041	47	226.00	0.029949	6.77	0.249259	56.33
2042	48	226.00	0.027795	6.28	0.241999	54.69
2043	49	226.00	0.025796	5.83	0.234950	53.10
2044	50	226.00	0.023941	5.41	0.228107	51.55
2045	51	4,664.00	0.022219	103.63	0.221463	1032.90
2046	52	226.00	0.020621	4.66	0.215013	48.59
2047	53	226.00	0.019137	4.33	0.208750	47.18
2048	54	226.00	0.017761	4.01	0.202670	45.80

Table A-3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS6b – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	226.00	0.016484	3.73	0.196767	44.47
2050	56	226.00	0.015298	3.46	0.191036	43.17
2051	57	226.00	0.014198	3.21	0.185472	41.92
2052	58	226.00	0.013176	2.98	0.180070	40.70
2053	59	226.00	0.012229	2.76	0.174825	39.51
2054	60	226.00	0.011349	2.56	0.169733	38.36
2055	61	226.00	0.010533	2.38	0.164789	37.24
2056	62	226.00	0.009775	2.21	0.159990	36.16
2057	63	226.00	0.009072	2.05	0.155330	35.10
2058	64	226.00	0.008420	1.90	0.150806	34.08
2059	65	226.00	0.007814	1.77	0.146413	33.09
2060	66	226.00	0.007252	1.64	0.142149	32.13
2061	67	226.00	0.006730	1.52	0.138009	31.19
2062	68	226.00	0.006246	1.41	0.133989	30.28
2063	69	226.00	0.005797	1.31	0.130086	29.40
2064	70	226.00	0.005380	1.22	0.126297	28.54
2065	71	4,664.00	0.004993	23.29	0.122619	571.89
2066	72	226.00	0.004634	1.05	0.119047	26.90
2067	73	226.00	0.004301	0.97	0.115580	26.12
2068	74	226.00	0.003991	0.90	0.112214	25.36
2069	75	226.00	0.003704	0.84	0.108945	24.62
2070	76	226.00	0.003438	0.78	0.105772	23.90
2071	77	226.00	0.003191	0.72	0.102691	23.21
2072	78	226.00	0.002961	0.67	0.099700	22.53
2073	79	226.00	0.002748	0.62	0.096796	21.88
2074	80	226.00	0.002550	0.58	0.093977	21.24
2075	81	226.00	0.002367	0.53	0.091240	20.62

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS6b – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	226.00	0.002197	0.50	0.088582	20.02
2077	83	226.00	0.002039	0.46	0.086002	19.44
2078	84	226.00	0.001892	0.43	0.083497	18.87
2079	85	226.00	0.001756	0.40	0.081065	18.32
2080	86	226.00	0.001630	0.37	0.078704	17.79
2081	87	226.00	0.001513	0.34	0.076412	17.27
2082	88	226.00	0.001404	0.32	0.074186	16.77
2083	89	226.00	0.001303	0.29	0.072026	16.28
2084	90	226.00	0.001209	0.27	0.069928	15.80
2085	91	4,664.00	0.001122	5.23	0.067891	316.64
2086	92	226.00	0.001041	0.24	0.065914	14.90
2087	93	226.00	0.000966	0.22	0.063994	14.46
2088	94	226.00	0.000897	0.20	0.062130	14.04
2089	95	226.00	0.000832	0.19	0.060320	13.63
2090	96	226.00	0.000773	0.17	0.058563	13.24
2091	97	226.00	0.000717	0.16	0.056858	12.85
2092	98	226.00	0.000665	0.15	0.055202	12.48
2093	99	226.00	0.000618	0.14	0.053594	12.11
2094	100	226.00	0.000573	0.13	0.052033	11.76
			Sum of PW	3,897.79	Sum of PW	12,023.11
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	302.252	An. Equiv =	380.491

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS6d						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	**B**	**C**	**D**	**E**	**F**	**G**
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	3,133.00	0.638993	2,001.97	0.837484	2623.84
2001	7	150.00	0.593033	88.95	0.813092	121.96
2002	8	150.00	0.550379	82.56	0.789409	118.41
2003	9	150.00	0.510792	76.62	0.766417	114.96
2004	10	150.00	0.474053	71.11	0.744094	111.61
2005	11	150.00	0.439957	65.99	0.722421	108.36
2006	12	150.00	0.408312	61.25	0.701380	105.21
2007	13	150.00	0.378944	56.84	0.680951	102.14
2008	14	150.00	0.351688	52.75	0.661118	99.17
2009	15	150.00	0.326393	48.96	0.641862	96.28
2010	16	150.00	0.302917	45.44	0.623167	93.48
2011	17	150.00	0.281129	42.17	0.605016	90.75
2012	18	150.00	0.260909	39.14	0.587395	88.11
2013	19	150.00	0.242143	36.32	0.570286	85.54
2014	20	150.00	0.224727	33.71	0.553676	83.05
2015	21	150.00	0.208563	31.28	0.537549	80.63
2016	22	150.00	0.193562	29.03	0.521893	78.28
2017	23	150.00	0.179640	26.95	0.506692	76.00
2018	24	150.00	0.166719	25.01	0.491934	73.79
2019	25	150.00	0.154728	23.21	0.477606	71.64
2020	26	3,133.00	0.143599	449.89	0.463695	1452.76
2021	27	150.00	0.133270	19.99	0.450189	67.53

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	150.00	0.123685	18.55	0.437077	65.56
2023	29	150.00	0.114789	17.22	0.424346	63.65
2024	30	150.00	0.106532	15.98	0.411987	61.80
2025	31	150.00	0.098870	14.83	0.399987	60.00
2026	32	150.00	0.091759	13.76	0.388337	58.25
2027	33	150.00	0.085159	12.77	0.377026	56.55
2028	34	150.00	0.079034	11.86	0.366045	54.91
2029	35	150.00	0.073349	11.00	0.355383	53.31
2030	36	150.00	0.068073	10.21	0.345032	51.75
2031	37	150.00	0.063177	9.48	0.334983	50.25
2032	38	150.00	0.058633	8.79	0.325226	48.78
2033	39	150.00	0.054416	8.16	0.315754	47.36
2034	40	150.00	0.050502	7.58	0.306557	45.98
2035	41	150.00	0.046870	7.03	0.297628	44.64
2036	42	150.00	0.043499	6.52	0.288959	43.34
2037	43	150.00	0.040370	6.06	0.280543	42.08
2038	44	150.00	0.037466	5.62	0.272372	40.86
2039	45	150.00	0.034771	5.22	0.264439	39.67
2040	46	3,133.00	0.032270	101.10	0.256737	804.36
2041	47	150.00	0.029949	4.49	0.249259	37.39
2042	48	150.00	0.027795	4.17	0.241999	36.30
2043	49	150.00	0.025796	3.87	0.234950	35.24
2044	50	150.00	0.023941	3.59	0.228107	34.22
2045	51	150.00	0.022219	3.33	0.221463	33.22
2046	52	150.00	0.020621	3.09	0.215013	32.25
2047	53	150.00	0.019137	2.87	0.208750	31.31
2048	54	150.00	0.017761	2.66	0.202670	30.40

Table A-3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	150.00	0.016484	2.47	0.196767	29.52
2050	56	150.00	0.015298	2.29	0.191036	28.66
2051	57	150.00	0.014198	2.13	0.185472	27.82
2052	58	150.00	0.013176	1.98	0.180070	27.01
2053	59	150.00	0.012229	1.83	0.174825	26.22
2054	60	150.00	0.011349	1.70	0.169733	25.46
2055	61	150.00	0.010533	1.58	0.164789	24.72
2056	62	150.00	0.009775	1.47	0.159990	24.00
2057	63	150.00	0.009072	1.36	0.155330	23.30
2058	64	150.00	0.008420	1.26	0.150806	22.62
2059	65	150.00	0.007814	1.17	0.146413	21.96
2060	66	3,133.00	0.007252	22.72	0.142149	445.35
2061	67	150.00	0.006730	1.01	0.138009	20.70
2062	68	150.00	0.006246	0.94	0.133989	20.10
2063	69	150.00	0.005797	0.87	0.130086	19.51
2064	70	150.00	0.005380	0.81	0.126297	18.94
2065	71	150.00	0.004993	0.75	0.122619	18.39
2066	72	150.00	0.004634	0.70	0.119047	17.86
2067	73	150.00	0.004301	0.65	0.115580	17.34
2068	74	150.00	0.003991	0.60	0.112214	16.83
2069	75	150.00	0.003704	0.56	0.108945	16.34
2070	76	150.00	0.003438	0.52	0.105772	15.87
2071	77	150.00	0.003191	0.48	0.102691	15.40
2072	78	150.00	0.002961	0.44	0.099700	14.96
2073	79	150.00	0.002748	0.41	0.096796	14.52
2074	80	150.00	0.002550	0.38	0.093977	14.10
2075	81	150.00	0.002367	0.36	0.091240	13.69

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	150.00	0.002197	0.33	0.088582	13.29
2077	83	150.00	0.002039	0.31	0.086002	12.90
2078	84	150.00	0.001892	0.28	0.083497	12.52
2079	85	150.00	0.001756	0.26	0.081065	12.16
2080	86	3,133.00	0.001630	5.11	0.078704	246.58
2081	87	150.00	0.001513	0.23	0.076412	11.46
2082	88	150.00	0.001404	0.21	0.074186	11.13
2083	89	150.00	0.001303	0.20	0.072026	10.80
2084	90	150.00	0.001209	0.18	0.069928	10.49
2085	91	150.00	0.001122	0.17	0.067891	10.18
2086	92	150.00	0.001041	0.16	0.065914	9.89
2087	93	150.00	0.000966	0.14	0.063994	9.60
2088	94	150.00	0.000897	0.13	0.062130	9.32
2089	95	150.00	0.000832	0.12	0.060320	9.05
2090	96	150.00	0.000773	0.12	0.058563	8.78
2091	97	150.00	0.000717	0.11	0.056858	8.53
2092	98	150.00	0.000665	0.10	0.055202	8.28
2093	99	150.00	0.000618	0.09	0.053594	8.04
2094	100	150.00	0.000573	0.09	0.052033	7.80
			Sum of PW	3,788.73	Sum of PW	9,358.95
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	293.795	An. Equiv =	296.179

Table A-3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS9a						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	4,652.00	0.439957	2,046.68	0.722421	3360.70
2006	12	225.00	0.408312	91.87	0.701380	157.81
2007	13	225.00	0.378944	85.26	0.680951	153.21
2008	14	225.00	0.351688	79.13	0.661118	148.75
2009	15	225.00	0.326393	73.44	0.641862	144.42
2010	16	225.00	0.302917	68.16	0.623167	140.21
2011	17	225.00	0.281129	63.25	0.605016	136.13
2012	18	225.00	0.260909	58.70	0.587395	132.16
2013	19	225.00	0.242143	54.48	0.570286	128.31
2014	20	225.00	0.224727	50.56	0.553676	124.58
2015	21	225.00	0.208563	46.93	0.537549	120.95
2016	22	225.00	0.193562	43.55	0.521893	117.43
2017	23	225.00	0.179640	40.42	0.506692	114.01
2018	24	225.00	0.166719	37.51	0.491934	110.69
2019	25	225.00	0.154728	34.81	0.477606	107.46
2020	26	225.00	0.143599	32.31	0.463695	104.33
2021	27	225.00	0.133270	29.99	0.450189	101.29

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	225.00	0.123685	27.83	0.437077	98.34
2023	29	225.00	0.114789	25.83	0.424346	95.48
2024	30	225.00	0.106532	23.97	0.411987	92.70
2025	31	4,652.00	0.098870	459.94	0.399987	1860.74
2026	32	225.00	0.091759	20.65	0.388337	87.38
2027	33	225.00	0.085159	19.16	0.377026	84.83
2028	34	225.00	0.079034	17.78	0.366045	82.36
2029	35	225.00	0.073349	16.50	0.355383	79.96
2030	36	225.00	0.068073	15.32	0.345032	77.63
2031	37	225.00	0.063177	14.21	0.334983	75.37
2032	38	225.00	0.058633	13.19	0.325226	73.18
2033	39	225.00	0.054416	12.24	0.315754	71.04
2034	40	225.00	0.050502	11.36	0.306557	68.98
2035	41	225.00	0.046870	10.55	0.297628	66.97
2036	42	225.00	0.043499	9.79	0.288959	65.02
2037	43	225.00	0.040370	9.08	0.280543	63.12
2038	44	225.00	0.037466	8.43	0.272372	61.28
2039	45	225.00	0.034771	7.82	0.264439	59.50
2040	46	225.00	0.032270	7.26	0.256737	57.77
2041	47	225.00	0.029949	6.74	0.249259	56.08
2042	48	225.00	0.027795	6.25	0.241999	54.45
2043	49	225.00	0.025796	5.80	0.234950	52.86
2044	50	225.00	0.023941	5.39	0.228107	51.32
2045	51	4,652.00	0.022219	103.36	0.221463	1030.25
2046	52	225.00	0.020621	4.64	0.215013	48.38
2047	53	225.00	0.019137	4.31	0.208750	46.97
2048	54	225.00	0.017761	4.00	0.202670	45.60

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	225.00	0.016484	3.71	0.196767	44.27
2050	56	225.00	0.015298	3.44	0.191036	42.98
2051	57	225.00	0.014198	3.19	0.185472	41.73
2052	58	225.00	0.013176	2.96	0.180070	40.52
2053	59	225.00	0.012229	2.75	0.174825	39.34
2054	60	225.00	0.011349	2.55	0.169733	38.19
2055	61	225.00	0.010533	2.37	0.164789	37.08
2056	62	225.00	0.009775	2.20	0.159990	36.00
2057	63	225.00	0.009072	2.04	0.155330	34.95
2058	64	225.00	0.008420	1.89	0.150806	33.93
2059	65	225.00	0.007814	1.76	0.146413	32.94
2060	66	225.00	0.007252	1.63	0.142149	31.98
2061	67	225.00	0.006730	1.51	0.138009	31.05
2062	68	225.00	0.006246	1.41	0.133989	30.15
2063	69	225.00	0.005797	1.30	0.130086	29.27
2064	70	225.00	0.005380	1.21	0.126297	28.42
2065	71	4,652.00	0.004993	23.23	0.122619	570.42
2066	72	225.00	0.004634	1.04	0.119047	26.79
2067	73	225.00	0.004301	0.97	0.115580	26.01
2068	74	225.00	0.003991	0.90	0.112214	25.25
2069	75	225.00	0.003704	0.83	0.108945	24.51
2070	76	225.00	0.003438	0.77	0.105772	23.80
2071	77	225.00	0.003191	0.72	0.102691	23.11
2072	78	225.00	0.002961	0.67	0.099700	22.43
2073	79	225.00	0.002748	0.62	0.096796	21.78
2074	80	225.00	0.002550	0.57	0.093977	21.14
2075	81	225.00	0.002367	0.53	0.091240	20.53

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS9a – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	**B**	**C**	**D**	**E**	**F**	**G**
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2076	82	225.00	0.002197	0.49	0.088582	19.93
2077	83	225.00	0.002039	0.46	0.086002	19.35
2078	84	225.00	0.001892	0.43	0.083497	18.79
2079	85	225.00	0.001756	0.40	0.081065	18.24
2080	86	225.00	0.001630	0.37	0.078704	17.71
2081	87	225.00	0.001513	0.34	0.076412	17.19
2082	88	225.00	0.001404	0.32	0.074186	16.69
2083	89	225.00	0.001303	0.29	0.072026	16.21
2084	90	225.00	0.001209	0.27	0.069928	15.73
2085	91	4,652.00	0.001122	5.22	0.067891	315.83
2086	92	225.00	0.001041	0.23	0.065914	14.83
2087	93	225.00	0.000966	0.22	0.063994	14.40
2088	94	225.00	0.000897	0.20	0.062130	13.98
2089	95	225.00	0.000832	0.19	0.060320	13.57
2090	96	225.00	0.000773	0.17	0.058563	13.18
2091	97	225.00	0.000717	0.16	0.056858	12.79
2092	98	225.00	0.000665	0.15	0.055202	12.42
2093	99	225.00	0.000618	0.14	0.053594	12.06
2094	100	225.00	0.000573	0.13	0.052033	11.71
			Sum of PW	3,885.44	Sum of PW	11,983.16
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	301.294	An. Equiv =	379.227

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS9c						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	5,245.00	0.439957	2,307.57	0.722421	3789.10
2006	12	251.00	0.408312	102.49	0.701380	176.05
2007	13	251.00	0.378944	95.12	0.680951	170.92
2008	14	251.00	0.351688	88.27	0.661118	165.94
2009	15	251.00	0.326393	81.92	0.641862	161.11
2010	16	251.00	0.302917	76.03	0.623167	156.41
2011	17	251.00	0.281129	70.56	0.605016	151.86
2012	18	251.00	0.260909	65.49	0.587395	147.44
2013	19	251.00	0.242143	60.78	0.570286	143.14
2014	20	251.00	0.224727	56.41	0.553676	138.97
2015	21	251.00	0.208563	52.35	0.537549	134.92
2016	22	251.00	0.193562	48.58	0.521893	131.00
2017	23	251.00	0.179640	45.09	0.506692	127.18
2018	24	251.00	0.166719	41.85	0.491934	123.48
2019	25	251.00	0.154728	38.84	0.477606	119.88
2020	26	251.00	0.143599	36.04	0.463695	116.39
2021	27	251.00	0.133270	33.45	0.450189	113.00

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS9c – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	251.00	0.123685	31.04	0.437077	109.71
2023	29	251.00	0.114789	28.81	0.424346	106.51
2024	30	251.00	0.106532	26.74	0.411987	103.41
2025	31	5,245.00	0.098870	518.57	0.399987	2097.93
2026	32	251.00	0.091759	23.03	0.388337	97.47
2027	33	251.00	0.085159	21.37	0.377026	94.63
2028	34	251.00	0.079034	19.84	0.366045	91.88
2029	35	251.00	0.073349	18.41	0.355383	89.20
2030	36	251.00	0.068073	17.09	0.345032	86.60
2031	37	251.00	0.063177	15.86	0.334983	84.08
2032	38	251.00	0.058633	14.72	0.325226	81.63
2033	39	251.00	0.054416	13.66	0.315754	79.25
2034	40	251.00	0.050502	12.68	0.306557	76.95
2035	41	251.00	0.046870	11.76	0.297628	74.70
2036	42	251.00	0.043499	10.92	0.288959	72.53
2037	43	251.00	0.040370	10.13	0.280543	70.42
2038	44	251.00	0.037466	9.40	0.272372	68.37
2039	45	251.00	0.034771	8.73	0.264439	66.37
2040	46	251.00	0.032270	8.10	0.256737	64.44
2041	47	251.00	0.029949	7.52	0.249259	62.56
2042	48	251.00	0.027795	6.98	0.241999	60.74
2043	49	251.00	0.025796	6.47	0.234950	58.97
2044	50	251.00	0.023941	6.01	0.228107	57.25
2045	51	5,245.00	0.022219	116.54	0.221463	1161.57
2046	52	251.00	0.020621	5.18	0.215013	53.97
2047	53	251.00	0.019137	4.80	0.208750	52.40
2048	54	251.00	0.017761	4.46	0.202670	50.87

Table A-3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS9c – CONT

Implementation year = 2005
First year of analysis = 1995 (year 1), and 100 year analysis
Costs present worthed an amortized at 7.75 % & 3.0 %

A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	251.00	0.016484	4.14	0.196767	49.39
2050	56	251.00	0.015298	3.84	0.191036	47.95
2051	57	251.00	0.014198	3.56	0.185472	46.55
2052	58	251.00	0.013176	3.31	0.180070	45.20
2053	59	251.00	0.012229	3.07	0.174825	43.88
2054	60	251.00	0.011349	2.85	0.169733	42.60
2055	61	251.00	0.010533	2.64	0.164789	41.36
2056	62	251.00	0.009775	2.45	0.159990	40.16
2057	63	251.00	0.009072	2.28	0.155330	38.99
2058	64	251.00	0.008420	2.11	0.150806	37.85
2059	65	251.00	0.007814	1.96	0.146413	36.75
2060	66	251.00	0.007252	1.82	0.142149	35.68
2061	67	251.00	0.006730	1.69	0.138009	34.64
2062	68	251.00	0.006246	1.57	0.133989	33.63
2063	69	251.00	0.005797	1.46	0.130086	32.65
2064	70	251.00	0.005380	1.35	0.126297	31.70
2065	71	5,245.00	0.004993	26.19	0.122619	643.14
2066	72	251.00	0.004634	1.16	0.119047	29.88
2067	73	251.00	0.004301	1.08	0.115580	29.01
2068	74	251.00	0.003991	1.00	0.112214	28.17
2069	75	251.00	0.003704	0.93	0.108945	27.35
2070	76	251.00	0.003438	0.86	0.105772	26.55
2071	77	251.00	0.003191	0.80	0.102691	25.78
2072	78	251.00	0.002961	0.74	0.099700	25.02
2073	79	251.00	0.002748	0.69	0.096796	24.30
2074	80	251.00	0.002550	0.64	0.093977	23.59
2075	81	251.00	0.002367	0.59	0.091240	22.90

Table A–3. Annual Equivalent Increased Pumping Cost – M&I Pumpers – Lower Snake – CONT

SOS9c – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	251.00	0.002197	0.55	0.088582	22.23
2077	83	251.00	0.002039	0.51	0.086002	21.59
2078	84	251.00	0.001892	0.47	0.083497	20.96
2079	85	251.00	0.001756	0.44	0.081065	20.35
2080	86	251.00	0.001630	0.41	0.078704	19.75
2081	87	251.00	0.001513	0.38	0.076412	19.18
2082	88	251.00	0.001404	0.35	0.074186	18.62
2083	89	251.00	0.001303	0.33	0.072026	18.08
2084	90	251.00	0.001209	0.30	0.069928	17.55
2085	91	5,245.00	0.001122	5.89	0.067891	356.09
2086	92	251.00	0.001041	0.26	0.065914	16.54
2087	93	251.00	0.000966	0.24	0.063994	16.06
2088	94	251.00	0.000897	0.23	0.062130	15.59
2089	95	251.00	0.000832	0.21	0.060320	15.14
2090	96	251.00	0.000773	0.19	0.058563	14.70
2091	97	251.00	0.000717	0.18	0.056858	14.27
2092	98	251.00	0.000665	0.17	0.055202	13.86
2093	99	251.00	0.000618	0.16	0.053594	13.45
2094	100	251.00	0.000573	0.14	0.052033	13.06
			Sum of PW	4,365.86	Sum of PW	13,452.95
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	338.549	An. Equiv =	425.741

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day

SOS5b						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	0.00	0.439957	0.00	0.722421	0.00
2006	12	0.00	0.408312	0.00	0.701380	0.00
2007	13	0.00	0.378944	0.00	0.680951	0.00
2008	14	0.00	0.351688	0.00	0.661118	0.00
2009	15	0.00	0.326393	0.00	0.641862	0.00
2010	16	38,698.95	0.302917	11,722.57	0.623167	24115.91
2011	17	2,551.75	0.281129	717.37	0.605016	1543.85
2012	18	2,551.75	0.260909	665.77	0.587395	1498.88
2013	19	2,551.75	0.242143	617.89	0.570286	1455.23
2014	20	2,551.75	0.224727	573.45	0.553676	1412.84
2015	21	2,551.75	0.208563	532.20	0.537549	1371.69
2016	22	2,551.75	0.193562	493.92	0.521893	1331.74
2017	23	2,551.75	0.179640	458.40	0.506692	1292.95
2018	24	2,551.75	0.166719	425.43	0.491934	1255.29
2019	25	2,551.75	0.154728	394.83	0.477606	1218.73
2020	26	2,551.75	0.143599	366.43	0.463695	1183.23
2021	27	2,551.75	0.133270	340.07	0.450189	1148.77

Table A-4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	2,551.75	0.123685	315.61	0.437077	1115.31
2023	29	2,551.75	0.114789	292.91	0.424346	1082.83
2024	30	2,551.75	0.106532	271.84	0.411987	1051.29
2025	31	2,551.75	0.098870	252.29	0.399987	1020.67
2026	32	2,551.75	0.091759	234.15	0.388337	990.94
2027	33	2,551.75	0.085159	217.30	0.377026	962.08
2028	34	2,551.75	0.079034	201.67	0.366045	934.06
2029	35	2,551.75	0.073349	187.17	0.355383	906.85
2030	36	8,301.75	0.068073	565.13	0.345032	2864.37
2031	37	2,551.75	0.063177	161.21	0.334983	854.79
2032	38	2,551.75	0.058633	149.62	0.325226	829.90
2033	39	2,551.75	0.054416	138.86	0.315754	805.72
2034	40	2,551.75	0.050502	128.87	0.306557	782.26
2035	41	2,551.75	0.046870	119.60	0.297628	759.47
2036	42	2,551.75	0.043499	111.00	0.288959	737.35
2037	43	2,551.75	0.040370	103.01	0.280543	715.88
2038	44	2,551.75	0.037466	95.60	0.272372	695.02
2039	45	2,551.75	0.034771	88.73	0.264439	674.78
2040	46	32,391.75	0.032270	1,045.30	0.256737	8316.15
2041	47	2,551.75	0.029949	76.42	0.249259	636.05
2042	48	2,551.75	0.027795	70.93	0.241999	617.52
2043	49	2,551.75	0.025796	65.83	0.234950	599.53
2044	50	2,551.75	0.023941	61.09	0.228107	582.07
2045	51	2,551.75	0.022219	56.70	0.221463	565.12
2046	52	2,551.75	0.020621	52.62	0.215013	548.66
2047	53	2,551.75	0.019137	48.83	0.208750	532.68
2048	54	2,551.75	0.017761	45.32	0.202670	517.16

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	2,551.75	0.016484	42.06	0.196767	502.10
2050	56	8,301.75	0.015298	127.00	0.191036	1585.93
2051	57	2,551.75	0.014198	36.23	0.185472	473.28
2052	58	2,551.75	0.013176	33.62	0.180070	459.49
2053	59	2,551.75	0.012229	31.20	0.174825	446.11
2054	60	2,551.75	0.011349	28.96	0.169733	433.12
2055	61	2,551.75	0.010533	26.88	0.164789	420.50
2056	62	2,551.75	0.009775	24.94	0.159990	408.25
2057	63	2,551.75	0.009072	23.15	0.155330	396.36
2058	64	2,551.75	0.008420	21.48	0.150806	384.82
2059	65	2,551.75	0.007814	19.94	0.146413	373.61
2060	66	3,108.95	0.007252	22.55	0.142149	441.93
2061	67	2,551.75	0.006730	17.17	0.138009	352.16
2062	68	2,551.75	0.006246	15.94	0.133989	341.91
2063	69	2,551.75	0.005797	14.79	0.130086	331.95
2064	70	2,551.75	0.005380	13.73	0.126297	322.28
2065	71	2,551.75	0.004993	12.74	0.122619	312.89
2066	72	2,551.75	0.004634	11.82	0.119047	303.78
2067	73	2,551.75	0.004301	10.97	0.115580	294.93
2068	74	2,551.75	0.003991	10.18	0.112214	286.34
2069	75	2,551.75	0.003704	9.45	0.108945	278.00
2070	76	38,141.75	0.003438	131.13	0.105772	4034.33
2071	77	2,551.75	0.003191	8.14	0.102691	262.04
2072	78	2,551.75	0.002961	7.56	0.099700	254.41
2073	79	2,551.75	0.002748	7.01	0.096796	247.00
2074	80	2,551.75	0.002550	6.51	0.093977	239.81
2075	81	2,551.75	0.002367	6.04	0.091240	232.82

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS5b – CONT						
Implementation year = 2010 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	2,551.75	0.002197	5.61	0.088582	226.04
2077	83	2,551.75	0.002039	5.20	0.086002	219.46
2078	84	2,551.75	0.001892	4.83	0.083497	213.06
2079	85	2,551.75	0.001756	4.48	0.081065	206.86
2080	86	2,551.75	0.001630	4.16	0.078704	200.83
2081	87	2,551.75	0.001513	3.86	0.076412	194.98
2082	88	2,551.75	0.001404	3.58	0.074186	189.31
2083	89	2,551.75	0.001303	3.32	0.072026	183.79
2084	90	2,551.75	0.001209	3.09	0.069928	178.44
2085	91	2,551.75	0.001122	2.86	0.067891	173.24
2086	92	2,551.75	0.001041	2.66	0.065914	168.20
2087	93	2,551.75	0.000966	2.47	0.063994	163.30
2088	94	2,551.75	0.000897	2.29	0.062130	158.54
2089	95	2,551.75	0.000832	2.12	0.060320	153.92
2090	96	8,301.75	0.000773	6.41	0.058563	486.18
2091	97	2,551.75	0.000717	1.83	0.056858	145.09
2092	98	2,551.75	0.000665	1.70	0.055202	140.86
2093	99	2,551.75	0.000618	1.58	0.053594	136.76
2094	100	2,551.75	0.000573	1.46	0.052033	132.77
			Sum of PW	23,250.65	Sum of PW	87,619.41
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	1,802.959	An. Equiv =	2,772.862

Table A-4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS6b, SOS9a, SOS9c						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	0.00	0.638993	0.00	0.837484	0.00
2001	7	0.00	0.593033	0.00	0.813092	0.00
2002	8	0.00	0.550379	0.00	0.789409	0.00
2003	9	0.00	0.510792	0.00	0.766417	0.00
2004	10	0.00	0.474053	0.00	0.744094	0.00
2005	11	38,698.75	0.439957	17,025.77	0.722421	27956.80
2006	12	2,551.75	0.408312	1,041.91	0.701380	1789.75
2007	13	2,551.75	0.378944	966.97	0.680951	1737.62
2008	14	2,551.75	0.351688	897.42	0.661118	1687.01
2009	15	2,551.75	0.326393	832.87	0.641862	1637.87
2010	16	2,551.75	0.302917	772.97	0.623167	1590.17
2011	17	2,551.75	0.281129	717.37	0.605016	1543.85
2012	18	2,551.75	0.260909	665.77	0.587395	1498.88
2013	19	2,551.75	0.242143	617.89	0.570286	1455.23
2014	20	2,551.75	0.224727	573.45	0.553676	1412.84
2015	21	2,551.75	0.208563	532.20	0.537549	1371.69
2016	22	2,551.75	0.193562	493.92	0.521893	1331.74
2017	23	2,551.75	0.179640	458.40	0.506692	1292.95
2018	24	2,551.75	0.166719	425.43	0.491934	1255.29
2019	25	2,551.75	0.154728	394.83	0.477606	1218.73
2020	26	2,551.75	0.143599	366.43	0.463695	1183.23
2021	27	2,551.75	0.133270	340.07	0.450189	1148.77

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS6b, SOS9a, SOS9c – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	2,551.75	0.123685	315.61	0.437077	1115.31
2023	29	2,551.75	0.114789	292.91	0.424346	1082.83
2024	30	2,551.75	0.106532	271.84	0.411987	1051.29
2025	31	8,301.75	0.098870	820.79	0.399987	3320.59
2026	32	2,551.75	0.091759	234.15	0.388337	990.94
2027	33	2,551.75	0.085159	217.30	0.377026	962.08
2028	34	2,551.75	0.079034	201.67	0.366045	934.06
2029	35	2,551.75	0.073349	187.17	0.355383	906.85
2030	36	2,551.75	0.068073	173.71	0.345032	880.44
2031	37	2,551.75	0.063177	161.21	0.334983	854.79
2032	38	2,551.75	0.058633	149.62	0.325226	829.90
2033	39	2,551.75	0.054416	138.86	0.315754	805.72
2034	40	2,551.75	0.050502	128.87	0.306557	782.26
2035	41	32,391.75	0.046870	1,518.19	0.297628	9640.69
2036	42	2,551.75	0.043499	111.00	0.288959	737.35
2037	43	2,551.75	0.040370	103.01	0.280543	715.88
2038	44	2,551.75	0.037466	95.60	0.272372	695.02
2039	45	2,551.75	0.034771	88.73	0.264439	674.78
2040	46	2,551.75	0.032270	82.35	0.256737	655.13
2041	47	2,551.75	0.029949	76.42	0.249259	636.05
2042	48	2,551.75	0.027795	70.93	0.241999	617.52
2043	49	2,551.75	0.025796	65.83	0.234950	599.53
2044	50	2,551.75	0.023941	61.09	0.228107	582.07
2045	51	8,301.75	0.022219	184.45	0.221463	1838.53
2046	52	2,551.75	0.020621	52.62	0.215013	548.66
2047	53	2,551.75	0.019137	48.83	0.208750	532.68
2048	54	2,551.75	0.017761	45.32	0.202670	517.16

Table A-4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS6b, SOS9a, SOS9c – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	2,551.75	0.016484	42.06	0.196767	502.10
2050	56	2,551.75	0.015298	39.04	0.191036	487.48
2051	57	2,551.75	0.014198	36.23	0.185472	473.28
2052	58	2,551.75	0.013176	33.62	0.180070	459.49
2053	59	2,551.75	0.012229	31.20	0.174825	446.11
2054	60	2,551.75	0.011349	28.96	0.169733	433.12
2055	61	3,108.95	0.010533	32.75	0.164789	512.32
2056	62	2,551.75	0.009775	24.94	0.159990	408.25
2057	63	2,551.75	0.009072	23.15	0.155330	396.36
2058	64	2,551.75	0.008420	21.48	0.150806	384.82
2059	65	2,551.75	0.007814	19.94	0.146413	373.61
2060	66	2,551.75	0.007252	18.51	0.142149	362.73
2061	67	2,551.75	0.006730	17.17	0.138009	352.16
2062	68	2,551.75	0.006246	15.94	0.133989	341.91
2063	69	2,551.75	0.005797	14.79	0.130086	331.95
2064	70	2,551.75	0.005380	13.73	0.126297	322.28
2065	71	38,141.75	0.004993	190.45	0.122619	4676.90
2066	72	2,551.75	0.004634	11.82	0.119047	303.78
2067	73	2,551.75	0.004301	10.97	0.115580	294.93
2068	74	2,551.75	0.003991	10.18	0.112214	286.34
2069	75	2,551.75	0.003704	9.45	0.108945	278.00
2070	76	2,551.75	0.003438	8.77	0.105772	269.90
2071	77	2,551.75	0.003191	8.14	0.102691	262.04
2072	78	2,551.75	0.002961	7.56	0.099700	254.41
2073	79	2,551.75	0.002748	7.01	0.096796	247.00
2074	80	2,551.75	0.002550	6.51	0.093977	239.81
2075	81	2,551.75	0.002367	6.04	0.091240	232.82

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS6b, SOS9a, SOS9c – CONT						
Implementation year = 2005 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	2,551.75	0.002197	5.61	0.088582	226.04
2077	83	2,551.75	0.002039	5.20	0.086002	219.46
2078	84	2,551.75	0.001892	4.83	0.083497	213.06
2079	85	2,551.75	0.001756	4.48	0.081065	206.86
2080	86	2,551.75	0.001630	4.16	0.078704	200.83
2081	87	2,551.75	0.001513	3.86	0.076412	194.98
2082	88	2,551.75	0.001404	3.58	0.074186	189.31
2083	89	2,551.75	0.001303	3.32	0.072026	183.79
2084	90	2,551.75	0.001209	3.09	0.069928	178.44
2085	91	8,301.75	0.001122	9.32	0.067891	563.61
2086	92	2,551.75	0.001041	2.66	0.065914	168.20
2087	93	2,551.75	0.000966	2.47	0.063994	163.30
2088	94	2,551.75	0.000897	2.29	0.062130	158.54
2089	95	2,551.75	0.000832	2.12	0.060320	153.92
2090	96	2,551.75	0.000773	1.97	0.058563	149.44
2091	97	2,551.75	0.000717	1.83	0.056858	145.09
2092	98	2,551.75	0.000665	1.70	0.055202	140.86
2093	99	2,551.75	0.000618	1.58	0.053594	136.76
2094	100	2,551.75	0.000573	1.46	0.052033	132.77
			Sum of PW	33,777.71	Sum of PW	102,279.68
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				----------		----------
			An. Equiv =	2,619.274	An. Equiv =	3,236.811

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS5c & SOS6d						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	0.00	0.741875	0.00	0.888487	0.00
1999	5	0.00	0.688515	0.00	0.862609	0.00
2000	6	38,698.75	0.638993	24,728.24	0.837484	32409.59
2001	7	2,551.75	0.593033	1,513.27	0.813092	2074.81
2002	8	2,551.75	0.550379	1,404.43	0.789409	2014.38
2003	9	2,551.75	0.510792	1,303.41	0.766417	1955.70
2004	10	2,551.75	0.474053	1,209.67	0.744094	1898.74
2005	11	2,551.75	0.439957	1,122.66	0.722421	1843.44
2006	12	2,551.75	0.408312	1,041.91	0.701380	1789.75
2007	13	2,551.75	0.378944	966.97	0.680951	1737.62
2008	14	2,551.75	0.351688	897.42	0.661118	1687.01
2009	15	2,551.75	0.326393	832.87	0.641862	1637.87
2010	16	2,551.75	0.302917	772.97	0.623167	1590.17
2011	17	2,551.75	0.281129	717.37	0.605016	1543.85
2012	18	2,551.75	0.260909	665.77	0.587395	1498.88
2013	19	2,551.75	0.242143	617.89	0.570286	1455.23
2014	20	2,551.75	0.224727	573.45	0.553676	1412.84
2015	21	2,551.75	0.208563	532.20	0.537549	1371.69
2016	22	2,551.75	0.193562	493.92	0.521893	1331.74
2017	23	2,551.75	0.179640	458.40	0.506692	1292.95
2018	24	2,551.75	0.166719	425.43	0.491934	1255.29
2019	25	2,551.75	0.154728	394.83	0.477606	1218.73
2020	26	8,301.75	0.143599	1,192.12	0.463695	3849.48
2021	27	2,551.75	0.133270	340.07	0.450189	1148.77

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS5c & SOS6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	2,551.75	0.123685	315.61	0.437077	1115.31
2023	29	2,551.75	0.114789	292.91	0.424346	1082.83
2024	30	2,551.75	0.106532	271.84	0.411987	1051.29
2025	31	2,551.75	0.098870	252.29	0.399987	1020.67
2026	32	2,551.75	0.091759	234.15	0.388337	990.94
2027	33	2,551.75	0.085159	217.30	0.377026	962.08
2028	34	2,551.75	0.079034	201.67	0.366045	934.06
2029	35	2,551.75	0.073349	187.17	0.355383	906.85
2030	36	32,391.75	0.068073	2,205.02	0.345032	11176.20
2031	37	2,551.75	0.063177	161.21	0.334983	854.79
2032	38	2,551.75	0.058633	149.62	0.325226	829.90
2033	39	2,551.75	0.054416	138.86	0.315754	805.72
2034	40	2,551.75	0.050502	128.87	0.306557	782.26
2035	41	2,551.75	0.046870	119.60	0.297628	759.47
2036	42	2,551.75	0.043499	111.00	0.288959	737.35
2037	43	2,551.75	0.040370	103.01	0.280543	715.88
2038	44	2,551.75	0.037466	95.60	0.272372	695.02
2039	45	2,551.75	0.034771	88.73	0.264439	674.78
2040	46	8,301.75	0.032270	267.90	0.256737	2131.36
2041	47	2,551.75	0.029949	76.42	0.249259	636.05
2042	48	2,551.75	0.027795	70.93	0.241999	617.52
2043	49	2,551.75	0.025796	65.83	0.234950	599.53
2044	50	2,551.75	0.023941	61.09	0.228107	582.07
2045	51	2,551.75	0.022219	56.70	0.221463	565.12
2046	52	2,551.75	0.020621	52.62	0.215013	548.66
2047	53	2,551.75	0.019137	48.83	0.208750	532.68
2048	54	2,551.75	0.017761	45.32	0.202670	517.16

Table A-4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS5c & SOS6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	2,551.75	0.016484	42.06	0.196767	502.10
2050	56	3,108.95	0.015298	47.56	0.191036	593.92
2051	57	2,551.75	0.014198	36.23	0.185472	473.28
2052	58	2,551.75	0.013176	33.62	0.180070	459.49
2053	59	2,551.75	0.012229	31.20	0.174825	446.11
2054	60	2,551.75	0.011349	28.96	0.169733	433.12
2055	61	2,551.75	0.010533	26.88	0.164789	420.50
2056	62	2,551.75	0.009775	24.94	0.159990	408.25
2057	63	2,551.75	0.009072	23.15	0.155330	396.36
2058	64	2,551.75	0.008420	21.48	0.150806	384.82
2059	65	2,551.75	0.007814	19.94	0.146413	373.61
2060	66	38,141.75	0.007252	276.61	0.142149	5421.80
2061	67	2,551.75	0.006730	17.17	0.138009	352.16
2062	68	2,551.75	0.006246	15.94	0.133989	341.91
2063	69	2,551.75	0.005797	14.79	0.130086	331.95
2064	70	2,551.75	0.005380	13.73	0.126297	322.28
2065	71	2,551.75	0.004993	12.74	0.122619	312.89
2066	72	2,551.75	0.004634	11.82	0.119047	303.78
2067	73	2,551.75	0.004301	10.97	0.115580	294.93
2068	74	2,551.75	0.003991	10.18	0.112214	286.34
2069	75	2,551.75	0.003704	9.45	0.108945	278.00
2070	76	2,551.75	0.003438	8.77	0.105772	269.90
2071	77	2,551.75	0.003191	8.14	0.102691	262.04
2072	78	2,551.75	0.002961	7.56	0.099700	254.41
2073	79	2,551.75	0.002748	7.01	0.096796	247.00
2074	80	2,551.75	0.002550	6.51	0.093977	239.81
2075	81	2,551.75	0.002367	6.04	0.091240	232.82

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

SOS5c & SOS6d – CONT						
Implementation year = 2000 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	**Project Year**	**Pump Cost Increase $000**	**Present Worth Fact @7.75%**	**Present Worth–Cost col c x d**	**Present Worth Fact @ 3 %**	**Present Worth–Cost col c x f**
2076	82	2,551.75	0.002197	5.61	0.088582	226.04
2077	83	2,551.75	0.002039	5.20	0.086002	219.46
2078	84	2,551.75	0.001892	4.83	0.083497	213.06
2079	85	2,551.75	0.001756	4.48	0.081065	206.86
2080	86	8,301.75	0.001630	13.53	0.078704	653.38
2081	87	2,551.75	0.001513	3.86	0.076412	194.98
2082	88	2,551.75	0.001404	3.58	0.074186	189.31
2083	89	2,551.75	0.001303	3.32	0.072026	183.79
2084	90	2,551.75	0.001209	3.09	0.069928	178.44
2085	91	2,551.75	0.001122	2.86	0.067891	173.24
2086	92	2,551.75	0.001041	2.66	0.065914	168.20
2087	93	2,551.75	0.000966	2.47	0.063994	163.30
2088	94	2,551.75	0.000897	2.29	0.062130	158.54
2089	95	2,551.75	0.000832	2.12	0.060320	153.92
2090	96	32,391.75	0.000773	25.03	0.058563	1896.97
2091	97	2,551.75	0.000717	1.83	0.056858	145.09
2092	98	2,551.75	0.000665	1.70	0.055202	140.86
2093	99	2,551.75	0.000618	1.58	0.053594	136.76
2094	100	2,551.75	0.000573	1.46	0.052033	132.77
			Sum of PW	49,090.35	Sum of PW	121,022.63
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	3,806.684	An. Equiv =	3,829.963

Table A-4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

Pref. Alt.						
Implementation year = 1998 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
1995	1	0.00	0.928074	0.00	0.970874	0.00
1996	2	0.00	0.861322	0.00	0.942596	0.00
1997	3	0.00	0.799371	0.00	0.915142	0.00
1998	4	42,075.75	0.741875	31,214.96	0.888487	37383.76
1999	5	2,551.75	0.688515	1,756.92	0.862609	2201.16
2000	6	2,551.75	0.638993	1,630.55	0.837484	2137.05
2001	7	2,551.75	0.593033	1,513.27	0.813092	2074.81
2002	8	2,551.75	0.550379	1,404.43	0.789409	2014.38
2003	9	2,551.75	0.510792	1,303.41	0.766417	1955.70
2004	10	2,551.75	0.474053	1,209.67	0.744094	1898.74
2005	11	2,551.75	0.439957	1,122.66	0.722421	1843.44
2006	12	2,551.75	0.408312	1,041.91	0.701380	1789.75
2007	13	2,551.75	0.378944	966.97	0.680951	1737.62
2008	14	2,551.75	0.351688	897.42	0.661118	1687.01
2009	15	2,551.75	0.326393	832.87	0.641862	1637.87
2010	16	2,551.75	0.302917	772.97	0.623167	1590.17
2011	17	2,551.75	0.281129	717.37	0.605016	1543.85
2012	18	2,551.75	0.260909	665.77	0.587395	1498.88
2013	19	2,551.75	0.242143	617.89	0.570286	1455.23
2014	20	2,551.75	0.224727	573.45	0.553676	1412.84
2015	21	2,551.75	0.208563	532.20	0.537549	1371.69
2016	22	2,551.75	0.193562	493.92	0.521893	1331.74
2017	23	2,551.75	0.179640	458.40	0.506692	1292.95
2018	24	11,678.55	0.166719	1,947.04	0.491934	5745.07
2019	25	2,551.75	0.154728	394.83	0.477606	1218.73
2020	26	2,551.75	0.143599	366.43	0.463695	1183.23
2021	27	2,551.75	0.133270	340.07	0.450189	1148.77

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

Pref. Alt. – CONT						
Implementation year = 1998 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2022	28	2,551.75	0.123685	315.61	0.437077	1115.31
2023	29	2,551.75	0.114789	292.91	0.424346	1082.83
2024	30	2,551.75	0.106532	271.84	0.411987	1051.29
2025	31	2,551.75	0.098870	252.29	0.399987	1020.67
2026	32	2,551.75	0.091759	234.15	0.388337	990.94
2027	33	2,551.75	0.085159	217.30	0.377026	962.08
2028	34	32,391.75	0.079034	2,560.04	0.366045	11856.83
2029	35	2,551.75	0.073349	187.17	0.355383	906.85
2030	36	2,551.75	0.068073	173.71	0.345032	880.44
2031	37	2,551.75	0.063177	161.21	0.334983	854.79
2032	38	2,551.75	0.058633	149.62	0.325226	829.90
2033	39	2,551.75	0.054416	138.86	0.315754	805.72
2034	40	2,551.75	0.050502	128.87	0.306557	782.26
2035	41	2,551.75	0.046870	119.60	0.297628	759.47
2036	42	2,551.75	0.043499	111.00	0.288959	737.35
2037	43	2,551.75	0.040370	103.01	0.280543	715.88
2038	44	11,678.55	0.037466	437.55	0.272372	3180.91
2039	45	2,551.75	0.034771	88.73	0.264439	674.78
2040	46	2,551.75	0.032270	82.35	0.256737	655.13
2041	47	2,551.75	0.029949	76.42	0.249259	636.05
2042	48	2,551.75	0.027795	70.93	0.241999	617.52
2043	49	2,551.75	0.025796	65.83	0.234950	599.53
2044	50	2,551.75	0.023941	61.09	0.228107	582.07
2045	51	2,551.75	0.022219	56.70	0.221463	565.12
2046	52	2,551.75	0.020621	52.62	0.215013	548.66
2047	53	2,551.75	0.019137	48.83	0.208750	532.68
2048	54	3,108.95	0.017761	55.22	0.202670	630.09

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

Pref. Alt. – CONT						
Implementation year = 1998 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2049	55	2,551.75	0.016484	42.06	0.196767	502.10
2050	56	2,551.75	0.015298	39.04	0.191036	487.48
2051	57	2,551.75	0.014198	36.23	0.185472	473.28
2052	58	2,551.75	0.013176	33.62	0.180070	459.49
2053	59	2,551.75	0.012229	31.20	0.174825	446.11
2054	60	2,551.75	0.011349	28.96	0.169733	433.12
2055	61	2,551.75	0.010533	26.88	0.164789	420.50
2056	62	2,551.75	0.009775	24.94	0.159990	408.25
2057	63	2,551.75	0.009072	23.15	0.155330	396.36
2058	64	41,518.55	0.008420	349.57	0.150806	6261.23
2059	65	2,551.75	0.007814	19.94	0.146413	373.61
2060	66	2,551.75	0.007252	18.51	0.142149	362.73
2061	67	2,551.75	0.006730	17.17	0.138009	352.16
2062	68	2,551.75	0.006246	15.94	0.133989	341.91
2063	69	2,551.75	0.005797	14.79	0.130086	331.95
2064	70	2,551.75	0.005380	13.73	0.126297	322.28
2065	71	2,551.75	0.004993	12.74	0.122619	312.89
2066	72	2,551.75	0.004634	11.82	0.119047	303.78
2067	73	2,551.75	0.004301	10.97	0.115580	294.93
2068	74	2,551.75	0.003991	10.18	0.112214	286.34
2069	75	2,551.75	0.003704	9.45	0.108945	278.00
2070	76	2,551.75	0.003438	8.77	0.105772	269.90
2071	77	2,551.75	0.003191	8.14	0.102691	262.04
2072	78	2,551.75	0.002961	7.56	0.099700	254.41
2073	79	2,551.75	0.002748	7.01	0.096796	247.00
2074	80	2,551.75	0.002550	6.51	0.093977	239.81
2075	81	2,551.75	0.002367	6.04	0.091240	232.82

Table A–4. Annual Equivalent Increased Pumping Cost – M&I Pumpers – John Day – CONT

Pref. Alt. – CONT						
Implementation year = 1998 First year of analysis = 1995 (year 1), and 100 year analysis Costs present worthed an amortized at 7.75 % & 3.0 %						
A	B	C	D	E	F	G
Year of Analysis	Project Year	Pump Cost Increase $000	Present Worth Fact @7.75%	Present Worth–Cost col c x d	Present Worth Fact @ 3 %	Present Worth–Cost col c x f
2076	82	2,551.75	0.002197	5.61	0.088582	226.04
2077	83	2,551.75	0.002039	5.20	0.086002	219.46
2078	84	11,678.55	0.001892	22.10	0.083497	975.13
2079	85	2,551.75	0.001756	4.48	0.081065	206.86
2080	86	2,551.75	0.001630	4.16	0.078704	200.83
2081	87	2,551.75	0.001513	3.86	0.076412	194.98
2082	88	2,551.75	0.001404	3.58	0.074186	189.31
2083	89	2,551.75	0.001303	3.32	0.072026	183.79
2084	90	2,551.75	0.001209	3.09	0.069928	178.44
2085	91	2,551.75	0.001122	2.86	0.067891	173.24
2086	92	2,551.75	0.001041	2.66	0.065914	168.20
2087	93	2,551.75	0.000966	2.47	0.063994	163.30
2088	94	32,391.75	0.000897	29.05	0.062130	2012.50
2089	95	2,551.75	0.000832	2.12	0.060320	153.92
2090	96	2,551.75	0.000773	1.97	0.058563	149.44
2091	97	2,551.75	0.000717	1.83	0.056858	145.09
2092	98	2,551.75	0.000665	1.70	0.055202	140.86
2093	99	2,551.75	0.000618	1.58	0.053594	136.76
2094	100	2,551.75	0.000573	1.46	0.052033	132.77
			Sum of PW	60,226.87	Sum of PW	135,034.97
		100 yr	Amtz @7.75	0.07754444	Amtz @ 3 %	0.03164667
				---------		---------
			An. Equiv =	4,670.259	An. Equiv =	4,273.406

Table A–5. Irrigation Pumping Requirement – Grand Coulee Reservoir

SOR Alternatives – Impact on Irrigation Pumping (Irrigation pumping from FDR to Banks Lake – Federal Columbia Basin Project)				
SOR Study No.	Annual Megawatt Hrs of Pumping (monthly analysis)1/	Value of Energy Cost of Service 2/ @ $.95/mwh	Value of Energy (rounded)	Implementation Date
SOS1a	968,701	$920,266	$920,300	1995
SOS1b	968,667	$920,234	$920,200	1995
SOS2c	959,254	$911,291	$911,300	1995
SOS2d	955,776	$907,987	$908,000	1995
SOS4c	939,874	$892,880	$892,900	1995
SOS5b	959,279	$911,315	$911,300	2010
SOS5c	959,279	$911,315	$911,300	2000
SOS6b	959,279	$911,315	$911,300	2005
SOS6d	959,279	$911,315	$911,300	2000
SOS9a	995,961	$946,163	$946,200	2005
SOS9b	964.975	$916,726	$916,700	1995
SOS9c	965,614	$917,333	$917,300	2005
Pref. Alt.	956,300	$908,485	$908,500	1998

1/ Based on: End of month elev at FDR for 1929–76 period of record, current level of irrigation pumping by month (5yr ave 1988–92), monthly elevations at Banks lake using 5 yr ave (1988–92), and pumping efficiency function utilzing data furnished by Reclamation.

2/ Current rate charged the Columbia Basin Project irrigation districts (3).

Incremental Analysis – Pumping Cost				
SOR Study No.	Implementation Date	Cost of Pumping	Incremental Annual Increased Pumping Cost (@3 & 7.75%) SOS1a 3/	SOS2c 4/
SOS1a	1995	$920,300	0	9,000
SOS1b	1995	$920,200	(100)	8,900
SOS2c	1995	$911,300	(9,000)	0
SOS2d	1995	$908,000	(12,300)	(3,300)
SOS4c	1995	$892,900	(27,400)	(18,400)
SOS5b	2010	$911,300	(9,000)	0
SOS5c	2000	$911,300	(9,000)	0
SOS6b	2005	$911,300	(9,000)	0
SOS6d	2000	$911,300	(9,000)	0
SOS9a	2005	$946,200	25,900	34,900
SOS9b	1995	$916,700	(3,600)	5,400
SOS9c	2005	$917,300	(3,000)	6,000
Pref. Alt.	1998	$908,500	(11,800)	(2,800)

3/ Respective plan less SOS1a, Negative numbers mean a reduction in pumping cost.

4/ Respective plan less SOS2c, Negative numbers mean a reduction in pumping cost.

Table A–6. SOR Plans – Annual Equivalent Pumping Cost Summary

Ice Harbor – Agr Pumpers 36,389 acres				
Plan	Implemention Date	Increased Pumping Required	Annual Equiv @3.0 %	Annual Equiv @7.75 %
SOS1a	1995	no	0	0
SOS1b	1995	no	0	0
SOS2c	1995	no	0	0
SOS2d	1995	no	0	0
SOS4c	1995	no	0	0
SOS5b	2010	yes	2,305,400	1,443,800
SOS5c	2000	yes	3,164,700	3,072,900
SOS6b	2005	yes	1,377,400	1 ,080,900
SOS6d	2000	no	0	0
SOS9a	2005	yes	1,378,100	1,081,300
SOS9b	1995	no	0	0
SOS9c	2005	yes	1,427,600	1,126,200
Pref Alt	1998	no	0	0

John Day – Agr Pumpers 139,500 acres				
Plan	Implemention Date	Increased Pumping Required	Annual Equiv @3.0 %	Annual Equiv @7.75 %
SOS1a	1995	no	0	0
SOS1b	1995	no	0	0
SOS2c	1995	no	0	0
SOS2d	1995	no	0	0
SOS4c	1995	no	0	0
SOS5b	2010	yes	1,013,800	650,700
SOS5c	2000	yes	1,375,000	1 ,373,000
SOS6b	2005	yes	1,181,100	945,200
SOS6d	2000	yes	1,375,000	1,373,000
SOS9a	2005	yes	945,900	748,400
SOS9b	1995	no	0	0
SOS9c	2005	yes	1,213,200	966,100
Pref Alt	1998	yes	1,540,200	1,663,700

Table A-6. SOR Plans – Annual Equivalent Pumping Cost – CONT

M&I Pumpers								
Plan	Implemen-tion Date	Increased Pumping Required	Lower S. An. Equiv Value @3.0 %	John Day An. Equiv Value @3.0 %	Total @3.0 %	Lower S. An. Equiv Value @7.75 %	John Day An. Equiv Value @7.75 %	Total @7.75 %
SOS1a	1995	no	0	0	0	0	0	0
SOS1b	1995	no	0	0	0	0	0	0
SOS2c	1995	no	0	0	0	0	0	0
SOS2d	1995	no	0	0	0	0	0	0
SOS4c	1995	no	0	0	0	0	0	0
SOS5b	2010	yes	484,000	2,772,900	3,256,900	308,100	1,803,000	2,111,100
SOS5c	2000	yes	690,100	3,830,000	4,520,100	677,100	3,806,700	4,483,800
SOS6b	2005	yes	380,500	3,236,800	3,617,300	302,300	2,619,300	2,921,600
SOS6d	2000	yes	296,200	3,830,000	4,126,200	293,800	3,806,700	4,100,500
SOS9a	2005	yes	379,200	3,236,800	3,616,000	301,300	2,619,300	2,920,600
SOS9b	1995	no	0	0	0	0	0	0
SOS9c	2005	yes	425,700	3,236,800	3,662,500	338,500	2,619,300	2,957,800
Pref Alt	1998	yes	0	4,273,400	4,273,400	0	4,670,300	4,670,300

Table A–7. Summary of Impacts – Incremental Increase in Pumping Cost – 3 %

Plan	Implemention Date	Ice Harbor Irrig Pump @3 %	John Day Irrig Pump @3 %	M&I Pumpers @3 %	Grand Coulee Irrig Pump SOS1a	Total Pumping Cost SOS1a	Grand Coulee Irrig Pump SOS2c	Total Pumping Cost SOS2c
SOS1a	1995	0	0	0	0	0	9,000	9,000
SOS1b	1995	0	0	0	(100)	(100)	8,900	8,900
SOS2c	1995	0	0	0	(9,000)	(9,000)	0	0
SOS2d	1995	0	0	0	(12,300)	(12,300)	(3,300)	(3,300)
SOS4c	1995	0	0	0	(27,400)	(27,400)	(18,400)	(18,400)
SOS5b	2010	2,305,400	1,013,800	3,256,900	(9,000)	6,567,100	0	6,576,100
SOS5c	2000	3,164,700	1,375,000	4,520,100	(9,000)	9,050,800	0	9,059,800
SOS6b	2005	1,377,400	1,181,100	3,617,300	(9,000)	6,166,800	0	6,175,800
SOS6d	2000	0	1,375,000	4,126,200	(9,000)	5,492,200	0	5,501,200
SOS9a	2005	1,378,100	945,900	3,616,000	25,900	5,965,900	34,900	5,974,900
SOS9b	1995	0	0	0	(3,600)	(3,600)	5,400	5,400
SOS9c	2005	1,427,600	1,213,200	3,662,500	(3,000)	6,300,300	6,000	6,309,300
Pref. Alt.	1998	0	1,540,200	4,273,400	(11,800)	5,801,800	(2,800)	5,810,800

1/ Negative number indicate a reduction in pumping cost (G. Coulee).

Table A–8. Summary of Impacts – Incremental Increase in Pumping Cost @7.75%

Plan	Implemention Date	Ice Harbor Irrig Pump @7.75 %	John Day Irrig Pump @7.75 %	M&I Pumpers @7.75 %	Grand Coulee Irrig Pump SOS1a	Total Pumping Cost SOS1a	Grand Coulee Irrig Pump SOS2c	Total Pumping Cost SOS2c
SOS1a	1995	0	0	0	0	0	9,000	9,000
SOS1b	1995	0	0	0	(100)	(100)	8,900	8,900
SOS2c	1995	0	0	0	(9,000)	(9,000)	0	0
SOS2d	1995	0	0	0	(12,300)	(12,300)	(3,300)	(3,300)
SOS4c	1995	0	0	0	(27,400)	(27,400)	(18,400)	(18,400)
SOS5b	2010	1,443,800	650,700	2,111,100	(9,000)	4,196,600	0	4,205,600
SOS5c	2000	3,072,900	1,373,000	4,483,800	(9,000)	8,920,700	0	8,929,700
SOS6b	2005	1,080,900	945,200	2,921,600	(9,000)	4,938,700	0	4,947,700
SOS6d	2000	0	1,373,000	4,100,500	(9,000)	5,464,500	0	5,473,500
SOS9a	2005	1,081,300	748,400	2,920,600	25,900	4,776,200	34,900	4,785,200
SOS9b	1995	0	0	0	(3,600)	(3,600)	5,400	5,400
SOS9c	2005	1,126,200	966,100	2,957,800	(3,000)	5,047,100	6,000	5,056,100
Pref. Alt.	1998	0	1,663,700	4,670,300	(11,800)	6,322,200	(2,800)	6,331,200

Table A–9. End of Month Reservoir Elevation Yearly Average – 1929–1978

Study No	Reservoir	Month													
		Sept	Oct	Nov	Dec	Jan	Feb	March	April 15	April 30	May	June	July	August 15	August 30
SOS1a	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	263.5	263.5	263.5	263.5	266.5	266.5	266.5
SOS1b	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	263.5	263.5	263.5	263.5	266.5	266.5	266.5
SOS2c	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	262.5	262.5	262.5	262.5	262.5	262.5	262.5
SOS5b	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	262.5	262.5	257.0	257.0	257.0	257.0	257.0
SOS6b	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	262.5	262.5	257.0	257.0	257.0	257.0	257.0
SOS6d	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	262.5	262.5	257.0	257.0	257.0	257.0	257.0
SOS2d	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	262.5	262.5	262.5	262.5	262.5	262.5	262.5
SOS4c	John Day	265.0	265.0	263.5	263.5	263.5	263.5	263.5	263.5	263.5	263.5	263.5	265.0	265.0	265.0
SOS5c	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	262.5	262.5	257.0	257.0	257.0	257.0	257.0
SOS9a	John Day	266.9	265.0	265.0	265.0	265.0	265.0	265.0	265.0	257.5	257.5	257.5	257.5	257.5	257.5
SOS9b	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	262.5	262.5	262.5	262.5	262.5	262.5	262.5
SOS9c	John Day	266.5	265.0	263.5	263.5	263.5	263.5	263.5	257.0	257.0	257.0	257.0	257.0	257.0	257.0
Pref. Alt.	John Day	257.0	257.0	257.0	257.0	257.0	257.0	257.0	257.0	257.0	257.0	257.0	257.0	257.0	257.0

Table A–9. End of Month Reservoir Elevation Yearly Average – 1929–1978 – CONT

Study No	Reservoir	Month													
		Sept	Oct	Nov	Dec	Jan	Feb	March	April 15	April 30	May	June	July	August 15	August 30
SOS1a	G Coulee	1288.9	1268.8	1288.8	1286.8	1264.1	1250.8	1238.5	1232.1	1230.6	1244.4	1284.6	1289.9	1289.7	1289.8
SOS1b	G Coulee	1288.8	1288.6	1288.9	1286.6	1263.7	1250.1	1237.3	1230.5	1229.4	1246.5	1285.0	1269.7	1289.7	1289.7
SOS2c	G Coulee	1288.9	1289.0	1289.0	1286.7	1271.0	1260.9	1247.2	1240.3	1238.4	1254.4	1285.4	1289.7	1289.7	1289.7
SOS5b	G Coulee	1288.9	1289.0	1289.0	1286.7	1271.0	1260.9	1247.4	1239.9	1238.4	1254.4	1285.4	1289.7	1289.7	1289.7
SOS6b	G Coulee	1288.9	1289.0	1289.0	1266.7	1271.0	1260.9	1247.4	1239.9	1238.4	1254.4	1285.4	1289.7	1289.7	1289.7
SOS6d	G Coulee	1288.9	1289.0	1289.0	1286.7	1271.0	1260.9	1247.4	1239.9	1238.4	1254.4	1285.4	1289.7	12897	1289.7
SOS2d	G Coulee	1288.0	1288.0	1288.0	1266.9	1287.0	1273.3	1250.8	1244.9	1242.5	1257.9	1286.0	1287.0	1288.2	1288.2
SOS4c	G Coulee	1288.0	1288.0	1288.0	1287.0	1270.0	1260.0	1264.6	1259.9	1255.9	1268.8	1286.5	1288.0	1288.0	1288.0
SOS5c	G Goulee	1288.9	1289.0	1289.0	1286.7	1271.0	1260.9	1247.4	1239.9	1238.4	1254.4	1285.4	1289.7	1289.7	1289.7
SOS9a	G Coulee	1251.9	1256.1	1271.5	1278.2	1284.9	1284.1	1267.1	1254.5	1235.6	1244.2	1275.9	1265.3	1260.4	1249.2
SOS9b	G Coulee	1268.5	1277.6	1286.1	1289.0	1289.2	1287.1	1269.5	1256.1	1241.9	1253.8	1278.5	1281.3	1277.2	1271.3
SOS9c	G Coulee	1285.1	1287.7	1288.0	1286.9	1286.5	1272.6	1250.2	1243.1	1234.1	1248.8	1284.3	1286.2	1284.0	1281.3
Pref. Alt.	G Coulee	1282.4	1287.2	1288.6	1288.3	1286.9	1284.1	1264.8	1252.8	1238.3	1253.3	1283.8	1285.9	1282.5	1280.5

Table A–9. End of Month Reservoir Elevation Yearly Average – 1929–1978 – CONT

Study No	Reservoir	Month													
		Sept	Oct	Nov	Dec	Jan	Feb	March	April 15	April 30	May	June	July	August 15	August 30
SOS1a	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3	725.1	735.3	735.3	735.3	735.3
SOS1b	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3	735.3
SOS2c	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	733.5	733.5	733.5	733.5	733.5	733.5	735.3	735.3
SOS5b	Lower Granite	735.3	735.3	735.3	735.3	735.3	715.0	653.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0
SOS6b	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	735.0	705.0	705.0	705.0	705.0	705.0	705.0	705.0
SOS6d	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	735.0	705.0	705.0	705.0	705.0	705.0	705.0	705.0
SOS2d	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	735.3	733.5	733.5	733.5	733.5	733.5	735.3	735.3
SOS4c	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	735.3	733.5	733.5	733.5	733.5	733.5	735.3	735.3
SOS5c	Lower Granite	624.1	823.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0
SOS9a	Lower Granite	732.9	732.9	732.9	732.9	732.9	732.9	732.9	704.9	704.9	704.9	704.9	704.9	704.9	704.9
SOS9b	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	735.3	733.5	733.5	733.5	733.5	733.5	733.5	733.5
SOS9c	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	695.0	695.0	695.0	695.0	735.3	735.3	735.3	735.3
Pref. Alt.	Lower Granite	735.3	735.3	735.3	735.3	735.3	735.3	735.3	733.5	733.5	733.5	733.5	733.5	733.5	733.5

Table A-9. End of Month Reservoir Elevation Yearly Average – 1929–1978 – CONT

Study No	Reservoir	Month													
		Sept	Oct	Nov	Dec	Jan	Feb	March	April 15	April 30	May	June	July	August 15	August 30
SOS1a	Little Goose	638.2	636.2	636.2	636.2	636.2	636.2	636.2	636.2	836.2	636.2	636.2	636.2	636.2	636.2
SOS1b	Little Goose	636.2	636.2	636.2	636.2	636.2	636.2	636.2	636.2	636.2	636.2	636.2	636.2	636.2	636.2
SOS2c	Little Goose	636.2	636.2	636.2	636.2	636.2	636.2	636.2	633.5	633.5	633.5	633.5	633.5	636.2	636.2
SOS5b	Little Goose	636.2	636.2	636.2	636.2	638.2	616.0	554.0	524.0	524.0	524.0	524.0	524.0	524.0	524.0
SOS6b	Little Goose	636.2	636.2	636.2	636.2	636.2	636.2	635.0	605.0	605.0	805.0	605.0	605.0	605.0	805.0
SOS6d	Little Goose	636.2	636.2	636.2	636.2	638.2	636.2	636.2	633.5	633.5	633.5	633.5	633.5	636.2	636.2
SOS2d	Little Goose	636.2	636.2	636.2	636.2	636.2	636.2	636.2	633.5	633.5	633.5	633.5	633.5	636.2	636.2
SOS4c	Little Goose	636.2	636.2	636.2	636.2	636.2	636.2	636.2	633.5	633.5	633.5	633.5	633.6	636.2	636.2
SOS5c	Little Goose	525.1	524.0	524.0	524.0	524.0	524.0	524.0	524.0	524.0	524.0	524.0	524.0	524.0	524.0
SOS9a	Little Goose	632.9	632.9	632.9	632.9	632.9	632.9	632.9	604.9	604.9	604.9	604.9	604.9	604.9	604.9
SOS9b	Little Goose	636.2	636.2	636.2	636.2	636.2	636.2	636.2	633.5	633.5	633.5	633.5	633.5	633.5	633.5
SOS9c	Little Goose	636.2	636.2	636.2	636.2	636.2	636.2	595.0	595.0	595.0	595.0	636.2	636.2	636.2	636.2
Pref. Alt.	Little Goose	636.2	636.2	636.2	636.2	636.2	636.2	636.2	633.5	633.5	633.5	633.5	633.5	633.5	633.5

Table A–9. End of Month Reservoir Elevation Yearly Average – 1929–1978 – CONT

Study No	Reservoir	Month													
		Sept	Oct	Nov	Dec	Jan	Feb	March	April 15	April 30	May	June	July	August 15	August 30
SOS1a	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7
SOS1b	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7	538.7
SOS2c	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	538.7	537.5	537.5	537.5	537.5	537.5	538.7	538.7
SOS5b	Lower Monumental	538.7	538.7	538.7	538.7	538.7	524.0	462.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0
SOS6b	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	537.0	507.0	507.0	507.0	507.0	507.0	507.0	507.0
SOS6d	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	538.7	537.5	537.5	537.5	537.5	537.5	538.7	538.7
SOS2d	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	538.7	537.5	537.5	537.5	537.5	537.5	538.7	538.7
SOS4c	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	538.7	537.5	537.5	537.5	537.5	537.5	538.7	538.7
SOS5c	Lower Monumental	433.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0
SOS9a	Lower Monumental	536.5	536.7	536.7	536.9	536.9	536.9	536.9	506.9	507.0	507.0	507.2	506.9	506.9	506.9
SOS9b	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	538.7	537.5	537.5	537.5	537.5	537.5	537.5	537.5
SOS9c	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	495.0	496.6	498.0	498.7	538.7	538.7	538.7	538.7
Pref. Alt.	Lower Monumental	538.7	538.7	538.7	538.7	538.7	538.7	538.7	537.5	537.5	537.5	537.5	537.5	537.5	537.5

Table A–9. End of Month Reservoir Elevation Yearly Average – 1929–1978 – CONT

Study No	Reservoir	Month													
		Sept	Oct	Nov	Dec	Jan	Feb	March	April 15	April 30	May	June	July	August 15	August 30
SOS1a	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7
SOS1b	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7	438.7
SOS2c	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	438.7	437.5	437.5	437.5	437.5	437.5	438.7	438.7
SOS5b	Ice Harbor	438.7	438.7	438.7	438.7	438.7	435.0	373.0	343.0	343.0	343.0	343.0	343.0	343.0	343.0
SOS6b	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	437.0	407.0	407.0	407.0	407.0	407.0	407.0	407.0
SOS6d	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	438.7	437.5	437.5	437.5	437.5	437.5	438.7	438.7
SOS2d	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	438.7	437.5	437.5	437.5	437.5	437.5	438.7	438.7
SOS4c	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	438.7	437.5	437.5	437.5	437.5	437.5	438.7	438.7
SOS5c	Ice Harbor	343.8	343.0	343.0	343.0	343.0	343.0	343.0	343.0	343.0	343.0	343.0	343.0	343.0	343.0
SOS9a	Ice Harbor	437.1	436.9	436.9	436.9	436.9	436.9	436.9	406.9	406.9	406.9	406.9	406.9	406.9	406.9
SOS9b	Ice Harbor	438.7	436.7	438.7	438.7	438.7	438.7	438.7	437.4	437.4	437.4	437.4	437.4	437.4	437.4
SOS9c	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	405.0	405.0	405.0	405.0	438.7	438.7	438.7	438.7
Pref. Alt.	Ice Harbor	438.7	438.7	438.7	438.7	438.7	438.7	438.7	437.5	437.5	437.5	437.5	437.5	437.5	437.5

Table A–10. Mwhrs of Pumping at Grand Coulee

	MEGAWATT HOURS OF PUMPING – SOS 1a													
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97952	54591	292	13	581	101	19744	63680	63808	169522	162298	162271	71998	71998	938848
1930	97952	54591	292	13	586	103	20319	65560	64818	168182	161313	162271	71998	71998	939995
1931	97952	54591	292	13	588	105	20776	68235	67886	174965	161666	163122	72012	72012	954212
1932	97888	54882	296	14	608	115	23131	74464	74464	183024	161450	161901	71998	71998	976232
1933	97952	54591	292	13	600	111	22371	74434	74434	190310	166433	162203	71998	71998	987741
1934	97952	54591	292	13	588	108	22371	74434	74434	180219	159491	161901	71998	71998	970390
1935	97952	54591	292	13	600	111	22371	74434	74434	183596	162238	162220	71998	71998	976849
1936	97952	54591	292	13	600	111	22371	74434	74434	179115	157506	161901	71998	71998	967316
1937	97952	54591	292	13	581	102	20346	67629	67777	176421	162198	162186	71998	71998	954083
1938	97952	54591	292	13	600	111	22371	74434	74434	184740	163701	162745	71998	71998	979980
1939	97952	54591	292	13	581	101	19799	64754	64669	165947	156987	162069	71998	71998	931749
1940	97952	54591	292	13	581	101	19744	63666	63666	163757	157039	162119	71998	71998	927517
1941	97952	54591	292	13	581	101	19744	63666	63666	166229	159564	162271	71998	71998	932666
1942	97952	54591	292	13	600	111	22371	74434	74434	182561	161118	161901	71998	71998	974375
1943	97952	54591	292	13	600	111	22371	74434	74404	183542	164350	163971	71998	71998	980627
1944	97952	54591	292	13	581	101	19744	63673	63707	168428	161548	162271	71480	72100	936480
1945	97144	54595	292	13	592	105	21024	70258	71146	180850	161118	161901	71998	71998	963035
1946	97952	54591	292	13	600	111	22371	74434	74434	182588	161568	162271	71998	71998	975221
1947	97952	54591	292	13	600	111	22371	74434	74434	183024	161450	161901	71998	71998	975170
1948	97952	54591	292	13	600	111	22371	74434	76357	187278	161099	163098	71998	71998	982193
1949	97952	54591	292	13	600	111	22371	74434	74434	176857	156100	161901	71998	71998	963653
1950	97952	54591	292	13	600	111	22371	74434	74434	190651	171118	165247	71998	71998	995811
1951	97952	54591	292	13	600	111	22284	74434	74434	187165	166238	163484	71998	71998	985593
1952	97952	54591	292	13	600	111	22371	74434	74434	181199	160479	162186	71998	71998	972660
1953	97952	54591	292	13	600	111	22371	75274	74434	183596	162298	162271	71998	71998	977798
1954	97952	54591	292	13	600	111	22371	74434	74434	190651	176354	170407	71998	71998	1006206
1955	97952	54591	292	13	600	111	22371	74434	74434	183596	162298	162271	71998	71998	976959
1956	97952	54591	292	13	600	111	22371	74434	75274	179756	157698	163098	71998	71998	970185
1957	97952	54591	292	13	600	111	22371	74434	74434	177459	155999	163098	71998	71998	965350
1958	97952	54591	292	13	600	111	22371	74434	74434	181254	160191	161901	71998	71998	972140
1959	97952	54591	292	13	600	111	22371	74434	74434	183596	162159	162153	71998	71998	976702
1960	97952	54591	292	13	600	111	22371	74224	74434	183596	162298	162271	71998	71998	976749
1961	97952	54591	292	13	600	111	22371	74434	74434	183596	161863	161901	71998	71998	976155
1962	97952	54591	292	13	600	111	22371	74434	74434	183596	161863	161901	71998	71998	976155
1963	97952	54591	292	13	600	111	21935	70951	71888	182561	161118	161901	71998	71998	967910
1964	97952	54591	292	13	600	111	22371	74434	74434	183596	161470	163213	71998	71998	977074
1965	97952	54591	292	13	595	109	22244	74434	74434	183596	162298	162271	71998	71998	976824
1966	97952	54591	292	13	600	111	22371	74434	74434	180991	158685	161901	71998	71998	970371
1967	97952	54591	292	13	600	111	22371	74434	74434	183596	161568	163285	71998	71998	977244
1968	97952	54591	292	13	600	111	22371	74434	74434	183596	161863	161901	71998	71998	976155
1969	97952	54591	292	13	600	111	22371	74299	74434	181199	160287	162018	71998	71998	972164
1970	97952	54591	292	13	581	103	20580	68095	70204	182725	162179	162170	71998	71998	963479
1971	97952	54591	292	13	595	108	22089	74119	74974	180246	157995	163098	71998	71998	970067
1972	97952	54591	292	13	598	110	21986	71748	73940	190499	163418	161968	71998	71998	981110
1973	97952	54591	292	13	581	101	19744	63666	63666	164173	157332	162018	71998	71998	928126
1974	97952	54591	292	13	586	105	21750	73655	75499	190499	164110	162524	71998	71998	985571
1975	97952	54591	292	13	600	111	22371	74434	74434	190651	167121	162524	71998	71998	989091
1976	97952	54591	292	13	594	110	22371	74434	74434	180681	158827	162220	71998	71998	970515
1977	97952	54591	292	13	581	101	19744	63666	63666	168305	161548	162271	71636	72329	936696
1978	97805	54231	292	14	603	111	22371	74434	74434	183596	162298	162271	71998	71378	975836
AVERAGE	97931	54589	292	13	595	109	21805	72166	72370	180628	161664	162563	71980	71994	968701

Table A-10. Mwhrs of Pumping at Grand Coulee – CONT

MEGAWATT HOURS OF PUMPING – SOS 1b														
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97952	54591	292	13	581	101	19755	64450	64832	169710	159600	162153	71998	71998	938025
1930	97952	54591	292	13	587	104	20976	69729	67428	170900	161372	162271	71998	71998	950210
1931	97952	54591	292	13	589	106	21861	72642	73073	181826	161548	163122	72012	72012	971640
1932	97888	54620	292	14	612	115	23522	75499	75499	182262	160905	161901	71998	71998	977123
1933	97952	54591	292	13	600	111	22371	74434	74434	190310	165313	163098	71998	71998	987516
1934	97952	54591	292	13	587	108	22371	74434	73700	180878	159491	161901	71998	71998	970314
1935	97952	54591	292	13	600	111	22371	74434	74434	183596	162238	162220	71998	71998	976849
1936	97952	54591	292	13	600	111	22291	74075	71457	171725	155948	163098	71998	71998	956148
1937	97952	54591	292	13	581	101	20246	67187	67237	172128	159383	161901	71998	71998	945608
1938	97952	54591	292	13	600	111	22371	74434	74434	184740	163701	162745	71998	71998	979980
1939	97952	54591	292	13	581	101	19749	64584	64499	165947	157194	162271	71998	71998	931768
1940	97952	54591	292	13	581	101	19744	63666	63666	163757	157194	162271	71998	71998	927824
1941	97952	54591	292	13	581	101	19744	63666	63666	163883	157315	162271	71998	71998	928071
1942	97952	54591	292	13	600	111	22371	74434	74434	180954	159981	161901	71998	71998	971631
1943	97952	54591	292	13	600	111	22371	74434	74404	183542	164350	163971	71998	71998	980627
1944	97952	54591	292	13	581	101	19744	64040	64241	170045	161548	163122	72012	72012	940294
1945	97888	54568	291	13	598	109	21959	73295	75019	182180	158952	161901	71998	71998	970768
1946	97952	54591	292	13	600	111	22371	74434	74434	182289	161353	162271	71998	71998	974707
1947	97952	54591	292	13	600	111	22371	74434	74434	182752	161255	161901	71998	71998	974703
1948	97952	54591	292	13	600	111	22371	74434	76357	186823	160866	163098	71998	71998	981505
1949	97952	54591	292	13	600	111	22371	74434	74434	175641	155346	161901	71998	71998	961682
1950	97952	54591	292	13	600	111	22371	74434	74434	190651	171118	165247	71998	71998	995811
1951	97952	54591	292	13	600	110	22200	74434	74434	187165	166238	163484	71998	71998	985509
1952	97952	54591	292	13	600	111	22371	74434	74404	181145	160479	162186	71998	71998	972575
1953	97952	54591	292	13	601	111	22371	74434	74434	183596	161529	163257	71998	71998	977176
1954	97952	54591	292	13	600	111	22371	74434	74434	190651	176354	170407	71998	71998	1006206
1955	97952	54591	292	13	600	111	22371	74434	74434	183596	162238	162220	71998	71998	976849
1956	97952	54591	292	13	600	111	22371	74434	75274	179756	157698	163098	71998	71998	970185
1957	97952	54591	292	13	600	111	22371	74434	74434	175641	154883	163098	71998	71998	962416
1958	97952	54591	292	13	600	111	22371	74434	74434	180954	159963	163487	71998	71998	973199
1959	97952	54591	292	13	600	111	22371	74434	74434	183596	161902	161935	71998	71998	976228
1900	97952	54591	292	13	600	111	22371	74269	74434	183596	162298	162271	71998	71998	976794
1961	97952	54591	292	13	600	111	22371	74434	74434	183596	161568	163285	71998	71998	977244
1962	97952	54591	292	13	600	111	22371	74434	74434	183596	161863	161901	71998	71998	976155
1963	97952	54591	292	13	600	111	21935	70951	71888	178339	157021	161901	71998	71998	959591
1964	97952	54591	292	13	600	111	22371	74434	74434	183596	161313	163098	71998	71998	976802
1965	97952	54591	292	13	595	109	22234	74434	74434	183215	161922	162186	71998	71998	975973
1966	97952	54591	292	13	600	111	22371	74434	74434	180991	158685	161901	71998	71998	970371
1967	97952	54591	292	13	600	111	22371	74434	74434	183596	161313	163098	71998	71998	976802
1968	97952	54591	292	13	600	111	22371	74434	74434	183596	161863	161901	71998	71998	976155
1969	97952	54591	292	13	600	111	22371	74314	74404	181145	160172	161918	71998	71998	971879
1970	97952	54591	292	13	581	103	20580	68095	70204	182725	161902	161935	71998	71998	962967
1971	97952	54591	292	13	598	110	22200	74434	75289	180246	157995	163098	71998	71998	970813
1972	97952	54591	292	13	599	111	22031	71748	73940	190499	163418	161968	71998	71998	981156
1973	97952	54591	292	13	581	101	19744	63666	63666	163757	156884	161968	71998	71998	927211
1974	97952	54591	292	13	586	105	21663	73655	75499	190499	164110	162524	71998	71998	985484
1975	97952	54591	292	13	600	111	22371	74434	74494	190803	167121	162524	71998	71998	989303
1976	97952	54591	292	13	592	109	22311	74434	74434	180681	158774	162170	71998	71998	970347
1977	97952	54591	292	13	581	101	19744	63700	63707	168428	161548	163122	72012	72674	938465
1978	97888	54870	293	14	610	111	22371	74434	74434	183596	162298	162271	71998	71486	976673
AVERAGE	97948	54596	292	13	596	109	21860	72414	72574	180383	161186	162695	71999	72002	968667

Table A–10. Mwhrs of Pumping at Grand Coulee – CONT

	MEGAWATT HOURS OF PUMPING – SOS 2c														
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97952	54591	292	13	581	101	19845	64040	64185	161466	154539	162271	71998	71998	923871
1930	97952	54591	292	13	581	102	19990	64818	64520	162669	155048	162102	71998	71998	926674
1931	97952	54591	292	13	581	101	19794	64373	64020	161484	154052	162592	72012	72012	923869
1932	97733	54192	292	13	599	110	21699	71188	71759	183596	162298	162271	71998	71998	969746
1933	97952	54591	292	13	594	108	22120	73670	73670	183596	161313	163098	71998	71998	975012
1934	97952	54591	292	13	589	108	22545	75289	75289	183596	161529	163257	71998	71998	979045
1935	97952	54591	292	13	594	108	22120	73670	73670	183596	162298	162271	71998	71998	975169
1936	97952	54591	292	13	581	103	20568	68115	66525	163523	153907	163257	71998	71998	933420
1937	97952	54591	292	13	581	102	L9885	64527	64890	167270	157995	162271	71998	71998	934364
1938	97952	54591	292	13	599	111	22545	75289	75289	187278	165483	162899	71998	71998	986337
1939	97952	54591	292	13	581	101	19994	66165	66501	173039	159781	163401	71998	71998	946407
1940	97952	54591	292	13	581	102	19968	64527	64268	167270	159347	163257	71998	71998	936164
1941	97952	54591	292	13	581	101	19780	63829	63849	161158	153907	163257	71998	71998	923303
1942	97952	54591	292	13	581	104	20770	67312	66622	163865	154653	162271	71998	71998	933021
1943	97952	54591	292	13	599	111	22545	75289	75259	183542	163903	163640	71998	71998	981732
1944	97952	54591	292	13	581	101	19780	63822	63972	161466	153907	162170	71801	71763	922210
1945	97315	54591	292	13	587	104	20075	64027	64027	161484	154555	162271	71998	71998	923335
1946	97952	54591	292	13	598	110	22317	74734	74734	182371	161411	162271	71998	71998	975389
1947	97952	54591	292	13	599	111	22545	75289	75289	183596	162298	162271	71998	71998	978841
1948	97952	54591	292	13	592	107	21403	72201	72265	182915	160827	163098	71998	71998	970251
1949	97952	54591	292	13	593	106	21162	71339	71834	182371	160653	163257	71998	71998	%8158
1950	97952	54591	292	13	592	107	21922	73220	73220	190651	170326	164712	71998	71998	991593
1951	97952	54591	292	13	599	110	22441	75289	76928	186975	163741	163208	71998	71998	986135
1952	97952	54591	292	13	599	111	22545	75289	75289	179620	159491	162271	71998	71998	972058
1953	97952	54591	292	13	592	106	21231	71013	71013	177376	159546	162203	71998	71998	959923
1954	97952	54591	292	13	592	107	21922	73220	73220	189628	173868	169023	71998	71998	998423
1955	97952	54591	292	13	592	106	20837	66834	66525	165517	156354	162271	71998	71998	935879
1956	97952	54591	292	13	599	111	22545	75289	76113	179592	157628	163098	71998	71998	971818
1957	97952	54591	292	13	592	106	20847	69686	71412	178311	156525	163098	71998	71998	957420
1958	97952	54591	292	13	592	106	21162	71209	71209	179374	159672	163257	71998	71998	963426
1959	97952	54591	292	13	598	110	22368	74854	74854	183596	162278	162254	71998	71998	977755
1960	97952	54591	292	13	592	106	21137	69135	71568	179810	161333	162271	71998	71998	962796
1961	97952	54591	292	13	592	106	21162	71339	71834	183596	161981	162002	71998	71998	%9456
1962	97952	54591	292	13	592	106	20837	69600	69729	176830	158383	163257	71998	71998	956176
1963	97952	54591	292	13	592	106	20419	65084	64415	161553	153939	163257	71998	71998	926208
1964	97952	54591	292	13	592	107	21259	70399	70983	183596	161313	163098	71998	71998	968192
1965	97952	54591	292	13	597	110	22545	75289	75289	183596	162298	162271	71998	71998	978838
1966	97952	54591	292	13	592	106	20837	67648	67512	167291	155881	162271	71998	71998	938980
1967	97952	54591	292	13	592	107	21922	72211	73220	183596	161411	163170	71998	71998	973073
1968	97952	54591	292	13	592	106	21162	69923	70258	174088	158295	162153	71998	71998	953419
1969	97952	54591	292	13	599	111	22545	75289	75259	179565	159347	162136	71998	71998	971694
1970	97952	54591	292	13	581	101	19988	66236	66260	168040	156525	162052	71998	71998	936626
1971	97952	54591	292	13	595	108	22113	73895	75694	181826	157907	163098	71998	71998	972078
1972	97952	54591	292	13	594	108	21837	72470	74734	190196	163256	161968	71998	71998	982007
1973	97952	54591	292	13	581	101	19780	64485	64811	166097	156168	163257	71998	71998	932123
1974	97952	54591	292	13	587	106	22175	75978	77553	190196	163903	162507	71998	71998	989849
1975	97952	54591	292	13	592	107	21922	73220	73775	188680	164734	162372	71998	71998	982246
1976	97952	54591	292	13	596	109	22160	74344	74434	180287	158525	162271	71998	71998	969570
1977	97952	54591	292	13	581	101	19780	63829	63849	161158	153907	162457	72012	72674	923194
1978	97888	54276	292	14	607	111	22545	74764	74689	182207	162198	162372	71998	71486	975447
TOTAL	97933	54576	292	13	591	106	21308	70491	70762	176680	159689	1621822	71994	71997	959254

Table A-10. Mwhrs of Pumping at Grand Coulee – CONT

	MEGAWATT HOURS OF PUMPING – SOS 2d [New]														
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	98038	54163	290	13	580	101	19773	63734	63747	165498	158738	163989	72364	72364	933394
1930	97539	54163	290	13	580	102	19947	64345	63938	165610	159818	164872	72403	72403	936021
1931	97590	54163	290	13	581	102	20033	64408	64102	166949	161021	164872	72785	72785	939696
1932	98095	54163	290	13	590	109	22639	75289	73460	170751	153746	163098	71998	71998	956239
1933	98038	54163	290	13	580	105	22265	75289	75259	183160	161041	163098	71998	71998	977296
1934	98038	54163	290	13	582	105	22265	75289	74299	181771	161509	163314	72049	72049	975736
1935	97114	54163	290	13	580	105	22213	75064	75064	182180	160905	161951	71998	71998	973638
1936	98038	54163	290	13	581	102	20104	64832	64164	160851	153331	163122	72341	72341	924274
1937	97508	54163	290	13	579	102	20159	64918	64563	165722	158899	163989	72644	72644	936193
1938	97908	54163	290	13	582	105	22265	75289	75259	187202	165483	162899	71998	71998	985454
1939	98038	54163	290	13	582	101	19885	65120	66141	168142	155999	163484	72310	72310	936579
1940	97467	54163	290	13	580	101	19889	64527	64268	161691	154670	163866	72403	72403	926333
1941	97590	54163	290	13	579	102	19709	63761	63747	164101	158277	164836	72675	72675	932519
1942	97950	54163	290	13	580	102	19707	63693	63666	161604	154311	163098	71998	71998	923173
1943	98038	54163	290	13	582	105	22265	75289	75259	181472	162377	163640	71998	71998	977488
1944	98038	54163	290	13	581	102	19915	63747	63747	166829	160982	164872	72636	72636	938553
1945	97898	54163	290	13	586	103	20226	65222	65244	162740	154003	162558	72272	72272	927591
1946	97754	54163	290	13	582	105	22265	75289	75259	179565	158596	163098	71998	71998	970973
1947	98038	54163	290	13	585	102	20181	69309	70650	179115	157907	163098	71998	71998	957447
1948	98038	54163	290	13	585	102	20565	72115	71296	180822	159618	163098	71998	71998	964699
1949	98038	54163	290	13	585	102	20565	72115	71177	171926	154100	163122	72264	72902	951362
1950	97407	54163	290	13	585	104	22265	75289	75259	190575	170326	164712	71998	71561	994546
1951	98038	54163	290	13	582	105	22265	75289	76928	186975	163741	163208	71998	71998	985592
1952	98038	54163	290	13	582	105	22265	75289	75259	179565	158596	163098	71998	71998	971258
1953	98038	54163	290	13	580	101	19891	65843	66141	170925	157732	163098	71998	71998	940812
1954	98038	54163	290	13	585	104	22265	75289	75259	189552	173868	169023	71998	71998	1002445
1955	98038	54163	290	13	580	101	19889	64520	64718	163577	154670	163098	71998	71998	927654
1956	98038	54163	290	13	582	105	22265	75289	76113	179592	157628	163098	71998	71998	971171
1957	98038	54163	290	13	581	102	19988	67072	67906	168428	154267	163098	71998	71998	937941
1958	98038	54163	290	13	580	101	20422	70345	69453	174190	157855	163487	71666	72357	952962
1959	97346	54163	290	13	582	105	22265	75289	75259	179565	158596	163098	71998	71386	969954
1960	98038	54163	290	13	580	101	19902	66260	67022	172431	156953	163098	71998	71998	942847
1961	98038	54163	290	13	580	101	20494	71479	71069	178560	157384	163098	71998	71998	959266
1962	98038	54163	290	13	585	102	19683	65589	67105	174784	157211	163098	71998	71998	944656
1963	98038	54163	290	13	580	102	19744	63910	63829	161055	153698	163098	71998	71998	922516
1904	98038	54163	290	13	585	102	19792	66850	68779	179756	158259	163098	71998	71998	953720
1965	98038	54163	290	13	582	105	22265	75289	75259	179620	158631	163098	71998	71998	971348
1966	98038	54163	290	13	580	101	19862	65012	65903	166173	154116	163098	71998	71998	931346
1967	98038	54163	290	13	585	104	22265	73940	75289	180625	157960	163098	71998	71998	970365
1968	98038	54163	290	13	580	101	19945	65383	66606	169314	156100	163098	71998	71998	937627
1969	98038	54163	290	13	582	105	22265	75289	75259	179565	158596	163098	71998	71998	971258
1970	98038	54163	290	13	580	101	19864	64918	66109	168839	155898	162916	72380	73005	937115
1971	97682	54163	290	13	585	104	22265	75289	77906	181826	157907	163098	71998	71596	974722
1972	98038	54163	290	13	585	104	22265	75289	77906	190196	163256	161968	71998	71998	988070
1973	98038	54163	290	13	579	102	19701	64116	63768	165834	159908	164872	72279	72916	936580
1974	97427	54163	290	13	582	105	22265	76249	77906	190196	163903	162507	71998	71565	989170
1975	98038	54163	290	13	585	102	20570	72136	72233	187278	164734	162372	71998	71998	976510
1976	98038	54163	290	13	582	105	22265	75289	75379	179700	157767	161901	71998	71998	969488
1977	98038	54163	290	13	581	101	19786	63761	63734	166809	161021	164872	72785	73364	939319
1978	98095	54163	290	14	586	105	22265	73700	74509	181880	162198	162372	71998	71722	973897
AVERAGE	97913	54163	290	13	5182	103	20961	699518	70243	174902	158962	163417	72124	72144	955776

Table A-10. Mwhrs of Pumping at Grand Coulee – CONT

	MEGAWATT HOURS OF PUMPING – SOS 4c [Rev]														
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	98038	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	927331
1930	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1931	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1932	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1933	97275	54163	290	13	591	106	20996	70074	71523	182997	161431	162102	71562	71562	964686
1934	97275	54163	290	13	591	106	20875	69197	70367	181771	161686	162102	71562	71562	961560
1935	97275	54163	290	13	591	106	20692	67678	68901	175879	157628	162102	71562	71562	948443
1936	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1937	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1938	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1939	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1940	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1941	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1942	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1943	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1944	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1945	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1946	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1947	97275	54163	290	13	591	106	20903	68486	70650	179115	158259	162102	71562	71562	955078
1948	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1949	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1950	97275	54163	290	13	591	106	20903	68890	71190	190575	170326	165068	71562	71562	982516
1951	97275	54163	290	13	591	106	21033	70139	71856	186975	163741	163553	71562	71562	972859
1952	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1953	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1954	97275	54163	290	13	591	106	20903	68890	71190	189552	173868	169424	71562	71562	989391
1955	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1956	97275	54163	290	13	591	106	21425	72158	72890	179592	157978	162102	71562	71562	961708
1957	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1958	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1959	97275	54163	290	13	591	106	20903	68890	71190	179565	158952	162102	71562	71562	957166
1960	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1961	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1962	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1963	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1964	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1965	97275	54163	290	13	591	106	21206	69977	71533	179620	158988	162102	71562	71562	958987
1966	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1967	97275	54163	290	13	591	106	20903	68890	71190	179421	157593	162102	71562	71562	955662
1968	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1969	97275	54163	290	13	591	106	21125	69697	71253	179565	158952	162102	71562	71562	958257
1970	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1971	97275	54163	290	13	591	106	20924	70247	71813	181826	158259	162102	71562	71562	960734
1972	97275	54163	290	13	591	106	21623	72470	74734	190196	163256	162304	71562	71562	980147
1973	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1974	97275	54163	290	13	591	106	22109	75978	77553	190196	163903	162848	71562	71562	988151
1975	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1976	97275	54163	290	13	591	106	20903	68962	71279	179700	157767	162237	71562	71562	956410
1977	97275	54163	290	13	591	106	20652	65412	65193	163041	154604	162102	71562	71562	926568
1978	97275	54163	290	13	591	106	21064	69729	71279	181880	162198	162711	71562	71562	964424
AVERAGE	97290	54163	290	13	591	106	20800	66979	67435	169776	156935	162371	71562	71562	939874

Table A-10. Mwhrs of Pumping at Grand Coulee – CONT

MEGAWATT HOURS OF PUMPING – SOS 5b														
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97952	54591	292	13	581	101	19845	64040	64185	161466	154539	162271	71998	71998	923871
1930	97952	54591	292	13	581	102	20148	65332	64969	163077	155048	162102	71998	71998	928201
1931	97952	54591	292	13	581	101	19794	64373	64020	161484	154052	162592	72012	72012	923869
1932	97733	54192	292	13	599	110	21699	71188	71759	183596	162298	162271	71998	71998	969746
1933	97952	54591	292	13	594	108	22120	73670	73670	1835%	161313	163098	71998	71998	975012
1934	97952	54591	292	13	589	108	22545	75289	75289	183596	161529	163257	71998	71998	979045
1935	97952	54591	292	13	594	108	22120	73670	73670	183596	162298	162271	71998	71998	975169
1936	97952	54591	292	13	581	103	20568	68125	66525	163523	153907	163257	71998	71998	933430
1937	97952	54591	292	13	581	102	19885	64669	64890	167270	157995	162271	71998	71998	934505
1938	97952	54591	292	13	599	111	22545	75289	75289	187278	165483	162899	71998	71998	986337
1939	97952	54591	292	13	581	101	19994	66165	66501	173039	159781	163401	71998	71998	946407
1940	97952	54591	292	13	581	102	19968	64527	64268	167270	159347	163257	71998	71998	936164
1941	97952	54591	292	13	581	101	19780	63979	63849	161158	153907	163257	71998	71998	923453
1942	97952	54591	292	13	581	104	20770	67757	66736	164119	154653	162271	71998	71998	933834
1943	97952	54591	292	13	599	111	22545	75289	75259	183542	163903	163640	71998	71998	981732
1944	97952	54591	292	13	581	101	19780	63822	63972	161466	153907	162170	71801	71763	922210
1945	97315	54591	292	13	587	104	20095	64054	64054	161484	154555	162271	71998	71998	923410
1946	97952	54591	292	13	598	110	22317	74734	74734	182371	161411	162271	71998	71998	975389
1947	97952	54591	292	13	599	111	22545	75289	75289	183596	162298	162271	71998	71998	978841
1948	97952	54591	292	13	592	107	21403	72201	72265	182915	160827	163098	71998	71998	970251
1949	97952	54591	292	13	593	106	21162	71339	71834	182371	160653	163257	71998	71998	968158
1950	97952	54591	292	13	592	107	21922	73220	73220	190651	170326	164712	71998	71998	991593
1951	97952	54591	292	13	599	110	22441	75289	76928	186975	163741	163208	71998	71998	986135
1952	97952	54591	292	13	599	111	22545	75289	75289	179620	159491	162271	71998	71998	972058
1953	97952	54591	292	13	592	106	21231	71013	71013	177376	159546	162203	71998	71998	959923
1954	97952	54591	292	13	592	107	21922	73220	73220	189628	173868	169023	71998	71998	998423
1955	97952	54591	292	13	592	106	20837	67055	66525	165517	156354	162271	71998	71998	936100
1956	97952	54591	292	13	599	111	22545	75289	76113	179592	157628	163098	71998	71998	971818
1957	97952	54591	292	13	592	106	20847	69686	71412	178311	156525	163098	71998	71998	957420
1958	97952	54591	292	13	592	106	21162	71209	71209	179374	159672	163257	71998	71998	963426
1959	97952	54591	292	13	598	110	22368	74854	74854	183596	162278	162254	71998	71998	977755
1960	97952	54591	292	13	592	106	21137	69135	71568	179810	161333	162271	71998	71998	962796
1961	97952	54591	292	13	592	106	21162	71339	71834	183596	161981	162002	71998	71998	969456
1962	97952	54591	292	13	592	106	20837	69600	69729	176830	158383	163257	71998	71998	956176
1963	97952	54591	292	13	592	106	20419	65084	64415	161553	153939	163257	71998	71998	926208
1964	97952	54591	292	13	592	107	21259	70399	70983	183596	161313	163098	71998	71998	968192
1965	97952	54591	292	13	597	110	22545	75289	75289	183596	162298	162271	71998	71998	978838
1966	97952	54591	292	13	592	106	20837	67648	67512	167291	155881	162271	71998	71998	938980
1967	97952	54591	292	13	592	107	21922	72211	73220	183596	161411	163170	71998	71998	973073
1968	97952	54591	292	13	592	106	21162	69923	70258	174088	158295	162153	71998	71998	953419
1969	97952	54591	292	13	599	111	22545	75289	75259	179565	159347	162136	71998	71998	971694
1970	97952	54591	292	13	581	101	19988	66236	66260	168040	156525	162052	71998	71998	936626
1971	97952	54591	292	13	595	108	22113	73895	75694	181826	157907	163098	71998	71998	972078
1972	97952	54591	292	13	594	108	21837	72470	74734	190196	163256	161968	71998	71998	982007
1973	97952	54591	292	13	581	101	19780	64718	64811	166097	156168	163257	71998	71998	932356
1974	97952	54591	292	13	587	106	22175	75978	77553	190196	163903	162507	71998	71998	989849
1975	97952	54591	292	13	592	107	21922	73220	73220	187278	164734	162372	71998	71998	980289
1976	97952	54591	292	13	596	109	22160	74344	74434	180287	158525	162271	71998	71998	969570
1977	97952	54591	292	13	581	101	19780	63829	63849	161158	153907	162457	72012	72674	923194
1978	97888	54276	292	14	607	111	22545	74764	74689	182207	162198	162372	71998	71486	975447
AVERAGE	97933	54576	292	13	591	106	21311	70526	70762	176665	159689	162822	71994	71997	959279

Table A–10. Mwhrs of Pumping at Grand Coulee – CONT

	MEGAWATT HOURS OF PUMPING – SOS 5c [New]														
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97952	54591	292	13	581	101	19845	64040	64185	161466	154539	162271	71998	71998	923871
1930	97952	54591	292	13	581	102	20148	65332	64969	163077	155048	162102	71998	71998	928201
1931	97952	54591	292	13	581	101	19794	64373	64020	161484	154052	162592	72012	72012	923869
1932	97733	54192	292	13	599	110	21699	71188	71759	183596	162298	162271	71998	71998	969746
1933	97952	54591	292	13	594	108	22120	73670	73670	183596	161313	163098	71998	71998	975012
1934	97952	54591	292	13	589	108	22545	75289	75289	183596	161529	163257	71998	71998	979045
1935	97952	54591	292	13	594	108	22120	73670	73670	183596	162298	162271	71998	71998	975169
1936	97952	54591	292	13	581	103	20568	68125	66525	163523	153907	163257	71998	71998	933430
1937	97952	54591	292	13	581	102	19885	64669	64890	167270	157995	162271	71998	71998	934505
1938	97952	54591	292	13	599	111	22545	75289	75289	187278	165483	162899	71998	71998	986337
1939	97952	54591	292	13	581	101	19994	66165	66501	173039	159781	163401	71998	71998	946407
1940	97952	54591	292	13	581	102	19968	64527	64268	167270	159347	163257	71998	71998	936164
1941	97952	54591	292	13	581	101	19780	63979	63849	161158	153907	163257	71998	71998	923453
1942	97952	54591	292	13	581	104	20770	67757	66736	164119	154653	162271	71998	71998	933834
1943	97952	54591	292	13	599	111	22545	75289	75259	183542	163903	163640	71998	71998	981732
1944	97952	54591	292	13	581	101	19780	63822	63972	161466	153907	162170	71801	71763	922210
1945	97315	54591	292	13	587	104	20095	64054	64054	161484	154555	162271	71998	71998	923410
1946	97952	54591	292	13	598	110	22317	74734	74734	182371	161411	162271	71998	71998	975389
1947	97952	54591	292	13	599	111	22545	75289	75289	183596	162298	162271	71998	71998	978841
1948	97952	54591	292	13	592	107	21403	72201	72265	182915	160827	163098	71998	71998	970251
1949	97952	54591	292	13	593	106	21162	71339	71834	182371	160653	163257	71998	71998	968158
1950	97952	54591	292	13	592	107	21922	73220	73220	190651	170326	164712	71998	71998	991593
1951	97952	54591	292	13	599	110	22441	75289	76928	186975	163741	163208	71998	71998	986135
1952	97952	54591	292	13	599	111	22545	75289	75289	179620	159491	162271	71998	71998	972058
1953	97952	54591	292	13	592	106	21231	71013	71013	177376	159546	162203	71998	71998	959923
1954	97952	54591	292	13	592	107	21922	73220	73220	189628	173868	169023	71998	71998	998423
1955	97952	54591	292	13	592	106	20837	67055	66525	165517	156354	162271	71998	71998	936100
1956	97952	54591	292	13	599	111	22545	75289	76113	179592	157628	163098	71998	71998	971818
1957	97952	54591	292	13	592	106	20847	69686	71412	178311	156525	163098	71998	71998	957420
1958	97952	54591	292	13	592	106	21162	71209	71209	179374	159672	163257	71998	71998	963426
1959	97952	54591	292	13	598	110	22368	74854	74854	183596	162278	162254	71998	71998	977755
1960	97952	54591	292	13	592	106	21137	69135	71568	179810	161333	162271	71998	71998	962796
1961	97952	54591	292	13	592	106	21162	71339	71834	183596	161981	162002	71998	71998	969456
1962	97952	54591	292	13	592	106	20837	69600	69729	176830	158383	163257	71998	71998	956176
1963	97952	54591	292	13	592	106	20419	65084	64415	161553	153939	163257	71998	71998	926208
1964	97952	54591	292	13	592	107	21259	70399	70983	183596	161313	163098	71998	71998	968192
1965	97952	54591	292	13	597	110	22545	75289	75289	183596	162298	162271	71998	71998	978838
1966	97952	54591	292	13	592	106	20837	67648	67512	167291	155881	162271	71998	71998	938980
1967	97952	54591	292	13	592	107	21922	72211	73220	183590	161411	163170	71998	71998	973073
1968	97952	54591	292	13	592	106	21162	69923	70258	174088	158295	162153	71998	71998	953419
1969	97952	54591	292	13	599	111	22545	75289	75259	179565	159347	162136	71998	71998	971694
1970	97952	54591	292	13	581	101	19988	66236	66260	168040	156525	162052	71998	71998	936626
1971	97952	54591	292	13	595	108	22113	73895	75694	181826	157907	163098	71998	71998	972078
1972	97952	54591	292	13	594	108	21837	72470	74734	190196	163256	161968	71998	71998	982007
1973	97952	54591	292	13	581	101	19780	64718	64811	166097	156168	163257	71998	71998	932356
1974	97952	54591	292	13	587	106	22175	75978	77553	190196	163903	162507	71998	71998	989849
1975	97952	54591	292	13	592	107	21922	73220	73220	187278	164734	162372	71998	71998	980289
1976	97952	54591	292	13	596	109	22160	74344	74434	180287	158525	162271	71998	71998	969570
1977	97952	54591	292	13	581	101	19780	63829	63849	161158	153907	162457	72012	72674	923194
1978	97888	54276	292	14	607	111	22545	74764	74689	182207	162198	162372	71998	71486	975447
AVERAGE	97933	54576	292	13	591	106	21311	70526	70762	176665	159689	162822	71994	71997	959279

Table A–10. Mwhrs of Pumping at Grand Coulee – CONT

	MEGAWATT HOURS OF PUMPING – SOS 6b														
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97952	54591	292	13	581	101	19845	64040	64185	161466	154539	162271	71998	71998	923871
1930	97952	54591	292	13	581	102	20148	65332	64969	163077	155048	162102	71998	71998	928201
1931	97952	54591	292	13	581	101	19794	64373	64020	161484	154052	162592	72012	72012	923869
1932	97733	54192	292	13	599	110	21699	71188	71759	183596	162298	162271	71998	71998	969746
1933	97952	54591	292	13	594	108	22120	73670	73670	183596	161313	163098	71998	71998	975012
1934	97952	54591	292	13	589	108	22545	75289	75289	183596	161529	163257	71998	71998	979045
1935	97952	54591	292	13	594	108	22120	73670	73670	183596	162298	162271	71998	71998	975169
1936	97952	54591	292	13	581	103	20568	68125	66525	163523	153907	163257	71998	71998	933430
1937	97952	54591	292	13	581	102	19885	64669	64890	167270	157995	162271	71998	71998	934505
1938	97952	54591	292	13	599	111	22545	75289	75289	187278	165483	162899	71998	71998	986337
1939	97952	54591	292	13	581	101	19994	66165	66501	173039	159781	163401	71998	71998	946407
1940	97952	54591	292	13	581	102	19968	64527	64268	167270	159347	163257	71998	71998	936164
1941	97952	54591	292	13	581	101	19780	63979	63849	161158	153907	163257	71998	71998	923453
1942	97952	54591	292	13	581	104	20770	67757	66736	164119	154653	162271	71998	71998	933834
1943	97952	54591	292	13	599	111	22545	75289	75259	183542	163903	163640	71998	71998	981732
1944	97952	54591	292	13	581	101	19780	63822	63972	161466	153907	162170	71801	71763	922210
1945	97315	54591	292	13	587	104	20095	64054	64054	161484	154555	162271	71998	71998	923410
1946	97952	54591	292	13	598	110	22317	74734	74734	182371	161411	162271	71998	71998	975389
1947	97952	54591	292	13	599	111	22545	75289	75289	183596	162298	162271	71998	71998	978841
1948	97952	54591	292	13	592	107	21403	72201	72265	182915	160827	163098	71998	71998	970251
1949	97952	54591	292	13	593	106	21162	71339	71834	182371	160653	163257	71998	71998	968158
1950	97952	54591	292	13	592	107	21922	73220	73220	190651	170326	164712	71998	71998	991593
1951	97952	54591	292	13	599	110	22441	75289	76928	186975	163741	163208	71998	71998	986135
1952	97952	54591	292	13	599	111	22545	75289	75289	179620	159491	162271	71998	71998	972058
1953	97952	54591	292	13	592	106	21231	71013	71013	177376	159546	162203	71998	71998	959923
1954	97952	54591	292	13	592	107	21922	73220	73220	189628	173868	169023	71998	71998	998423
1955	97952	54591	292	13	592	106	20837	67055	66525	165517	156354	162271	71998	71998	936100
1956	97952	54591	292	13	599	111	22545	75289	76113	179592	157628	163098	71998	71998	971818
1957	97952	54591	292	13	592	106	20847	69686	71412	178311	156525	163098	71998	71998	957420
1958	97952	54591	292	13	592	106	21162	71209	71209	179374	159672	163257	71998	71998	963426
1959	97952	54591	292	13	598	110	22368	74854	74854	183596	162278	162254	71998	71998	977755
1960	97952	54591	292	13	592	106	21137	69135	71568	179810	161333	162271	71998	71998	962796
1961	97952	54591	292	13	592	106	21162	71339	71834	183596	161981	162002	71998	71998	969456
1962	97952	54591	292	13	592	106	20837	69600	69729	176830	158383	163257	71998	71998	956176
1963	97952	54591	292	13	592	106	20419	65084	64415	161553	153939	163257	71998	71998	926208
1964	97952	54591	292	13	592	107	21259	70399	70983	183596	161313	163098	71998	71998	968192
1965	97952	54591	292	13	597	110	22545	75289	75289	183596	162298	162271	71998	71998	978838
1966	97952	54591	292	13	592	106	20837	67648	67512	167291	155881	162271	71998	71998	938980
1967	97952	54591	292	13	592	107	21922	72211	73220	183596	161411	163170	71998	71998	973073
1968	97952	54591	292	13	592	106	21162	69923	70258	174088	158295	162153	71998	71998	953419
1969	97952	54591	292	13	599	111	22545	75289	75259	179565	159347	162136	71998	71998	971694
1970	97952	54591	292	13	581	101	19988	66236	66260	168040	156525	162052	71998	71998	936626
1971	97952	54591	292	13	595	108	22113	73895	75694	181826	157907	163098	71998	71998	972078
1972	97952	54591	292	13	594	108	21837	72470	74734	190196	163256	161968	71998	71998	982007
1973	97952	54591	292	13	581	101	19780	64718	64811	166097	156168	163257	71998	71998	932356
1974	97952	54591	292	13	587	106	22175	75978	77553	190196	163903	162507	71998	71998	989849
1975	97952	54591	292	13	592	107	21922	73220	73220	187278	164734	162372	71998	71998	980289
1976	97952	54591	292	13	596	109	22160	74344	74434	180287	158525	162271	71998	71998	969570
1977	97952	54591	292	13	581	101	19780	63829	63849	161158	153907	162457	72012	72674	923194
1978	97888	54276	292	14	607	111	22545	74764	74689	182207	162198	162372	71998	71486	975447
AVERAGE	97933	54576	292	13	591	106	21311	70526	70762	176665	159689	162822	71994	71997	959279

Table A–10. Mwhrs of Pumping at Grand Coulee – CONT

MEGAWATT HOURS OF PUMPING – SOS 6d															
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97952	54591	292	13	581	101	19845	64040	64185	161466	154539	162271	71998	71998	923871
1930	97952	54591	292	13	581	102	20148	65332	64969	163077	155048	162102	71998	71998	928201
1931	97952	54591	292	13	581	101	19794	64373	64020	161484	154052	162592	72012	72012	923869
1932	97733	54192	292	13	599	110	21699	71188	71759	183596	162298	162271	71998	71998	969746
1933	97952	54591	292	13	594	108	22120	73670	73670	183596	161313	163098	71998	71998	975012
1934	97952	54591	292	13	589	108	22545	75289	75289	183596	161529	163257	71998	71998	979045
1935	97952	54591	292	13	594	108	22120	73670	73670	183596	162298	162271	71998	71998	975169
1936	97952	54591	292	13	581	103	20568	68125	66525	163523	153907	163257	71998	71998	933430
1937	97952	54591	292	13	581	102	19885	64669	64890	167270	157995	162271	71998	71998	934505
1938	97952	54591	292	13	599	111	22545	75289	75289	187278	165483	162899	71998	71998	986337
1939	97952	54591	292	13	581	101	19994	66165	66501	173039	159781	163401	71998	71998	946407
1940	97952	54591	292	13	581	102	19968	64527	64268	167270	159347	163257	71998	71998	936164
1941	97952	54591	292	13	581	101	19780	63979	63849	161158	153907	163257	71998	71998	923453
1942	97952	54591	292	13	581	104	20770	67757	66736	164119	154653	162271	71998	71998	933834
1943	97952	54591	292	13	599	111	22545	75289	75259	183542	163903	163640	71998	71998	981732
1944	97952	54591	292	13	581	101	19780	63822	63972	161466	153907	162170	71801	71763	922210
1945	97315	54591	292	13	587	104	20095	64054	64054	161484	154555	162271	71998	71998	923410
1946	97952	54591	292	13	598	110	22317	74734	74734	182371	161411	162271	71998	71998	975389
1947	97952	54591	292	13	599	111	22545	75289	75289	183596	162298	162271	71998	71998	978841
1948	97952	54591	292	13	592	107	21403	72201	72265	182915	160827	163098	71998	71998	970251
1949	97952	54591	292	13	593	106	21162	71339	71834	182371	160653	163257	71998	71998	968158
1950	97952	54591	292	13	592	107	21922	73220	73220	190651	170326	164712	71998	71998	991593
1951	97952	54591	292	13	599	110	22441	75289	76928	186975	163741	163208	71998	71998	986135
1952	97952	54591	292	13	599	111	22545	75289	75289	179620	159491	162271	71998	71998	972058
1953	97952	54591	292	13	592	106	21231	71013	71013	177376	159546	162203	71998	71998	959923
1954	97952	54591	292	13	592	107	21922	73220	73220	189628	173868	169023	71998	71998	998423
1955	97952	54591	292	13	592	106	20837	67055	66525	165517	156354	162271	71998	71998	936100
1956	97952	54591	292	13	599	111	22545	75289	76113	179592	157628	163098	71998	71998	971818
1957	97952	54591	292	13	592	106	20847	69686	71412	178311	156525	163098	71998	71998	957420
1958	97952	54591	292	13	592	106	21162	71209	71209	179374	159672	163257	71998	71998	963426
1959	97952	54591	292	13	598	110	22368	74854	74854	183596	162278	162254	71998	71998	977755
1960	97952	54591	292	13	592	106	21137	69135	71568	179810	161333	162271	71998	71998	962796
1961	97952	54591	292	13	592	106	21162	71339	71834	183596	161981	162002	71998	71998	969456
1962	97952	54591	292	13	592	106	20837	69600	69729	176830	158383	163257	71998	71998	956176
1963	97952	54591	292	13	592	106	20419	65084	64415	161553	153939	163257	71998	71998	926208
1964	97952	54591	292	13	592	107	21259	70399	70983	183596	161313	163098	71998	71998	968192
1965	97952	54591	292	13	597	110	22545	75289	75289	183596	162298	162271	71998	71998	978838
1966	97952	54591	292	13	592	106	20837	67648	67512	167291	155881	162271	71998	71998	938980
1967	97952	54591	292	13	592	107	21922	72211	73220	183596	161411	163170	71998	71998	973073
1968	97952	54591	292	13	592	106	21162	69923	70258	174088	158295	162153	71998	71998	953419
1969	97952	54591	292	13	599	111	22545	75289	75259	179565	159347	162136	71998	71998	971694
1970	97952	54591	292	13	581	101	19988	66236	66260	168040	156525	162052	71998	71998	936626
1971	97952	54591	292	13	595	108	22113	73895	75694	181826	157907	163098	71998	71998	972078
1972	97952	54591	292	13	594	108	21837	72470	74734	190196	163256	161968	71998	71998	982007
1973	97952	54591	292	13	581	101	19780	64718	64811	166097	156168	163257	71998	71998	932356
1974	97952	54591	292	13	587	106	22175	75978	77553	190196	163903	162507.	71998	71998	989849
1975	97952	54591	292	13	592	107	21922	73220	73220	187278	164734	162372	71998	71998	980289
1976	97952	54591	292	13	596	109	22160	74344	74434	180287	158525	162271	71998	71998	969570
1977	97952	54591	292	13	581	101	19780	63829	63849	161158	153907	162457	72012	72674	923194
1978	97888	54276	292	14	607	111	22545	74764	74689	182207	162198	162372	71998	71486	975447
AVERAGE	97933	54576	292	13	591	106	21311	70526	70762	176665	159689	162822	71994	71997	959279

Table A–10. Mwhrs of Pumping at Grand Coulee – CONT

	MEGAWATT HOURS OF PUMPING – SOS 9a													
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97865	54494	292	14	583	102	19683	63666	65244	179429	180217	193090	93129	93129	1040935
1930	125009	69562	342	15	630	111	22044	71253	73340	188680	172534	189743	93129	93129	1099519
1931	120325	65462	336	15	623	108	20783	67129	68125	177843	168262	185087	92233	92233	1058564
1932	122876	66883	337	15	633	114	22140	71013	71748	170751	153746	164481	74484	75214	994434
1933	102992	56504	295	14	583	102	20108	68506	70837	185914	162775	163098	71998	72010	975734
1934	97882	54494	292	14	583	102	20079	68425	69987	181771	180617	210647	93129	93129	1071151
1935	122834	66930	331	14	591	102	19864	66533	68265	180512	160982	162035	71998	71921	992911
1936	97826	54523	292	14	583	102	19683	64082	63944	161260	154457	169852	79680	81196	947493
1937	115464	63721	327	14	593	102	19778	64234	65858	180203	172743	188127	93129	93129	1057421
1938	125218	69678	347	15	614	102	20161	68799	71090	187202	165483	168544	78020	80939	1036212
1939	113318	61840	321	14	593	103	19994	64633	65873	165703	153618	166815	76871	78751	968447
1940	109690	60082	306	14	583	101	19771	63680	64492	168387	162755	177888	84350	85742	997840
1941	123168	66161	338	15	637	107	20291	64415	65354	166689	156067	168277	79989	81305	992814
1942	117732	64403	326	14	583	102	19683	63693	63931	161158	153268	162848	72310	72825	952873
1943	99414	54859	290	14	583	102	20181	68890	71190	185080	165168	163640	72150	72303	973863
1944	100073	55293	291	14	583	102	19683	63666	65244	179429	194226	210647	93129	93129	1075507
1945	124758	69422	343	15	622	110	21591	69740	71423	180540	159491	165934	76636	78541	1019165
1946	111673	64544	338	15	610	102	20181	68890	71190	179565	158596	163002	73214	74735	986656
1947	104302	57421	300	14	583	102	20181	68486	70859	179644	158988	166741	75923	78043	981585
1948	109269	58154	293	14	583	102	19966	67270	69227	180822	159618	163098	71998	73590	974003
1949	97874	54494	292	14	583	102	20181	68105	70150	171926	154100	165499	76373	78615	958307
1950	114587	66068	335	15	595	102	20181	68890	71190	190575	170326	164712	71998	74377	1013950
1951	97672	54499	292	14	583	102	20289	70139	71856	186975	163741	166171	73915	74603	980849
1952	107223	57421	293	14	583	102	20181	68890	71190	179565	158596	165068	75451	77278	981854
1953	110728	62312	326	14	590	102	19683	64394	66038	174810	159564	163098	71998	73869	967524
1954	97713	54600	292	14	583	102	20181	68890	71301	189931	173868	169023	71998	71401	989896
1955	97865	54494	292	14	583	102	19683	63666	65244	177513	163599	163098	71998	72419	950569
1956	97569	54523	292	14	583	101	20770	72158	72890	179592	157628	163710	74646	75143	969619
1957	109401	60221	309	14	583	102	19683	65619	67420	169107	154267	162321	72919	75363	957329
1958	104945	57959	301	14	584	102	19874	65850	67337	174088	157855	168601	80399	79744	977653
1959	116386	63387	325	14	583	102	20181	68890	71190	179565	158596	163098	72004	72957	987279
1960	98314	54494	292	14	583	102	19711	65208	66590	181254	166140	163259	71989	72862	960812
1961	100577	54835	292	14	583	102	19843	66109	68035	176993	158224	164499	74673	74716	959493
1962	105797	58720	305	14	583	102	19683	65589	67105	183160	165969	166428	75068	75835	984357
1963	105222	57690	296	14	583	102	19683	63666	65063	169107	157663	164570	74500	75667	953825
1964	103794	56878	297	14	583	102	19792	66850	68962	195612	168537	163098	71998	72870	989386
1965	97275	54494	292	14	583	102	20657	69977	71533	184815	162218	163849	73890	73800	973498
1966	104531	57400	295	14	583	102	19683	64317	65951	175198	165241	170717	75543	76236	975809
1967	106787	58893	305	14	583	102	20181	68890	71301	183814	161313	163098	71998	73820	981098
1968	98535	54214	292	14	583	102	19836	64983	66703	184304	171383	165499	73238	73543	973231
1969	100173	54271	292	14	583	101	20501	69697	71253	179565	158596	166062	77790	78362	977258
1970	118150	64595	326	14	590	102	19683	64220	65843	177404	161902	167093	78634	81309	999865
1971	122541	70457	351	16	627	102	20296	70247	71813	181826	157907	161918	71853	73868	1003822
1972	102665	56762	295	13	583	102	20776	72470	74734	190196	163256	161968	71998	72616	988436
1973	99545	54637	292	14	583	102	19683	64380	66022	184005	196007	207452	93129	87996	1073844
1974	126699	70457	344	15	590	104	22027	75978	77553	190196	163903	162507	71658	73792	1035823
1975	102045	56330	296	13	583	102	20181	68890	71301	192590	167889	162372	72364	73568	988524
1976	104180	56687	293	14	583	102	20181	68962	71279	179700	157767	161901	71998	72032	965678
1977	97865	54494	292	14	583	102	19683	63666	65244	179429	194226	210647	93129	93129	1072501
1978	126699	70457	348	16	669	109	20806	68475	70640	181880	162198	162440	72023	72055	1008815
AVERAGE	108301	59823	309	14	593	103	20192	67301	68999	179706	164522	170547	77373	78177	995961

Table A-10. Mwhrs of Pumping at Grand Coulee – CONT

MEGAWATT HOURS OF PUMPING – SOS 9b														
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97865	54494	292	14	583	102	20012	64275	63999	165164	157384	164676	74753	74753	938366
1930	105253	58427	298	14	583	101	19845	64075	63890	166079	161607	169506	75305	75305	960287
1931	104546	57768	296	13	582	104	20607	66883	66769	168080	156490	166043	75305	75305	958793
1932	105548	61831	327	15	602	102	19683	65919	67512	170751	153746	163098	71868	72848	953849
1933	101214	55689	292	14	583	102	20108	68506	70760	197123	168537	163098	71998	72125	990148
1934	98038	54494	292	14	583	102	20079	68425	69987	187240	188816	183179	75305	75305	1021859
1935	102341	56126	292	14	583	102	19864	66533	68265	187847	190135	183456	75305	75305	1026168
1936	101567	55634	292	14	581	102	19724	64089	63781	160851	153331	162541	73660	73717	929884
1937	102941	57218	300	14	582	103	20055	64563	64450	163901	154572	163070	73973	73973	939715
1938	106534	59630	300	14	583	102	20161	68799	71090	187202	173391	173700	75305	75305	1012115
1939	102379	56183	292	14	583	102	19763	64633	65873	167533	155313	164570	74611	74611	946459
1940	102640	56362	293	14	583	102	19683	63680	63842	161622	153907	165771	75305	75305	939106
1941	102979	56330	292	14	583	102	19683	63666	64089	166003	158756	167223	75305	75305	950328
1942	104577	57197	292	14	583	102	19683	63666	63666	160496	153268	163098	71629	72801	931070
1943	101640	56241	293	14	583	102	20181	68890	71190	186596	172351	170924	72372	73465	994841
1944	101812	56202	293	14	585	102	20020	64310	64192	166969	160711	167635	75305	75305	953454
1945	106424	60203	303	14	581	102	20049	64199	64520	161812	153379	163098	72574	73182	940440
1946	106016	59814	306	14	584	102	20181	68890	71190	179565	164063	168410	73587	74073	986793
1947	101653	55782	292	14	583	102	20181	68486	70650	179115	160634	164676	72777	73497	968441
1948	101861	55143	292	14	583	102	19966	67270	69227	180822	159618	163098	71998	72129	962121
1949	97215	54494	292	14	583	102	20181	68105	70150	171926	154100	165771	75305	74048	952284
1950	103245	57499	297	14	583	102	20181	68890	71190	197536	173580	164712	71998	72892	1002717
1951	97437	54494	292	14	583	102	20289	70139	71856	186975	170722	173497	74978	74094	995470
1952	101640	55036	292	14	583	102	20181	68890	71190	179565	164806	171908	75305	75305	984816
1953	103080	57591	302	14	583	102	19683	64394	65627	170825	157732	163098	71547	73471	948048
1954	99984	54689	292	14	583	102	20181	68890	71190	189552	173868	169023	71998	71634	992000
1955	97865	54494	292	14	583	102	19683	63666	64082	163059	154670	163098	71998	73040	926643
1956	99534	54516	292	14	583	101	20770	72158	72890	179592	157628	163098	71688	72574	965437
1957	100296	54747	292	14	583	102	19683	65619	67146	168428	154267	163430	72983	73132	940720
1958	102803	56755	295	13	583	102	19874	65850	67312	174011	157855	162558	73726	73603	955341
1959	102466	55950	291	14	583	102	20181	68890	71190	197536	169149	163444	72061	72851	994708
1960	98451	54494	292	14	583	102	19711	65208	66590	172431	156953	163098	72125	72834	942884
1961	101168	55030	292	14	583	102	19843	66109	67678	174758	157384	163098	72035	73130	951223
1962	103068	56906	297	14	583	102	19683	65589	67105	174784	157211	163098	71696	72995	953128
1963	101616	55646	291	14	583	102	19683	63666	64013	161829	153698	163098	71898	73091	929228
1964	101482	55463	291	14	583	102	19792	66850	68779	181445	160711	163098	71998	72394	963000
1965	97981	54523	292	14	583	102	20657	69977	71533	179620	158631	163098	71998	71654	960660
1966	97275	54533	292	14	583	102	19683	64317	65538	166173	154116	163098	71688	72672	930082
1967	102057	56171	293	14	583	102	20181	68890	71301	198222	168537	163098	71998	72421	993867
1968	98430	54186	292	14	583	102	19836	64983	66276	169982	156884	163098	71703	72470	938837
1969	98747	54494	292	14	583	101	20501	69697	71253	179565	165362	172394	75305	74381	982688
1970	102329	55844	291	14	583	102	19683	64220	65843	169169	155898	163098	72912	73933	943917
1971	103729	58231	305	14	583	101	20296	70247	71813	181826	157907	163098	71998	72485	972633
1972	99479	54923	290	14	583	102	20776	72470	74734	190196	163256	161968	71998	71531	982320
1973	97865	54494	292	14	583	102	19683	64331	64116	167816	165048	171739	75305	75473	956859
1974	104196	58214	298	13	584	104	22027	75978	77553	190196	163903	162507	71998	72870	1000443
1975	97396	54494	292	14	583	102	20181	68890	71301	198222	169985	162372	71599	72311	987742
1976	100207	54742	292	14	583	102	20181	68962	71279	179700	159095	163173	71998	71661	961986
1977	97865	54494	292	14	583	101	19782	63768	64151	168983	163518	169282	75305	75473	953611
1978	106993	62809	326	14	585	102	20181	68475	70640	181880	162198	162372	71998	72626	981200
AVERAGE	101475	56215	295	14	583	102	20055	66958	68285	176611	161774	165888	73187	73533	964975

Table A-10. Mwhrs of Pumping at Grand Coulee – CONT

MEGAWATT HOURS OF PUMPING – SOS 9c															
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	98038	54163	290	13	584	103	20128	65222	66077	180791	170116	164872	72785	72785	965968
1930	98588	54430	290	13	583	103	20049	64499	64990	175120	165532	164872	72785	72785	954639
1931	98095	54163	290	13	585	104	20350	65398	65619	175224	165217	164872	72785	72785	955500
1932	98095	54163	290	13	590	109	22639	75289	75679	174500	153746	163098	71959	72012	962182
1933	98095	54163	290	13	580	105	22265	75289	77906	205915	168537	163098	71998	71458	1009712
1934	97336	54163	290	13	582	105	22265	75289	74299	181771	163277	164872	72785	72785	979832
1935	98209	54225	290	13	580	105	22213	75154	77499	205915	171145	163122	71998	72012	1012480
1936	98095	54163	290	13	581	102	20104	64832	64164	160851	153331	163122	72785	72785	925219
1937	98387	54322	290	13	585	104	20582	66380	66809	178284	166336	164872	72785	72785	962536
1938	98821	54556	290	13	582	105	22265	75289	77906	191826	165799	164872	72785	72785	997894
1939	98095	54163	290	13	582	101	19885	65120	66141	168142	157350	164872	72785	72785	940324
1940	98293	54271	290	13	580	101	19889	64527	64690	163685	156507	164872	72785	72785	933289
1941	98199	54220	290	13	579	102	19709	64102	64570	169940	161646	164872	72785	72785	943812
1942	98230	54237	290	13	580	102	19707	63693	63795	162020	154392	163098	71488	72012	923657
1943	98577	54424	290	13	582	105	22265	75289	75259	181472	162377	163640	71458	72012	977762
1944	99036	54672	290	13	582	103	20092	64619	65354	178976	168337	164872	72785	72785	962515
1945	99111	54712	290	13	586	103	20257	65935	66826	166989	154653	163122	72785	72785	938169
1946	99197	55125	292	13	582	105	22265	75289	76982	181962	160421	163122	71861	72012	979228
1947	98095	54163	290	13	585	102	20181	69309	70962	179892	159690	163122	72012	72012	960428
1948	98126	54180	290	13	585	102	20565	72115	73235	183624	159618	163098	71998	71690	969238
1949	97478	54163	290	13	585	102	20565	72115	71640	173014	154100	163122	72785	72420	952392
1950	99111	54847	291	13	585	104	22265	75289	77906	204610	173068	164712	71998	72120	1016917
1951	97846	54163	290	13	582	105	22265	75289	77227	187392	163741	163208	71998	71959	986078
1952	98095	54163	290	13	582	105	22265	75289	75259	179565	160421	164872	72785	72548	976252
1953	98982	54643	290	13	580	101	19891	65843	67648	175562	157732	163098	71591	72249	948225
1954	98283	54265	290	13	585	104	22265	75289	77906	195681	173868	169023	71998	71486	1011055
1955	98038	54163	290	13	580	101	19889	64520	65288	165016	154670	163098	71998	72674	930339
1956	98095	54163	290	13	582	105	22265	75289	76113	179592	157628	163098	71666	72012	970911
1957	98335	54293	290	13	581	102	19988	66533	67906	168428	154267	163002	72730	72511	938979
1958	98577	54424	290	13	580	101	20422	70345	70095	175745	157855	163122	72785	72768	957123
1959	98209	54225	290	13	582	105	22265	75289	77906	205503	168387	163098	71998	72249	1010119
1960	98095	54163	290	13	580	101	19902	66260	67022	172431	156953	163098	71599	72012	942520
1961	98178	54208	290	13	580	101	20494	71479	72804	182452	158312	163098	72012	72012	966034
1962	99208	54765	290	13	585	102	19683	65589	67105	174784	157211	163098	71921	72012	946365
1963	98662	54470	290	13	580	102	19744	64116	64890	163721	153698	163098	72012	72012	927408
1964	98095	54163	290	13	585	102	19792	66850	68962	182561	161157	163098	71998	72012	959678
1965	98095	54163	290	13	582	105	22265	75289	75259	179620	158631	163098	71998	71744	971151
1966	97580	54163	290	13	580	101	19862	65012	65903	166173	154116	163098	71868	71904	930664
1967	98503	54384	290	13	585	104	22265	75199	77906	205915	168537	163098	71998	72012	1010809
1968	98095	54163	290	13	580	101	19945	65383	67154	176530	160076	163098	71846	72012	949286
1969	98095	54163	290	13	582	105	22265	75289	75259	179565	160421	163122	72012	72012	973193
1970	98630	54453	290	13	580	101	19864	64918	66630	170191	155898	162916	72691	72484	939661
1971	99175	54959	291	13	585	104	22265	75289	77906	181826	157907	163098	71998	72219	977635
1972	98651	54464	290	13	585	104	22265	75289	77906	190196	163256	161968	71998	71506	988492
1973	97114	54163	290	13	579	102	19701	65142	65361	179449	167393	164872	72785	73364	960328
1974	99122	54718	290	13	582	105	22265	76249	77906	190196	163903	162507	71998	71981	991835
1975	97580	54163	290	13	585	102	20570	72136	73700	196780	166630	162372	72012	71904	988836
1976	98325	54288	290	13	582	105	22265	75289	77607	180546	158471	162575	71998	71486	973839
1977	98038	54163	290	13	581	101	19855	64933	65523	175458	164158	164872	72785	73364	954135
1978	99338	55054	291	14	586	105	22265	73700	74509	181880	162198	162372	71998	71747	976056
AVERAGE	98327	54349	290	13	582	103	20991	70143	71259	180146	161254	163647	72241	72269	965614

Table A–10. Mwhrs of Pumping at Grand Coulee – CONT

MEGAWATT HOURS OF PUMPING – SOS PREFERRED ALTERNATIVE															
YEAR	SEP	OCT	NOV	DEC	JAN	FEB	MAR	15–Apr	30–Apr	MAY	JUNE	JULY	15–Aug	31–Aug	TOTAL
1929	97908	54518	292	14	580	102	20108	65034	65746	170800	161313	164872	72785	72785	946857
1930	98886	54870	291	14	587	104	20630	67006	67229	173090	161313	164872	72785	72785	954462
1931	98567	54695	292	14	595	107	21438	69433	69279	174630	161313	164872	72785	72785	960854
1932	99457	55838	301	14	626	111	21540	68880	70969	171725	154376	163098	72012	72012	950959
1933	98864	54683	290	14	584	101	20346	70074	71523	182997	161041	163098	72138	72012	967765
1934	98609	54327	292	14	584	101	20210	69197	70367	181771	163277	164872	72785	72785	969189
1935	98886	54870	291	14	584	101	20079	67678	68901	179198	161313	163139	72020	72020	959093
1936	98853	54841	292	14	580	102	20090	64832	64164	160851	154052	163901	72785	72785	928143
1937	98864	54853	291	13	585	104	20680	66461	67445	173218	161313	164872	72785	72785	954269
1938	98886	54870	291	13	584	102	20161	68799	71090	187202	165483	164641	72785	72785	977693
1939	98886	54788	291	14	585	101	19885	65120	66141	173065	161313	164872	72785	72785	950631
1940	98864	54747	290	14	584	101	19889	64527	64782	167715	160038	164872	72785	72785	941994
1941	98886	54870	292	14	584	102	19709	63761	64464	169273	161313	164872	72785	72785	943710
1942	98939	54900	292	13	584	102	19707	63666	63795	163326	155613	163098	72012	72012	928059
1943	98886	54689	290	14	583	102	20181	68890	71190	181472	162377	163640	71786	72012	966111
1944	98864	54527	292	14	579	102	20186	65041	66157	172027	161313	164872	72785	72785	949544
1945	98768	54806	292	14	599	106	20781	67245	68275	174113	161313	164872	72785	72785	956753
1946	98907	54882	292	14	579	102	20181	68890	71190	179565	158596	163098	72012	72012	960319
1947	98853	54527	292	14	583	102	20181	68486	70650	179115	159690	163122	72012	72012	959639
1948	98853	54458	292	14	583	102	19966	67270	69227	180822	159618	163098	71998	72012	958313
1949	98116	54600	292	14	583	102	20181	68105	70150	171926	154100	163122	72785	72548	946623
1950	98886	54870	292	13	584	102	20181	68890	71190	190575	170326	164712	71998	72249	984867
1951	98821	54441	292	14	583	102	20289	70139	71856	186975	163741	163208	72080	72012	974552
1952	98853	54458	292	14	583	102	20181	68890	71190	179565	160421	164872	72785	72548	964755
1953	98864	54847	291	13	580	101	19891	65317	66566	174319	159167	163098	71733	72249	947037
1954	98853	54458	292	14	583	102	20181	68890	71190	189552	173868	169023	71998	71486	990490
1955	97865	54494	292	14	584	101	19889	64520	65244	164905	154670	163098	71998	72674	930348
1956	98853	54458	292	14	583	101	20770	72158	72890	179592	157628	163098	72012	72012	964462
1957	98853	54458	292	14	579	102	19988	67072	67906	168428	154267	163122	72785	72548	940414
1958	98864	54649	290	14	584	101	20077	66785	67836	174011	157855	163122	72785	72785	949757
1959	98864	54470	292	14	583	102	20181	68890	71190	180818	159419	163098	72004	72249	962174
1960	97888	54494	292	14	584	101	19902	66038	67022	176042	160402	162321	72012	72012	949123
1961	98853	54458	292	14	584	101	20062	67245	68325	174758	157384	163098	72012	72012	949198
1962	98864	54516	292	14	583	102	19683	65589	67105	177130	160595	164872	72785	72548	954677
1963	98853	54458	292	14	584	102	19744	63910	64584	162952	153698	163401	72172	72361	927126
1964	98853	54562	292	14	583	102	19824	66973	68931	179565	159419	163098	71584	72059	955859
1965	98345	54186	292	14	583	102	20657	69977	71533	179620	153631	163098	71793	72012	960841
1966	98853	54458	292	14	584	101	19862	65012	66022	170507	159203	163122	72012	72012	942054
1967	98853	54718	290	14	583	102	20181	68890	71190	180818	159419	163098	71465	72012	961634
1968	98853	54458	292	14	584	101	19945	65383	66875	174680	161216	163036	72012	72012	949460
1969	97888	54494	292	14	583	101	20501	69697	71253	179565	158685	163170	72012	72012	960265
1970	98864	54464	292	14	584	101	19864	64918	66461	169751	155898	163122	72785	72548	939667
1971	98864	54654	290	14	583	101	20296	70247	71813	181826	157907	163098	71998	72249	963939
1972	98251	54135	292	14	583	102	20776	72470	74734	190196	163256	161968	71998	71781	980556
1973	97447	54494	292	14	583	102	19701	64268	64754	170170	161313	164872	72785	72455	943251
1974	98896	54876	291	14	584	104	22027	75978	77553	190196	163903	162507	71998	72238	991166
1975	98043	54576	292	14	583	102	20181	68890	71190	187202	164734	162372	72012	72008	972198
1976	98262	54141	292	14	583	102	20181	68962	71279	179700	157767	161901	71998	71486	956666
1977	97865	54494	292	14	584	101	19949	65149	66260	172785	161313	164872	72785	73364	949828
1978	98779	54573	290	14	588	101	20396	69729	71279	181880	163076	163122	71569	72249	967644
AVERAGE	98671	54620	292	14	585	102	20230	67585	68959	176721	160185	163727	72283	72326	956300

CENPP-PE-PE

May 23, 1995
Fredericks/5041

MEMORANDUM FOR RECORD

SUBJECT: IRRIGATION COSTS

1. This memorandum gives information about the development of irrigation costs for SOR for the Lower Snake Projects (Ice Harbor, Little Goose, Lower Monumental, and Lower Granite).

2. Sources and Price Leveling. Information for the irrigation costs for Lower Snake River projects were taken from the study "Investigation of Pumping Facilities, Lower Snake River" by Anderson Perry, 1991. Costs associated with the draw-down were prepared to reconnaissance level of detail for all types of pump stations (i.e. Wildlife, Recreational, Irrigation, and Municipal & Industrial.) at draw-down to spillway height and run-of-river height. Costs were price leveled to 1992 using the ENR Index.

3. Adjusting to Average Elevations for Time Periods. The hydro-regs specify the end of month elevation, I estimated the average elevation over the period by averaging the elevations at the beginning and end of the period. The average elevation was used to calculate increased costs.

4. Adjusting Power to Market Rates. Minor adjustments were made to the estimates for use in the SOR analysis. An average market rate of 29 mills is assumed for the irrigation pumps on the Ice Harbor pool based on information the USBR obtained from the Franklin County PUD and the Columbia REA. For this analysis it is also the assumed market rates for the wildlife, recreation, and M&I pump stations on Lower Monumental, Little Goose, and Lower Granite are 29 mills.

5. Estimating the Costs. Three different costs were quantified that are associated with pump modification for drawdown. The first being increased power costs. For ICE HARBOR under Alternative 1a (Pre-Salmon Summit Operation) the low elevation is 438.7 and under Alternative 2C (Current Operations, Final Supplemental EIS Operation) the low elevation is 437.5. For this analysis, it is assumed increased power costs begin at elevation 437. This is the elevation where pumpers begin incurring increased economic costs as the result of the lower pool elevation. Increased power cost estimates were interpolated for elevations between the zero point (438) and draw-down to spillway height as well as the elevations between spillway height and run of the river level.

For LOWER GRANITE under Alternative 1a (Pre-Salmon Summit Operation) the low elevation is 735.3 and under Alternative 2C (Current Operations, Final Supplemental EIS Operation) the low

Figure A–1. Development of Irrigation Costs for SOR for the Lower Snake Projects

elevation is 733.5. For this analysis, it is assumed increased power costs begin at elevation 733. This is the elevation where pumpers begin incurring increased economic costs as the result of the lower pool elevation. Increased power cost estimates were interpolated for elevations between the zero point (734) and draw-down to spillway height as well as the elevations between spillway height and run of the river level.

For LITTLE GOOSE under Alternative 1a (Pre-Salmon Summit Operation) the low elevation is 636.2 and under Alternative 2C (Current Operations, Final Supplemental EIS Operation) the low elevation is 633.5. For this analysis, it is assumed increased power costs begin at elevation 633. This is the elevation where pumpers begin incurring increased economic costs as the result of the lower pool elevation. Increased power cost estimates were interpolated for elevations between the zero point (634) and draw-down to spillway height as well as the elevations between spillway height and run of the river level.

For LOWER MONUMENTAL under Alternative 1a (Pre-Salmon Summit Operation) the low elevation is 538.7 and under Alternative 2C (Current Operations, Final Supplemental EIS Operation) the low elevation is 537.5. For this analysis, it is assumed increased power costs begin at elevation 536. This is the elevation where pumpers begin incurring increased economic costs as the result of the lower pool elevation. Increased power cost estimates were interpolated for elevations between the zero point (537) and draw-down to spillway height as well as the elevations between spillway height and run of the river level.

The second cost was the cost of pump modification. Typical modifications to pumps include lengthening pipes, adding stronger pumps, and installing fish screens. For this analysis, it is assumed that the pumps begin modification costs when a water surface level is reached where the pump station is affected. Interviews conducted by Anderson Perry with pump station owners were used to identify the water surface level where each particular pump station was affected. For those pumps where the pump station owner did not know where the pump was affected the average elevation where other pumps on that pool were affected was used. Because neither of the two pump station owners on Lower Monumental knew where the pumps were affected it was assumed they were effected at Minimum Operating Pool (MOP) elevation 536. Pump modification cost estimates for elevations between the zero point (where the particular pumper said he was affected) and spillway height were interpolated. As well as the elevations between spillway height and run of river height.

Since the slope of the river runs downstream, some pumps located further upstream on a particular pool will reach a point where the water elevation will not decrease (the pump is at the run of the river level). This leads to different levels of impact

Figure NO TAG. Development of Irrigation Costs for SOR for the Lower Snake Projects – CONT

depending on where on the pool the pump station is located. This has been accounted for in the analysis done by Anderson Perry.

To calculate annual modification costs, I assumed pumps were modified according to the lowest drawdown month for that alternative based on the hydro-regs. If the average elevation for a particular alternative on John Day pool is 260 in May and 257 in June, it is assumed the annual pump modifications costs are those associated with modifying the pumps to operate at 257.

The third cost was the increased cost of operation and maintenance associated with the increased pumping facilities (more pumps and pipes). This cost was estimated at 5% of the pump modification cost. This estimate was revised upward slightly from the original estimate of 3%. Operation and maintenance costs were increased to take into account the increased sedimentation as a result of the large drawdowns proposed on the Snake River.

6. Estimating Monthly Increased Power Costs. To estimate the monthly increased power costs, data on the amount of power usage per month was necessary. I used information provided by the USBR on the amount of water used by month. The study had the percent of irrigation occurring during a given month. To get the increased power costs I multiplied the 29 mills - kw/hr figure by the increased energy (kw/hr calculated by Anderson Perry) needed to pump from the lower water surface to get the annual increased power cost. To estimate the monthly cost I multiplied the annual figure by the percentage of irrigation occurring during that month (all months equal 100%). For the half months, irrigation usage was assumed to be one-half of what occurs during the month.

Both pump modification and increased O & M are in annual terms and do not vary by month. The pump modifications costs are annualized at a rate of 7 3/4% and 3% over 20 years.

7. Other Pertinent Information. There are fifteen affected pump stations on the Ice Harbor pool. Three pump stations are characterized as for wildlife use, while the other 12 are characterized as for agriculture use.

There are two affected pump stations on the Little Goose pool, and they are characterized as for wildlife use.

There are two affected pump stations on the Lower Monumental pool, and they are characterized as for wildlife use.

There are nine affected pump stations on the Lower Granite pool. Two are characterized as for wildlife use. Five are characterized as for recreational use. One is characterized as for Municipal & Industrial (M & I) use, and one is characterized as for M & I / Recreational use.

JIM K. FREDERICKS
Economics Section

Figure NO TAG. Development of Irrigation Costs for SOR for the Lower Snake Projects – CONT

CENPD-PE-PE

May 23, 1995
Fredericks/5041
File: C:\word\irr\irrsor

MEMORANDUM FOR RECORD

SUBJECT: IRRIGATION COSTS

1. This memorandum gives information about the development of irrigation costs for SOR for John Day pool.

2. Sources and Price Leveling. Information for the irrigation costs for John Day were taken from a combination of sources including the study "Effects of the Columbia River Pool Draw-Down on Selected Pumping Stations in Washington" by Pacam and IRZ, August 1991; "Feasibility of Irrigation Canal Along the Columbia River in Oregon" by IRZ and Pacam, November 1992; and "John Day Reservoir, Washington Shore, Irrigation Pumping Stations Evaluation" by Bovay Northwest, Inc, February, 1993. One pump station was not covered in any of these studies, so the cost was preliminarily estimated by a local engineer familiar with the situation. All other costs associated with the drawdown were prepared to reconnaissance level of detail for pump stations at MOP on John Day. Costs were price leveled to 1992 using the ENR Index.

3. Adjusting to Average Elevations for Time Periods. The hydro-regs specify the end of month elevation, I estimated the average elevation over the period by averaging the elevations at the beginning and ends of the period. The average elevation was used to calculate increased costs.

4. Adjusting Power to Market Rates. Minor adjustments were made to the estimates for use in the SOR analysis. A market rate of 33.5 mills is assumed for the irrigation pumps on the Oregon side of the John Day pool based on information the USBR obtained from Benton County PUD. A market rate of 25 mills is assumed for the irrigation pumps on the Washington side of the John Day pool based on information the USBR obtained from the Umatilla Electric Co-op.

5. Estimating the Costs. Three different costs were quantified that are associated with pump modification for drawdown. The first being increased power costs. Under Alternative 1a (Pre-Salmon Summit Operation) the low elevation is 263.5. Under Alternative 2C (Current Operations, Final Supplemental EIS Operation) the low elevation is 262.5. For this analysis, it is assumed increased power costs begin at elevation 263. This is the elevation where pumpers begin incurring increased economic costs as the result of

Figure A–2. Development of Irrigation Costs for SOR for the John Day Pool

the lower pool elevation. Increased power cost estimates for elevations between the zero point (264) and MOP were interpolated.

The second cost was the cost of pump modification. Typical modifications to pumps include lengthening pipes, adding stronger pumps, and installing fish screens. For this analysis, it is assumed that modification costs begin when a water surface level is reached where the pump station is affected. Interviews conducted by IRZ with pump station owners were used to identify the water surface level where each particular pump station was affected. Pump modification cost estimates for elevations between the zero point (where the particular pumper said he was affected) and MOP were interpolated.

To calculate annual modification costs, I assumed pumps were modified according to the lowest drawdown month for that alternative based on the hydro-regs. If the average elevation for a particular alternative on John Day pool is 260 in May and 257 in June, it is assumed the annual pump modifications costs are those associated with modifying the pumps to operate at 257.

The third cost was the increased cost of operation and maintenance associated with the increased pumping facilities (more pumps and pipes). This cost was estimated at 3% of the pump modification cost.

6. Estimating Monthly Increased Power Costs. To estimate the monthly increased power costs, data on the amount of power usage per month was necessary. I used Columbia-Snake Drawdown Studies, Mitigation of Irrigation and Water Supply Impacts, John Day Project - Irrigation Withdrawals for Oregon and Washington, John Day Pool. The study had the percent of irrigation occurring during a given month. To get the increased power costs, I multiplied the 25 mills (or 33.5 mills) - kw/hr figure by the increased energy (kw/hr) needed to pump from the lower water surface to get the annual increased power cost. To estimate the monthly cost, I multiplied the annual figure by the percentage of irrigation occurring during that month (all months equal 100%). For the half months, irrigation usage was assumed to be one-half of what occurs during the month.

Both pump modification and increased O & M are in annual terms and do not vary by month. The pump modifications costs are annualized at a rate of 7 3/4% and 3% over 20 years.

7. Pump Station Uses. Bovay and IRZ identified a total of 25 pump stations that will be impacted. Twenty-four are characterized as for agricultural use. One pump station is characterized as for agricultural\wildlife\recreation use. Other facilities impacted are discussed below.

Figure NO TAG. Development of Irrigation Costs for SOR for the John Day Pool – CONT

8. <u>Estimated Costs for Other Facilities Affected by Draw-down.</u> Costs on other non-irrigation facilities comes from CRSMA - SCS, Phase 1, Appendix B, John Day Reservoir, Minimum Operating Pool, Technical Report, April 1994 for the John Day pool. Work has begun on the Evaluation (Feasibility) Study/Design Report for mitigation of damages caused by the proposed drawdown. Where preliminary feasibility level estimates have been made they are incorporated into this analysis. Other non-irrigation facilities include modifying the Umatilla and Irrigon Hatcheries to receive water; modifying the City of Boardman's M & I Pump; modifying groundwater wells affected by the drawdown; extending the pipeline for the City of Umatilla's sewage treatment outfall; dredging the Umatilla River to prevent sedimentation blockage for salmon; extending pipes for pumps used by Columbia Aluminum; extending pipes for pumps used by a school in Umatilla to irrigate a ball field.

JIM K. FREDERICKS
Economics Section

Figure NO TAG. Development of Irrigation Costs for SOR for the John Day Pool – CONT