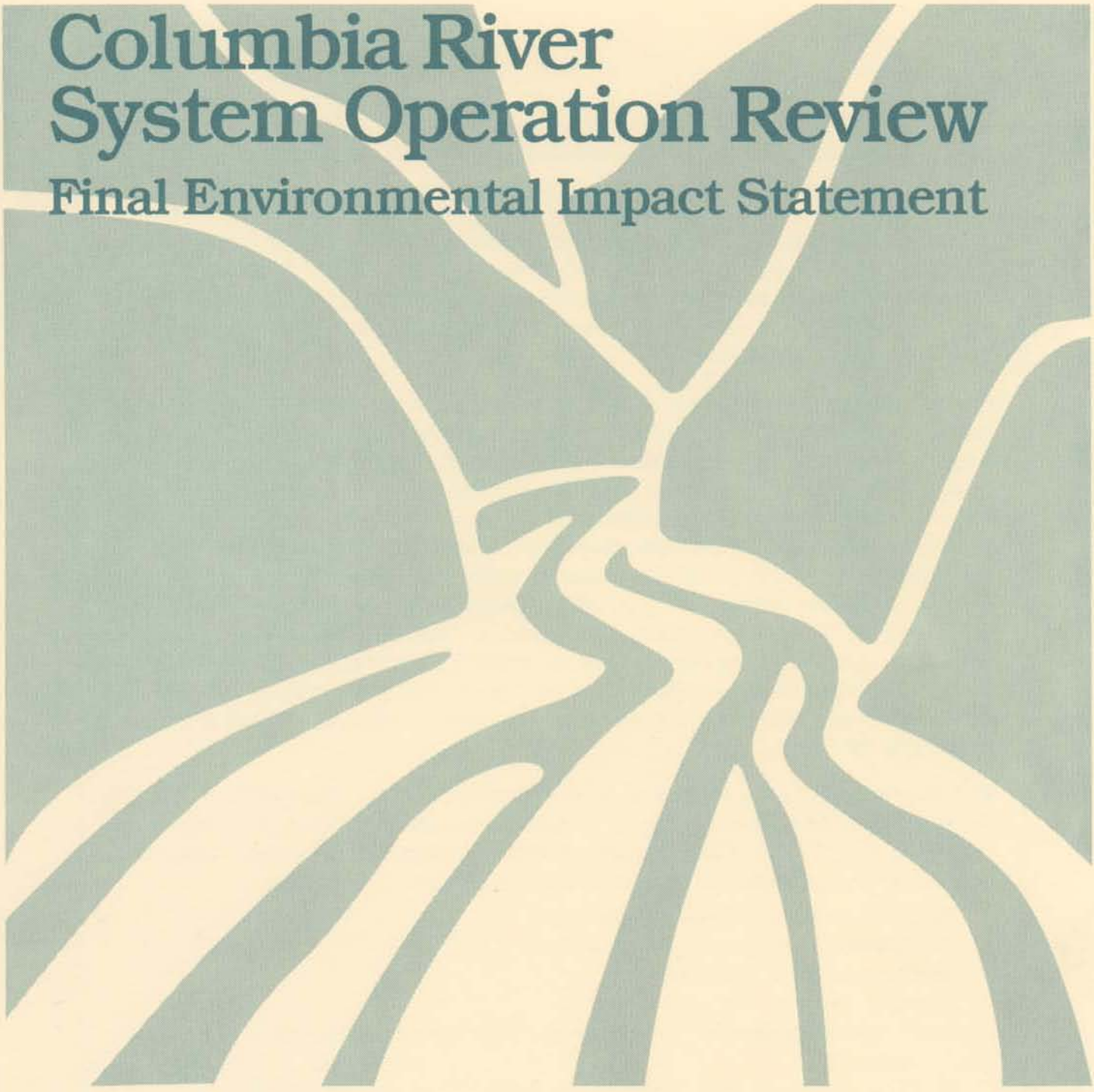
Columbia River System Operation Review

Final Environmental Impact Statement



Appendix G

Land Use and Development

BONNEVILLE POWER ADMINISTRATION

US Army Corps of Engineers
North Pacific Division

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

DOE/EIS-0170

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.

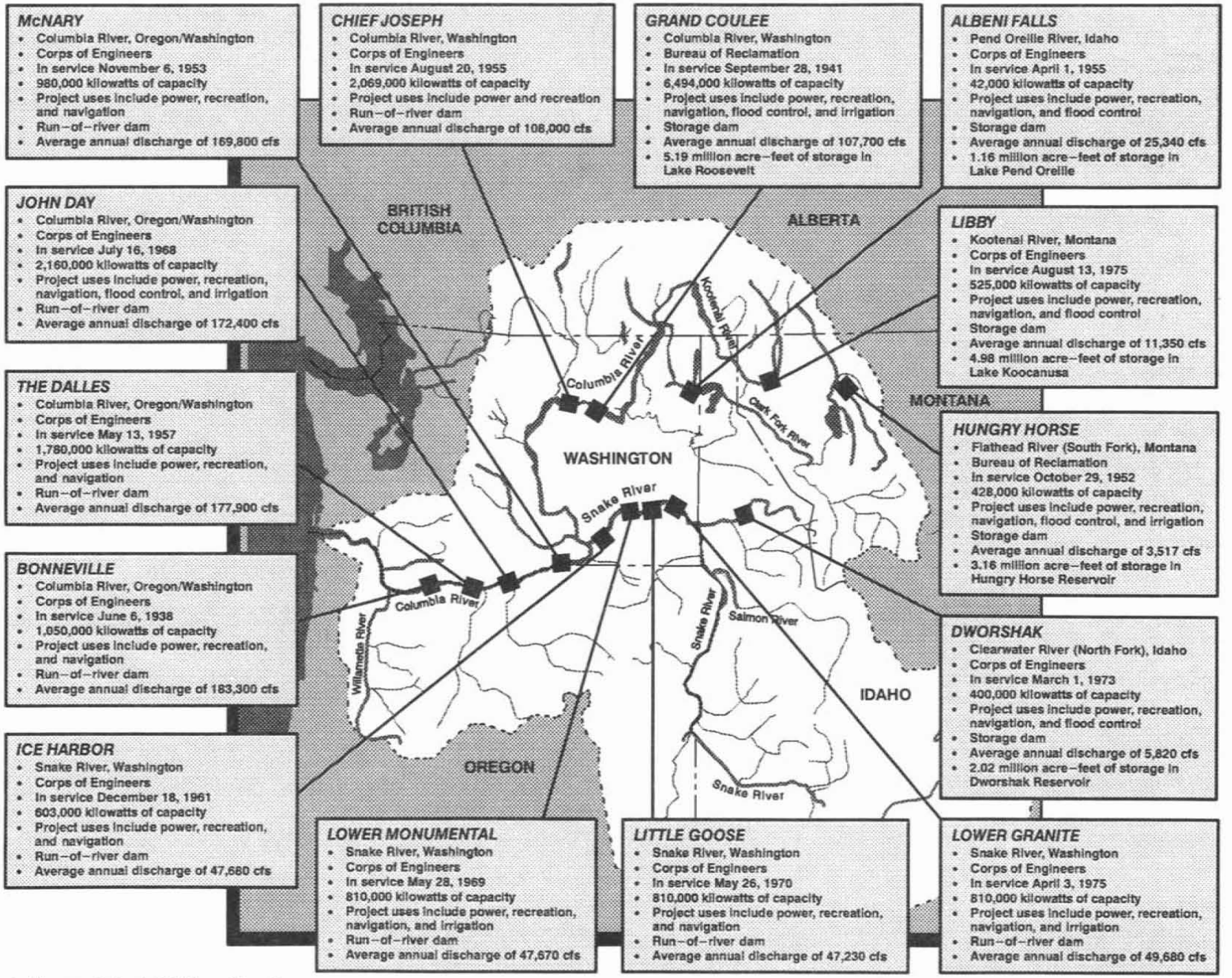
WHAT DO THE TECHNICAL APPENDICES COVER?

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 Land Use and Development appendix relies on supporting data contained in Appendices H and O. For complete coverage of all aspects of land use, readers may wish to review all three 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.

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CHAPTER 1

SCOPE AND PROCESS

1.1 INTRODUCTION

This chapter describes the context for the land use studies conducted to support the System Operation Review (SOR). It provides a brief summary of the issues addressed in this appendix, and the process and scope for the land use studies. More complete discussion of these subjects is included in Chapter 3 of this appendix.

1.2 SUMMARY OF ISSUES

1.2.1 Issues Raised During Scoping

Individuals and organizations representing a variety of interests were encouraged to participate in the SOR scoping process. Citizens from the States of Montana, Idaho, Oregon, and Washington have been involved in meetings and decisionmaking. The public was encouraged to become involved in the process through public meetings, citizen participation in work group duties, a scoping document, and updates on the SOR process in a newsletter called *Streamline*.

Fourteen SOR scoping meetings were held in late 1990 and another 14 mid-point meetings were held in late 1992. In addition, there were six roundtable discussions held in fall 1991 to update the public on the SOR. Written reports describing the meetings and hundreds of letters and cards reacting to the SOR were generated.

Overall, there were few scoping comments that addressed land use. (See the "Other Resources" category in the January 1991 Comment Summary and the May 1991 Scoping Document). Land use issues raised during the public scoping process for the SOR focused on lands along the river corridor and highways and roads in the larger area surrounding the river. The two primary issues associated with land use in the river corridor were the preservation of the natural environment and the development of waterfront properties.

Several of the comments addressing land management or shoreline development advocated protecting wetlands; reestablishing native vegetation; considering watersheds as a whole to preserve land quality; limiting use of shoreline areas and adjacent waters; stopping or removing all development from flood-prone areas; protecting all wild river stretches from development; and preserving the ground adjacent to the rivers to keep the water clean. While these preservation-oriented comments raise valid issues, they address land management and land use regulation concerns that go beyond the authority and jurisdiction of the SOR lead agencies. Because these are not system operations issues within the scope of the SOR, they are not addressed in this appendix.

Some commentors addressed existing development along the river or the future development potential of lands within the river corridor. Specific comments included statements that the SOR must allow waterfront land to be developed for commercial and industrial issues, and that ownership of waterfront land should be turned over to local jurisdictions where practical. Technically, these comments address real estate issues at the Federal projects that are not directly connected with system operations. Nevertheless, the SOR Interagency Team recognizes the potential for system operations to affect private land uses within the river corridor, and interprets these comments to include concern for such effects. Therefore, the effects of river operating patterns on existing and potential future development in the river corridor are a key issue addressed in the land use appendix.

Another issue identified during scoping relates to the roads and highways that link towns and ports along the Columbia River system. Some of the system operation alternatives under consideration would result in interruptions in river navigation. This could cause shippers to shift from barge to rail or truck transportation, creating greater demands on railroads and highways. Public scoping comments on transportation generally addressed the regional importance of navigation and the need to maintain navigation service. While these comments did not specifically refer to the indirect effects of navigation interruptions on land transportation, these effects were identified as issues in recent environmental analyses of short-term Columbia River system operations (i.e., the Columbia River Salmon Flows Measures 1992 Options Analysis/Environmental Impact Statement [1992 OA/EIS] and the subsequent Supplemental Environmental Impact Statement [SEIS]). Based on past experience, the SOR Interagency Team recognized that potential deterioration of railroads and highways that could result from decreased navigational use of the Columbia River system is a public concern that needs to be addressed in this appendix.

1.2.2 Issues from Draft EIS Review

Very few of the public and agency review comments on the Draft EIS addressed the land use issues discussed in Section 1.2.1. However, there were a few comments that raised new concerns that directly or indirectly related to land use. The testimony at the Sandpoint public meeting included a few comments expressing concern over the potential effects of a late-summer draft of Lake Pend Oreille (included as part of SOS 4) on the property values and rights of lakeshore landowners. Some of the discussion at the Kalispell meeting reflected similar concerns over property at Flathead Lake. One commentor at the Seattle meeting also raised the issue of effects on property rights, although this was in the context of rights to irrigation water. His point was that drawdown actions would make irrigation water inaccessible to lower river pumpers, and this would constitute condemnation of their water rights.

These concerns over property rights and values are, in some aspects, a subset of the river corridor development issue described in Section 1.2.1. Because they also address economic measures, such as land values and potential mitigation costs, they are more directly economic issues that should be addressed in Appendix O, Economic and Social Impacts, rather than in Appendix G. Comments on property rights and values and responses to those comments, are included in Appendix T (see Common Issue Nos. 8 and 13 in Chapter 1, in particular).

Nevertheless, through consideration of the Draft EIS analysis and public comments, the SOR Interagency Team did identify an additional related issue concerning potential indirect land use impacts resulting from effects on irrigation. The Irrigation/M&I Water Supply Work Group (see Appendix F) concluded that, at least in some cases, SOS alternatives with impacts to irrigators could potentially result in changes in cropping patterns, on-farm management, and acreage in production. These types of cropping shifts would likely occur only if the increased pumping costs were borne by irrigators (i.e., if there were no mitigation for these impacts). These types of agricultural changes, if they were to occur, could in turn alter land use patterns and therefore represent potential indirect land use impacts.

1.3 STUDY PROCESS

Land use issues were coordinated within the context of the overall SOR scoping process; the SOR agencies did not conduct separate public involvement or agency coordination activities specifically for land use issues. As a result of the limited scoping input concerning land use, the agencies did not establish a separate work group for land use, nor did they assign land use to one of the 10 resource work groups. Some of the navigation, recreation, flood control, and economics scoping issues incorporated land use concerns and were addressed by the appropriate resource work group. The SOR National Environmental Policy Act (NEPA) Action Group, one of the functional groups providing support to the resource work groups, took overall responsibility

for integrating documentation of land use issues and preparing this appendix.

The land use issues addressed in the SOR and identified in Section 1.1 are related to navigation, recreation, and economic considerations. For instance, the extent to which navigation would be interrupted as a result of reservoir drawdowns would directly influence the impacts on railroads and highways. Similarly, there are strong economic aspects to the land use issue of effects on the use and development of river corridor lands. As a result of these relationships, the SOR land use staff (the NEPA Action Group and its contractor) coordinated with the Navigation, Recreation, and Economic and Social Impacts work groups in preparing this appendix.

The land use study process included the standard NEPA steps of characterizing affected resources, determining the operations aspects that could affect these resources, analyzing the effects of the alternative operations, comparing and evaluating alternatives, and identifying potential mitigation measures. The information on the affected resources presented in Chapter 2 is based on readily available existing data for the study area. The impact analysis results reported in Chapters 4 and 5 are founded on simulation model output indicating river flows and reservoir elevations for the respective operations alternatives. The analysis of indirect effects on land transportation also included the economic analysis for navigation as a primary input.

1.4 SCOPE OF STUDIES

The technical and geographic scope of the land use studies are based on the two specific issues identified during the scoping process (see Section 1.1). Effects of system operations on land use and development potential would be limited to lands with direct physical access to the river system, or to lands where aesthetic or water–use factors could have an indirect effect. Consequently, the assessment of land development impacts is based on a general inventory of primary land uses and managing entities within the river corridor.

The study team did not define a specific boundary for the river corridor. In general, however, the width of the river corridor addressed in Chapters 2 and 4 includes the viewshed for the respective river reaches or reservoirs (locations from which the river or reservoir can be seen). Within this corridor, lands immediately adjacent to the river or to Federal project lands are of primary interest. Longitudinally, the study scope includes the 14 Federal projects and immediately affected downstream reaches (see Figure P–1 in the Preface for locations), as follows:

- Lake Koocanusa and the Kootenai River downstream
- the upper Columbia River in Canada
- Hungry Horse Reservoir and the Flathead River downstream
- Albeni Falls Dam and Lake Pend Oreille
- Grand Coulee Dam and Lake Roosevelt
- the middle Columbia River
- the middle Snake River
- Dworshak Reservoir and the Clearwater River downstream
- the lower Snake River
- the lower Columbia River

Indirect land transportation impacts could extend much farther from the river corridor, due to the existing transportation patterns for producing areas that are tributary to the waterway. However, the geographic scope for this issue area is also limited by the location of potential actions that would interrupt barge service on the waterway; these actions would only occur on the lower Snake River. Therefore, this component of the study has a primary geographic focus on a multi–county area in Idaho, Washington, and Oregon surrounding the lower Snake River. Secondary coverage is necessary for portions of the regional transportation network outside the primary area. Additional details for the geographic extent of this study component are provided in Chapter 3 of this appendix.

CHAPTER 2

LAND USE AND DEVELOPMENT IN THE COLUMBIA RIVER BASIN TODAY

This chapter generally describes land use and development conditions in the Columbia River Basin that are relevant to the SOR. To provide some perspective on why these conditions exist, it begins with a brief review of historical development patterns. This is followed by discussions of land ownership and management, general land use patterns, and land transportation.

A primary source for this overview is the Pacific Northwest River Basin Commission's (PNRBC's) Columbia—North Pacific Region Comprehensive Framework Study of Water and Related Lands (PNRBC, 1969 and 1970). Except where other references are specifically cited, the PNRBC report is the source for the factual information presented in Sections 2.1 through 2.3. This source provides information on land and related resources throughout the entire Pacific Northwest region, as opposed to the Columbia River Basin specifically. This region, as defined by the PNRBC, includes all of the Columbia River Basin in the United States, plus portions of western Oregon and Washington that do not drain to the Columbia River. The basin includes eastern Washington; almost all of Idaho; most of Oregon; and small areas of Wyoming, Utah, and Nevada. The basin also includes a large area of southeastern British Columbia that is not covered in the PNRBC review.

2.1 HISTORICAL OVERVIEW

Current land use patterns in the Northwest and the Columbia River Basin reflect the strong influence of settlement and development patterns throughout the history of the region. Settlement and development patterns were largely shaped by the distribution of natural resources and by the evolution of Federal land policies over time. The review of existing conditions, therefore, begins with a summary of historical developments and how they shaped existing land use characteristics.

2.1.1 Regional Settlement History

The first settlers in the Pacific Northwest were Indians who migrated to the region approximately 10,000 years ago. The original inhabitants are thought to trace back to small groups of Siberian hunters who crossed the Bering land bridge to North America during the last glacial period (Jackson and Kimerling, 1993).

Distinctive coastal and interior cultures developed among the early Indians. Approximately 100,000 to 180,000 early Indians were concentrated along the Pacific coast. Their livelihood depended upon using the natural resources of the region. Indians hunted, fished, and gathered existing available indigenous plant and animal life. One of the principal food sources was salmon, caught as they ascended the streams to spawn. Other fish, marine mammals, waterfowl, game, and plant food sources were also plentiful. Coastal Indians lived in villages of plank houses distributed along the ocean or bays (Jackson and Kimerling, 1993).

The Indian peoples living in the interior plateau of the region (in what is essentially the Columbia River Basin) reflected the influence of the neighboring coastal culture, plus that of desert peoples to the south and the plains Indians to the east. The interior peoples lived in villages that were concentrated in the major river valleys, although seasonal migration between high-elevation areas and the relatively protected valleys was common (Jackson and Kimerling, 1993). Reports by early explorers indicate that upwards of 50,000 Indians lived along the Columbia and Snake Rivers. Salmon were also important to the interior Indians, and much of the population was concentrated at major falls and rapids such as Celilo

Falls on the lower Columbia (near The Dalles) and Kettle Falls on the upper Columbia.

Apart from sporadic coastal explorations from the 1500s through the 1700s, Euro–American contact with the Indians of the region began in the early 1800s. Fur traders came to the region following the Lewis and Clark expedition of 1804–1806. Later, the Pacific Northwest attracted early settlers because of its land, which is rich with natural resources. Fertile soils, gold, and other minerals for mining, abundant water, and seemingly unlimited forest land offered opportunity.

Fur traders employed by John Jacob Astor built Fort Astoria near the mouth of the Columbia River in 1811. Fort Vancouver, within the present city of Vancouver, Washington, was established in 1824 by the Hudson's Bay Company, the British fur–trading organization. By 1829, the Fort was producing small grains, in addition to maize, vegetables, fruit, and livestock. Hudson's Bay Company also established Fort Nisqually, near present–day Tacoma, in 1833 as an agricultural and shipping point.

During the 1830s, Catholic and Protestant clergy came to the region and set up missions. The first was a Methodist mission founded by Nathaniel Wyeth and others in the Willamette Valley in 1834 (Jackson and Kimerling, 1993). The Spalding Mission near present–day Lewiston and the Whitman Mission near Walla Walla, both established in 1836, were key early settlements in the interior of the basin.

Settlers, most attracted by the agricultural potential of the region, followed the missionaries in the 1840s. Significant numbers of settlers began arriving in 1843, and the westward migration continued for decades. The first of the settlers following the Oregon Trail came to the Willamette Valley, which was initially the dominant area of development. Settlement later spread to the Puget Sound area and other parts of the region, beginning in the 1850s.

Gold was discovered in several locations during the 1850s and 1860s, creating an influx of people to the interior parts of the region. Mining settlements created demand for local agricultural production and other services in previously unpopulated areas. The development of agriculture, mining, and fishing that resulted from the discovery of gold led to population concentrations at Colville, Washington; Jacksonville, Oregon; and along the John Day and Powder Rivers in Oregon. Grasslands adjacent to these areas were used for grazing purposes.

Settlers continued to disperse to new areas of the region through the last half of the 1800s, while the Willamette Valley and other areas that had already been settled continued to develop. Settlement here was sufficient that Congress made Oregon a state in 1859, while the remainder of the Northwest (what is now Washington, Idaho, the northwestern part of Montana and part of western Wyoming) was then designated as the Washington Territory. Washington and Montana became states in 1889, followed by Idaho and Wyoming in 1890. In addition to the attraction of natural resources, Federal land disposal policies (see Section 2.1.2 for more discussion) and the development of railroads spurred late–19th–century growth in the interior of the region.

By 1900, the region's population had increased to approximately 1.2 million people. Natural resources continued to influence regional settlement patterns in the 1900s, while government works projects and major industrial developments became new factors. From Coos Bay, Oregon, to Grays Harbor, Washington, small coastal towns developed in association with farms, salmon canneries, and sawmills. Mining activities developed in northern Idaho, western Montana, and southern Oregon. Spokane, Boise, Pendleton, Salem, Yakima, and Missoula developed as trading centers. New towns were developed around large government projects, particularly hydroelectric and irrigation developments, beginning in the 1930s. Access to inexpensive and abundant electrical power attracted wartime industries to the area during the 1940s.

Agricultural production evolved to suit local growing conditions. Farmers in Oregon's Willamette and Hood River Valleys and along rivers draining into Puget Sound in Washington came to emphasize fruits and vegetables, such as berries, sweet corn, and snap beans. Wheat production dominated in

the drier areas east of the Cascades. Irrigation led to increased production on fertile but arid lands located in eastern areas of the Pacific Northwest. Washington's Yakima, Wenatchee, and Okanogan Valleys were developed for fruits, processed vegetables, hops, and spearmint. The Snake River Basin of southern Idaho and southeast Oregon produced potatoes and sugar beets, among other crops. Irrigated areas along the Columbia River in south-central Washington and north-central Oregon were planted to a mixture of crops including wheat, alfalfa, potatoes, and sugar beets (Corps, 1979).

2.1.2 Federal Land Policies

A series of 19th-century Federal policy initiatives sought to make lands easily available for settlement. These laws were key factors in the continued dispersal of settlers throughout the region during the last half of the 19th century and the early part of the 20th century. Four primary facets of Federal land disposal policy during this period were laws that allowed transfer of public lands directly to individuals land grants to states and railroads, and direct Federal support of irrigation development.

The majority of the Pacific Northwest was originally public land of the Oregon Territory and was subject to disposal. The Donation Land Act of 1850 allowed married settlers to acquire title to 640 acres (259.1 ha) of land, providing that they occupied and cultivated the land for 4 years. Approximately 2.6 million acres (1.05 million ha) in western Oregon were claimed under this act by 1855.

A large part of the former public domain was passed into private ownership under the Homestead Act of 1862. This law allowed individuals to claim 160-acre (64.8-ha) tracts of land for subsistence and commercial farm development. The Homestead Act was followed by the Timber Culture Act and the Desert Land Act. In 1873, the Timber Culture Act authorized any person who kept 40 acres (16.2 ha) of timber (subsequently reduced to 10 acres [4 ha]) in good condition to acquire title to an additional 160 acres (64.8 ha). The Desert Land Act of 1877 allowed each claimant 640 acres (259.1 ha) (reduced to 320 acres [129.6 ha] in 1891), providing 80 acres (32.4 ha) were irrigated within 3 years.

Irrigation efforts were successful only in areas where lands could be easily and cheaply irrigated. Even in those areas, individual farmers or private companies were limited in the size of projects they could afford to develop. As a result, the Federal Reclamation Act of 1902 provided for the Federal construction of irrigation works and set up a reclamation revolving fund to which certain revenues from western lands accrued.

Throughout the early 1800s waterways were the primary means of transporting goods. This limited the movement of crops and other goods to the eastern states, and concentrated the spread of western development in selected river valleys. To encourage settlement and develop transportation routes, Congress made a series of railroad land grants in the 1860s and 1870s. Railroad grants in the Pacific Northwest totaled approximately 14 million acres (5.67 million ha), 9.5 million (3.85 million ha) of which were in Washington State (approximately 22 percent of the total Washington land area). Transcontinental railroad construction brought a new surge of settlement to the region in the late 1800s.

The railroads sold much of their land grant acreage to individuals, who converted these lands to farms and communities. Much of the grant land also remained in railroad ownership, however, or was transferred to successor timber resource companies. Because the railroads received alternating 640-acre (259.1-ha) sections, this resulted in large areas of intermingled private and Federal land ownership in a "checkerboard" pattern.

The Federal government also granted large acreages to each state in the region at the time of statehood. Approximately 14 million acres (5.67 million ha) in the region were transferred to the States of Idaho, Montana, Washington, and Oregon in this manner. The states adopted varying policies toward land disposal or retention. In Oregon, most of the state land grant acreage was sold to individuals. Washington and Idaho retained over 70 percent of their land grant acreage, and made most of this land available

for agricultural and grazing leases or timber production (Jackson and Kimerling, 1993).

Near the end of the 19th century, Federal land policies began to focus on retaining and managing lands for specific purposes rather than emphasizing disposal and settlement. Withdrawals were made to delineate Indian lands, timber resources, power sites, scenic areas, grazing lands, and lands to be managed for other public uses.

The first regional example of this shift in public land policy was establishment of the Bull Run Forest Reserve, now the Mt. Hood National Forest, in 1892. In 1893, additional forest lands were reserved in Washington and Oregon. Forest reserve withdrawals followed in Idaho and Montana in 1897. These reserves initially became national forests to be administered by the U.S. Forest Service (FS). Some areas were subsequently designated as national parks to be managed by the National Park Service (NPS). The Federal government also began purchasing cutover timber lands for national forests under the Weeks Act of 1911 and added these lands to the national forests.

The trend toward land retention and management extended into agricultural lands with the Bankhead–Jones Act of 1937. This act authorized Federal purchase of privately owned farm lands that were submarginal and incapable of providing a livelihood for the owner. Owners and their families were relocated to more suitable agricultural lands, and the acquired lands were added to various Federal withdrawals for proper management.

By 1934, the Federal government had withdrawn from entry about 73 million acres (29.6 million ha) in the Pacific Northwest (42 percent of the total land area). These lands consisted largely of Indian reservations, mineral deposit land, parks, water power and reservoir sites, forest reserves, and grazing lands. An additional 27.6 million acres (11.2 million ha) (15.9 percent) were vacant public domain. The states and counties owned 12.3 million acres (9.98 million ha). The remaining lands (35 percent) were in private ownership.

2.2 LAND OWNERSHIP AND MANAGEMENT

The historical land disposal and management policies resulted in the land ownership distribution found in the basin today. This section provides an overview of the existing land ownership patterns and a summary of land management characteristics for the major ownership classes.

As discussed in the introduction to Chapter 2, the primary source for this review is a regional inventory published by the PNRBC in 1970. The acreage data from this inventory apply to an area termed the Columbia–North Pacific Region, which includes all of the Columbia River Basin within the United States plus western Washington and Oregon and is essentially interchangeable with the Pacific Northwest region. Specific absolute acreage data cited from the PNRBC report exceed the actual figures for the basin, but the percentage distributions of land ownership between the region and the basin are very similar.

2.2.1 Regional Land Ownership Patterns

The Federal government is the largest single landowner in the Pacific Northwest. Through various land managing agencies, the Federal government owns and manages approximately 55 percent of the total regional land area (see Table 2–1). Private individuals and corporations own almost 40 percent of the total. The remaining 5 percent is held by state and local governments.

Among the states that are entirely or partially within the basin and the region, the proportion of Federal land ownership is highest in Wyoming at 93 percent (PNRBC, 1970). Washington has the smallest share of Federal lands, approximately 35 percent. Corresponding figures for Idaho, northwestern Montana, and Oregon are 67, 64, and 53 percent, respectively. Federal lands are concentrated in the various mountain ranges within the region (primarily the Northern Rockies, the Cascades, the Blue Mountains, and the coastal ranges) and in the sparsely populated high–desert areas of southern Idaho and southeastern Oregon.

Table 2–1. Summary of Land Ownership in the Pacific Northwest.[1/]

Ownership Class[2/]	Million Acres[3/]	Percent
Federal		
Forest Service	54.4	31.2
Bureau of Land Management	29.5	17.0
National Park Service	3.4	2.0
Fish and Wildlife Service	0.6	0.3
Bureau of Reclamation	1.1	0.6
Department of Defense	0.7	0.4
Department of Energy	0.9	0.5
Other Federal	5.0	2.9
Total Federal	95.6	55.0
State	8.4	4.8
County and Municipal	1.0	0.6
Private	68.7	39.6
Total	173.7	100.0

Source: PNRBC, 1970.

1/ Data are for the Columbia–North Pacific Region, as defined by the PNRBC, which includes all of the Columbia River Basin in the United States plus western Washington and Oregon outside the basin.

2/ Indian lands are included in both the Federal and private categories and cannot be reliably extracted from the source data.

3/ 1 million acres equal 0.4 million ha.

Private lands account for 56 percent of the total area of Washington and less than half of the total acreage in the other states of the region. The lower–elevation areas of the region, including the large valleys west of the Cascades and the interior plateau of northeastern Oregon, northwestern Idaho, and central and southeastern Washington, are predominantly in private ownership. There also are sizable blocks of private lands in southern Idaho near Boise and along the upper Snake River.

The State of Washington has retained approximately 3.3 million acres (1.34 million ha) of state–owned land, accounting for about 8 percent of the state by area. Corresponding figures for other states include about 2.8 million acres (1.13 million ha) in Idaho, 1.7 million acres (0.69 million ha) in Oregon, and 0.6 million acres (0.24 million ha) in northwestern Montana (PNRBC, 1970). The proportion of state–owned land in these states is 5 percent or less. State–owned lands are managed by a variety of

state agencies, most commonly natural resource agencies responsible for forestry, parks, fish, and wildlife.

Some of the Federal and private lands in the region are owned by or held in trust for Native Americans. Lands not ceded by Indian tribes to the United States through various treaties were retained as Indian reservations. Some of the lands within reservation boundaries were later allotted to individual Indians as private property that could be (and often was) resold. Other reservation lands were transferred to tribal ownership or were held in trust for tribes by the Federal government. The Federal acreage total in the region includes approximately 4.8 million acres (1.9 million ha) of such lands that are nominally under the jurisdiction of the Bureau of Indian Affairs (BIA) (PNRBC, 1970).

2.2.2 Land Management

Federal, state, private and tribal lands within the region are subject to a variety of management regimes. General land management characteristics for the major ownership categories are summarized below. More specific information on such lands in the river corridor is provided in Section 2.3.2.

2.2.2.1 Federal Lands

Approximately 20 or more individual Federal agencies distributed among nine departments and several sub–cabinet level organizations manage lands within the region. By acreage, the primary agencies are the FS, NPS, Bureau of Land Management (BLM), Fish and Wildlife Service (USFWS), Bureau of Reclamation (Reclamation), U.S. Army Corps of Engineers (Corps), other Defense Department agencies, and the Department of Energy (DOE). Management emphasis and geographic distribution for these Federal lands are summarized below (PNRBC, 1970).

Forest Service

The FS, an agency within the U.S. Department of Agriculture, administers over 54 million acres (21.9 million ha) of Federal lands within the Pacific Northwest. These lands are distributed among 44 national forests, of which 35 are within the Columbia River Basin. They are primarily located in the mountains of Washington, Idaho, Oregon, and Montana. The upstream tributary areas in northwestern Montana and northern Idaho are predominantly in national forest ownership.

The FS manages most national forest acreage to provide outdoor recreation, forage, wood, water, wilderness, and wildlife and fish habitat in a manner that meets the multiple use nature of the national forest system. Some areas with special values have been legislatively or administrately established for single–use or dominant–use management, such as wilderness areas and research natural areas. A number of Federal wild and scenic rivers that are within or near national forests are managed by the FS, including a portion of the middle Snake River in Hells Canyon. The FS also administers Federal lands within the Columbia River Gorge National Scenic Area, on the lower Columbia River.

Bureau of Land Management

The BLM, an Interior Department agency, manages over 29 million acres (11.7 million ha) in the Pacific Northwest. Most of these lands are within the Columbia River Basin, and most are rangelands within the drier interior portions of the basin. BLM lands are concentrated in southern Idaho and southeastern Oregon. Use of these lands is guided by resource management plans designed to achieve balance between the protection of resources and the production and development of renewable and non–renewable resources. Multiple use and sustained yield of resources are prominent management goals. Grazing is the predominant use.

National Park Service

The NPS manages 20 units of the national park system within the region, accounting for over 3 million total acres (1.2 million ha) (NPS, 1991; PNRBC, 1970). Fourteen of these units are located in the basin, and four are located adjacent to the river system within the SOR geographic scope. In terms of area and potential sensitivity to system operations, the most significant of these is the Coulee Dam National Recreation Area, located on

Lake Roosevelt behind Grand Coulee Dam. The area is administered under cooperative agreement with the BIA, the Colville Confederated Tribes, the Spokane Tribe of Indians, and Reclamation. The NPS manages approximately 100,000 acres (40,486 ha) that comprise 55 percent of the total reservoir area and adjacent lands.

The other three national park system units along the river system are smaller historical sites. The Nez Perce National Historical Park includes 24 individual sites distributed in a large area of northern Idaho, southeastern Washington, and northeastern Oregon; several of the sites are near or on the Clearwater River. Fort Clatsop and Fort Vancouver (discussed previously) are historical sites located west of Astoria, Oregon and in Vancouver, Washington, respectively.

The NPS is also one of several Federal agencies that may be assigned responsibility for national wild and scenic rivers. Under this authority the agency is addressing potential wild and scenic designation of the Hanford Reach of the mid–Columbia River.

The NPS is authorized by Congress (Act of August 7, 1946) to administer Federal project areas for recreation use pursuant to cooperative agreements (Appendix J, Recreation). NPS management emphasizes protection of resources and provision of recreation opportunities.

Fish and Wildlife Service

The USFWS manages approximately 0.6 million acres (0.24 million ha) of land and water areas within the region as national wildlife refuges and fish hatcheries. These lands include properties donated or leased for fish and wildlife conservation purposes, as well as areas acquired to meet various statutory and management goals and objectives. There are 51 national wildlife refuge system units in the region, of which two–thirds are within the Columbia River Basin. A number of national wildlife refuges in the basin exemplify responsibilities for endangered species protection, wetland preservation, conservation of wildlife and ecosystems, waterfowl management, and mitigation for impacts of water development projects such as hydroelectric dams. When consistent with these purposes, the public is also afforded many opportunities for environmental education, viewing, hiking, boating, hunting, fishing, and other activities.

Bureau of Reclamation

Reclamation administers approximately 1.1 million acres (0.45 million ha) of land within the basin. These are primarily lands associated with facilities of the Federal water resource projects developed and operated by Reclamation. More than half of the total acreage is located in Idaho.

Corps of Engineers

The Corps has constructed and operates 12 of the 14 Federal dam and reservoir projects included in the SOR. Projects are operated for a variety of purposes including recreation, power production, flood control, water supply, navigation, irrigation, and recreation. Development of these projects included Federal acquisition, if necessary, of lands within the designated project boundaries. These generally encompass inundated areas, shoreline zones, and adjacent uplands of variable extent. Project lands are managed for a variety of purposes, although wildlife habitat and recreation are primary uses in terms of area. In many cases the Corps directly manages recreation resources and provides recreation facilities at these projects. Alternatively, many other agencies, including the FS; USFWS; the States of Oregon, Washington, and Idaho; and a variety of other local entities such as counties, cities, and port districts manage recreation sites on project lands under agreement with the Corps.

Other Defense Department Agencies

Federal military reservations managed by Defense Department agencies other than the Corps (primarily the Army, Navy and Air Force) account for over 0.5 million acres (0.2 million ha) within the region. Key installations in the basin include the Army's Yakima Training Center, near the southern end of the middle Columbia River reach, and the Navy's bombing range near Boardman, Oregon. Both of these reservations are used for live–fire training exercises.

Department of Energy

The DOE operates two major installations in the basin. These are the Idaho National Engineering Laboratory near Idaho Falls and the Hanford Nuclear Reservation near Richland, Washington. Both are (or were) key facilities in the Federal defense nuclear fuel cycle. The total area among these and other DOE lands in the region is over 0.9 million acres (0.36 million ha).

2.2.2.2 State Lands

Lands under state ownership are generally managed for timber production, grazing, mineral extraction, wildlife habitat, and recreation. State lands are scattered throughout the region in various patterns. Federal land grants to the states generally included Sections 16 and 36 of each township in surveyed areas. (In the public land survey system, a 6–mile [9.7–km] square township consists of 36 1–mile [1.6–km] square sections.) Where these lands have been retained, land ownership maps show a stippled pattern of evenly scattered state parcels. In other areas states have retained or acquired contiguous blocks of several thousand acres, although these are generally much smaller in area than Federal public land units. State ownerships in selected locations have the checkerboard pattern associated with Federal grants of alternating sections within a wide band.

State–owned lands along or near the Columbia River system reflect all of these distribution characteristics. There are relatively few large blocks of state lands near the river system. These occur along the upper reach of the Columbia River and tributaries in northern Washington; near Rock Island and Wanapum Dams along the middle Columbia River in Washington; surrounding Dworshak Reservoir; near the lower Columbia River in Oregon and Washington; and in some of the upper tributary valleys in Montana.

Montana

State lands in Montana are managed primarily by the Department of State Lands. Statewide, most of these are classified as agricultural and grazing lands, although much of the state land in northwestern Montana is classified as forest (Montana Department of Fish, Wildlife, and Parks, 1983). The Montana Department of Fish, Wildlife, and Parks manages a smaller acreage as fish and wildlife habitat, fishing and hunting access sites, and state parks and recreation areas. State lands at the SOR projects in Montana are limited to scattered parcels, primarily near Libby.

Idaho

The Idaho Department of Lands manages state lands for timber, rangeland, minerals, and recreation. The majority of these lands are held as endowments, under which they are managed to provide funds for the benefit of the public school system or other purposes. Other land management agencies within Idaho include the Idaho Department of Parks and Recreation and the Idaho Department of Fish and Game. With respect to the SOR projects, the most significant state–owned lands in Idaho are several forest tracts on or near Dworshak Reservoir.

Washington

Washington State lands are primarily managed for multiple uses by the Department of Natural Resources. The State Parks and Recreation Commission and the Department of Wildlife are responsible for smaller acreages that are managed for special purposes. All three agencies manage significant acreages near the river system.

The Washington Department of Natural Resources manages state–owned aquatic lands, including beds and shores of navigable freshwater bodies (Washington State Department of Natural Resources, 1992), plus extensive areas of forest and rangelands. These lands are managed for the benefit of all current and future citizens of the State of Washington. State–owned forest lands are generally managed to produce income from timber harvest; most are located in western Washington. State–owned range lands are primarily in eastern Washington, and most are leased for grazing.

Oregon

Most state lands in Oregon are managed by one of three agencies. The Department of Forestry manages the largest acreage as state forest lands. These lands are concentrated in western Oregon, primarily in selected areas of the coastal mountains, The Division of State Parks and Recreation administers the state parks system, which includes numerous units along the south side of the lower Columbia River. The Oregon Department of Fish and Wildlife manages hatcheries and fish and wildlife habitat areas, including one large area on Lake Umatilla.

2.2.2.3 Private Lands

Management of private lands is generally at the discretion of the individual landowners, subject to land use regulations adopted by state and local governments. The following material is a brief summary of the key planning and regulatory programs that pertain to private lands in the basin.

Montana

Montana does not have a statewide land use planning program that regulates the planning activities of individual local jurisdictions, although there is a statewide law addressing subdivisions above a minimum size. Some counties and municipalities do have comprehensive plans and zoning ordinances.

Idaho

Local planning in Idaho occurs under state law, which acts as enabling legislation for individual counties and incorporated cities to create and follow comprehensive plans. Not all cities and counties are required to have a comprehensive plan. Among key local jurisdictions relative to the SOR, the City of Lewiston and the County of Nez Perce have comprehensive plans.

Washington

In 1990, Washington State adopted a new land use planning law known as the Growth Management Act. The Act requires counties and cities that have populations that exceed 50,000 people and have had their populations increase by more than 10 percent in the past 10 years, or cities and counties of any size that have had their populations increase by more than 20 percent, to develop comprehensive plans. Each comprehensive plan must address certain elements such as the amount and location of future growth and development, and the treatment of agricultural lands, forest lands, and other critical areas.

Oregon

The Oregon Land Use Act calls for all cities and counties to adopt comprehensive plans that meet mandatory state standards. Under the Act, the Oregon Land Conservation and Development Commission has implemented a statewide planning program that seeks to promote development while conserving farmland, forests, and natural resources. The program standards are 19 statewide planning goals that deal with land use, development, housing and conservation of natural resources. The program also requires the coordination of land use plans and programs adopted by local governments and state and Federal agencies.

2.2.2.4 Indian Lands

There are 14 Federally recognized Indian reservations within the SOR study area. Five of the reservations are in Idaho, four in Washington, three in Oregon, and two in Montana. Lands within the boundaries of these reservations are generally in one of three status categories: (1) lands in tribal ownership and held in trust, either by the tribal government or by the Federal government and administered by the BIA; (2) lands allotted to individual Indians and now held as private Indian lands; and (3) non–Indian private lands, generally lands allotted to individual Indians and later transferred to non–Indians or reservation lands that were opened to homesteading. The total land area of the 14 reservations is approximately 6.5 million acres (2.6 million ha) (U.S. Department of Commerce, 1974). Tribal acreage amounted to about 4.5 million acres (1.8 million ha) in 1991 (Appendix O, Economic and Social Impacts).

Indian trust and tribal lands are managed for a variety of purposes by the BIA or the tribes. Forestry is a primary land use on a number of reservations that have significant timber resources. In other areas lands have been developed for agriculture or are used for grazing.

In addition to their tribal lands, many Indian tribes retain various rights to use former tribal lands that were ceded to the United States by treaty. These rights typically include access to usual and accustomed hunting, fishing and gathering areas.

2.3 GENERAL LAND USE PATTERNS

The land ownership and management conditions are reflected in the existing land use characteristics found in the Columbia River Basin, which are summarized in the following discussion. Section 2.3.1 describes broad land use patterns for the basin as a whole. This is followed in Section 2.3.2 by a more specific review of land use and development conditions within the Columbia River system corridor, organized by river reach. The intent of this discussion is not to provide a detailed, parcel–specific inventory of land uses for each project or river segment, but to indicate the general types and extent of uses along the river system. The corridor–specific material also identifies key public land units in each river reach.

2.3.1 Columbia River Basin

General land use types throughout the Columbia River Basin and along the river system include forest, range, cropland, urban development, and other. The forest category includes all forested lands for which the primary use is commercial timber, firewood, wildlife habitat, and other aesthetic/open space values. Rangeland includes natural meadow areas and the dry shrub–steppe land cover types that are common to much of the basin. Cropland includes pasture, irrigated and dry cropland, orchards, and nurseries. Land that has been developed for residential, commercial, industrial, or transportation purposes is considered urban. The "other" category consists primarily of barren land, such as sand dunes or unvegetated mountain areas.

The distribution of land use by these land cover types throughout the region is summarized in Table 2–2. These figures were taken from the 1970 PNRBC inventory and are admittedly somewhat dated. They also pertain to a region that extends somewhat beyond the Columbia River Basin. Nevertheless, they represent the most recent comprehensive inventory that includes the basin. The land cover acreage distribution has probably not changed significantly (on a regional basis; localized changes would be more pronounced in some cases) over the intervening period, and broad trends of change can be readily identified. Similarly, it is possible to qualitatively indicate differences between the basin and the larger region.

Forest is the predominant land cover in the Pacific Northwest, occupying about 86 million acres (34 million ha) or 49 percent of the land area in the region (Table 2–2). The acreage of forest land in the Columbia River Basin is noticeably less than the regional total, and the proportion of forest land in the Basin would probably be slightly smaller when the extensive forests of western Washington and Oregon were factored out. Well over half of the regional forest land total is commercial forest. The remaining forest acres are in areas such as parks and wildernesses that are reserved from timber harvest and/or are unproductive lands. Commercial forest lands are located primarily in the Coast Range and Cascades in Oregon and Washington and in the Northern Rocky Mountains in Idaho and Montana.

Rangeland accounts for about 59 million acres (23.9 million ha), or 34 percent of the regional land area. The rangeland proportion for the Columbia River Basin would be somewhat higher, as it contains most of the drier interior zones within the region. The highest concentrations of rangeland are in Oregon and Idaho, where range covers most of the Snake River Plain and the southeastern quadrant of Oregon. Over 60 percent of all rangelands in the region are in Federal ownership, with two–thirds of that acreage administered by the BLM.

Table 2–2. Land Cover and Use, By State, in the Pacific Northwest.[1/]

	Land Cover Acreage[2/] (millions) and Percent by Type[3/]										
	Forest		Range		Cropland		Urban		Other		Total
State	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres
Idaho	20.9	41	22.0	43	6.0	12	0.3	1	1.6	3	50.8
Montana	12.7	80	1.4	9	0.8	5	0.2	1	0.8	5	15.9
Nevada	0.1	3	3.0	91	0.2	6	–	–	–	–	3.3
Oregon	27.5	48	22.5	39	5.3	9	1.0	2	1.3	2	57.6
Utah	–	–	0.2	100	–	–	–	–	–	–	0.2
Washington	23.0	54	8.5	20	8.3	19	1.3	3	1.6	4	42.7
Wyoming	1.7	53	1.1	34	0.2	6	–	–	–	–	3.2
TOTAL	85.8		58.7		20.8		2.8		5.3		173.7
Percent of Total	49.4		33.8		12.0		1.6		3.1		100.0

1/ Data are for the Columbia–North Pacific Region, as defined by the PNRBC, which includes all of the Columbia River Basin in the United States plus western Washington and Oregon outside the basin.

2/ 1 million acres equal 0.4 million hectares.

3/ Totals may not add due to rounding.

Source: PNRBC, 1970.

Approximately 12 percent of the region's lands are cropland, at about 20 million acres (8.1 million ha) (PNRBC, 1970). Of these about two–thirds are in dryland agriculture, and one–third is irrigated. By state, Washington has the highest total and proportion of cropland acreage, with about 8 million acres (3.2 million ha) accounting for 19 percent of the total state area. Most of these lands are in the eastern half of the state, and are concentrated in the Palouse, Columbia Basin, Kittitas Valley, Yakima Valley, Walla Walla Valley, and Horse Heaven Hills areas. Other areas of extensive croplands include the Willamette Valley of western Oregon; the interior plateau area of northcentral Oregon; and sectors of the Snake River Plain in Idaho located west of Boise and extending east (upstream) from about Twin Falls into the Teton Valley near the Wyoming border. Detailed information on irrigated lands is provided in Appendix F, Irrigation/Municipal and Industrial Water Supply.

Urban and developed uses occupy about 3 million acres (1.2 million hectares) and account for approximately 2 percent of the total regional area. While urbanized uses represent a small area in relative terms, that proportion is increasing rather rapidly as a result of conversion of rural land to urban uses. Between 1982 and 1987 (the dates of the last two published Federal censuses of agriculture), the acreage of developed lands in Washington, Oregon, and Idaho increased by more than 5 percent (Jackson and Kimerling, 1993).

Much of the urbanized land in the basin is concentrated in the Portland–Vancouver, Spokane, Boise, and Eugene–Springfield urban areas. These areas also have been accounting for much of the rural–to–urban land conversion. The remaining urban land in the basin is distributed among a number of smaller cities and hundreds of other communities. The most extensive areas of urban use along the river system reaches within the SOR scope are Lewiston–Clarkston on the lower Snake River and the Tri–Cities (Richland, Kennewick, and Pasco) near the confluence of the Columbia and Snake Rivers.

2.3.2 River Corridor

Any directly attributable effects of river system operations on existing or future land use and development would be felt within the immediate river corridor, and primarily on lands adjacent to the river or reservoirs. The following section describes overall land use patterns, the general level of development, and key public land units within the potentially affected sections of the river corridor. This material largely summarizes comparable information included in other SOR documents, including Appendices E (Flood Control), F (Irrigation/Municipal and Industrial Water Supply), J (Recreation), and O (Economic and Social Impacts).

2.3.2.1 Kootenai River

The Kootenai (Kootenay in Canada) River drainage, one of the key northern tributary areas of the Columbia River Basin, is largely undeveloped. The Kootenai River flows through the southeastern corner of British Columbia, northwestern Montana, and the northern tip of Idaho before reentering Canada near Creston. The river corridor upstream in Canada occupies a largely forested valley between the Purcell Mountains to the west and the Hughes and MacDonald Ranges of the Rocky Mountains to the east. The river is generally paralleled by a provincial highway, and passes several small communities. There are some agricultural lands in the valley, particularly around Cranbrook and to the south.

Lake Koocanusa, the reservoir formed by Libby Dam, extends north from the dam for 90 miles (144.8 km). The northern 42 miles (67.6 km) of the reservoir are in British Columbia. Much of the land adjacent to this portion of the reservoir is Crown land managed for timber production. Private lands are concentrated near the towns of Newgate and Wardner, B.C., and support residential and commercial development. B.C. Highway 3/93 crosses the northern end of the reservoir, but most of the lakeshore is not bounded by major roads.

The lower 48 miles (77.3 km) of Lake Koocanusa are within the United States and are almost entirely contained within the Kootenai National Forest.

These lands are generally managed for timber production, wildlife habitat, and recreation. Private lands in the Tobacco Plains area around Rexford and Eureka abut the upper east side of the reservoir for approximately 9 miles (14.5 km) (Forest Service, 1985). Most of this area is cropland. Another area of private lands around Olsen Hill is located across the reservoir to the west. There also are scattered tracts of private and state–owned lands near the lower 10 miles (16.1 km) of the lake, again on the east side, and some checkerboard ownership with private industrial forest lands. Montana Highway 37 parallels the east side of the reservoir for over 30 miles (48.3 km), and a FS road provides access along the western shoreline.

The Kootenai River downstream from Libby Dam flows through a mixture of Federal and private lands. Kootenai National Forest lands surround the river for most of the distance from the dam to the Idaho state line, but are interspersed with pockets of private lands just downstream of Libby Dam and around the communities of Libby and Troy. The area below the dam is largely cropland, while the two towns have a variety of urban uses. In Idaho the river flows through a relatively broad valley that is almost entirely in private ownership. Most of this area is developed as cropland, or as mixed urban uses in and near the communities of Moyie Springs and Bonners Ferry. The Kootenai National Wildlife Refuge downstream from Bonners Ferry is the primary public land feature in the Idaho portion of the river corridor. U.S. Highway 2 parallels the Kootenai River from the town of Libby to Bonners Ferry, from where U.S. 95 and Idaho Highway 1 extend to the north near the river.

The lower section of the Kootenay River is largely confined within Kootenay Lake behind Corra Linn Dam. The river passes near several towns in this reach, including Creston shortly after reentering Canada, Nelson at the outlet of Kootenay Lake, and Castlegar at the confluence with the Columbia River. A number of smaller communities are located along Kootenay Lake. Provincial highways parallel the free–flowing river sections and much of the shoreline of Kootenay Lake.

2.3.2.2 Upper Columbia River in Canada

The upper Columbia River corridor from the outlet of Arrow Lakes (Hugh Keenleyside Dam) to Lake Roosevelt near the U.S. border extends for a distance of about 50 miles (80.4 km) and is similar in development character to the lower Kootenay River. The adjacent land is primarily forested, with some areas of cropland. Mixed urban land uses occur in several communities located on or near the river, including Castlegar, Trail, Rossland, and Montrose. Provincial highways traverse the valley floor throughout the reach.

2.3.2.3 Flathead River

The upper reaches of the Flathead River in Montana are surrounded by Glacier National Park and adjacent national forests. Hungry Horse Reservoir is located on the South Fork of the Flathead River, within the Flathead National Forest. Lands immediately adjacent to the reservoir are managed for multiple uses, including timber production, wildlife habitat and recreation. The Great Bear Wilderness includes the higher–elevation areas to the east of Hungry Horse and extends to within 1.5 miles (2.4 km) of the reservoir in places (Forest Service, 1982). The Coram Experimental Forest designation extends to within 1 mile (1.6 km) of the northern end of the reservoir. There are no private lands on or near the reservoir. Development is limited to recreation sites and a relatively dense network of FS roads.

Downstream of the confluence of its three forks the Flathead River enters the Flathead Valley, which is predominantly cropland. Near Columbia Falls and Kalispell, land use is more developed and urban in character. The river continues south beyond Kalispell through more agricultural land to Flathead Lake. The lake is surrounded by a mixture of forest, rangeland, irrigated and dry cropland, orchards, and pasture/meadow areas. There also is significant residential, commercial and recreational development along the shores of Flathead Lake. Several communities border the lake, including Polson, Bigfork, and Somers. The Flathead Indian Reservation surrounds the southern portion of Flathead Lake. Virtually all other land in the Flathead Valley

is in private ownership, as is much of the acreage within the reservation boundaries.

2.3.2.4 Albeni Falls/Lake Pend Oreille

Albeni Falls Dam is located 25 miles (40 km) downstream from Lake Pend Oreille, which extends an additional 43 miles (69 km) to the east and south. The southern lobe of Lake Pend Oreille is almost entirely bordered by Kaniksu National Forest lands (now administered as part of the Idaho Panhandle National Forests). The only exceptions to this situation are Farragut State Park and a small adjacent area of private lands, located at the southern end of the lake. Almost all of the lands along the northern lobe of the lake and the Pend Oreille River downstream to Albeni Falls are in private ownership. A narrow band of largely private lands that includes a highway and rail corridor separates the northeastern shore of Lake Pend Oreille from more Kaniksu National Forest lands. Elsewhere within the lake and river corridor there are only scattered small parcels of national forest and BLM lands, plus Corps project lands at Albeni Falls Dam.

Most of the upland areas adjoining Lake Pend Oreille are forested. There are several areas of cropland in the vicinity, including near the river delta area at the east end of the lake, to the north and east of Sandpoint at the north end of the lake, and in portions of the river corridor between Sandpoint and Albeni Falls. Sandpoint is the center of a significant area of urban land uses. Other mixed urban uses occur within several small communities located along the three major highways serving the area (U.S. Highways 2 and 95 and Idaho Highway 200). There are also a number of areas of residential and commercial (largely recreational) development on private lands along the shore of Lake Pend Oreile.

2.3.2.5 Grand Coulee/Lake Roosevelt

Grand Coulee Dam forms Lake Roosevelt, most of which is managed by the NPS under cooperative agreement with Reclamation, the BIA, the Colville Confederated Tribes and the Spokane Tribe of Indians as the Coulee Dam National Recreation Area (CDNRA). The CDNRA boundary is generally within no more than 0.5 mile (0.8 km) of the lakeshore, and its upstream end is a few miles below Northport. The Colville Indian Reservation borders the CDNRA to the west and north along the lower half of Lake Roosevelt. The Spokane Indian Reservation abuts a smaller portion of the reservoir, primarily along the Spokane Arm. The Sherman Creek Wildlife Area is located on the west bank of the reservoir opposite Kettle Falls. The remainder of the corridor, including most of the east and south banks, is almost entirely in private ownership. The limited public lands in this part of the corridor include scattered tracts of BLM and state lands, and parts of the Colville National Forest extend near the reservoir.

Lands surrounding Lake Roosevelt to the north and west are generally forested. East of the lake, a mixture of cropland and grassy rangeland occupies the corridor from approximately Northport south to near the Spokane River. The hills adjoining this area to the east are forested. Range is the dominant land cover along the western end of Lake Roosevelt, from about the Spokane River to Grand Coulee Dam.

2.3.2.6 Middle Columbia River

The middle Columbia River sub-region extends from below Grand Coulee to the Tri-Cities area. It includes the reservoirs formed by Chief Joseph, Wells, Rocky Reach, Rock Island, Wanapam, and Priest Rapids Dams, plus the free-flowing Hanford Reach. River corridor lands in this reach are predominantly in private ownership, although there are a number of public land units of various types. In the northern end of this reach, the Colville Indian Reservation occupies the north bank of the river along all of Lake Rufus Woods (the reservoir behind Chief Joseph Dam) and approximately the upstream half of Lake Pateros (behind Wells Dam). Between Wells Dam and Rocky Reach Dam there are several locations where Okanogan or Wenatchee National Forest lands extend into the river corridor. There are also scattered tracts of BLM lands in the corridor, primarily near the three upstream projects.

Three relatively large Federal land units are located in the southern portion of this reach. The U.S. Army's Yakima Training Center occupies the west bank of the river for approximately 15 miles (24.1 km) from just below Wanapum Dam to about Priest Rapids Dam. The Hanford Reservation, operated by the DOE, extends along the south and west bank from about 4 miles (6.4 km) below Priest Rapids to Richland at the downstream end of the reach. The USFWS administers the Saddle Mountain National Wildlife Refuge, which adjoins the north bank of the Columbia River for about 17 miles (27.4 km) downstream of Priest Rapids.

The most common public land units along the mid–Columbia reach are 13 state wildlife areas managed by the Washington Department of Wildlife. From north to south, these wildlife areas include the following:

- Wells
- Indian Dan
- Central Ferry
- Chelan Butte
- Entiat
- Swakane
- Colockum
- Quincy
- Quilomene
- Schaake
- Crab Creek
- Priest Rapids
- Wahluke

State parks are also common along the river corridor in this reach. They include Bridgeport, Chief Joseph, Fort Okanogan, Daroga, Lincoln Rock, Confluence, and Ginkgo/Wanapum State Parks.

River corridor land use patterns vary considerably from north to south. Most of the area around Lake Rufus Woods is rangeland. From about Chief Joseph downstream to Rock Island Dam, the valley floor and river terrace areas have generally been developed as irrigated cropland, primarily for orchard crops. The adjoining valley walls and higher–elevation areas in this section are predominantly rangeland. Farther south, below Rock Island Dam, land cover in the corridor is almost entirely rangeland until reaching the large expanse of irrigated cropland that extends northward from Pasco on the east side of the river. Significant areas of urban land occur around Wenatchee and the Tri–Cities of Richland, Kennewick, and Pasco, Washington. Mixed urban land uses also are found at a number of smaller communities such as Bridgeport, Brewster, Pateros, Chelan Falls, and Desert Aire. Large sections of Lake Rufus Woods, Wanapum Lake, and the Hanford Reach are not accessed by major roads. Highways and/or railroads are generally located on one or both sides of the river elsewhere along the middle Columbia.

2.3.2.7 Middle Snake River

The middle Snake River in southeastern Washington, northeastern Oregon, and western Idaho has three distinct segments, based on land ownership and use characteristics. The upstream segment, from the headwaters of Brownlee Reservoir to about Oxbow Dam, has a mixture of BLM and private lands within the corridor. There is little development in this segment, primarily consisting of some cropland and residential areas located near Huntington, near the upper (southern) end of Brownlee Reservoir, and around Richland, on an arm of the northern part of the reservoir. Both of these areas are west of the reservoir, in Oregon. The remainder of the corridor in this segment is rangeland.

The second segment of this reach is where the Snake River flows through Hells Canyon. Virtually all of this part of the corridor is Federally owned land within the Nez Perce, Payette, and Wallowa–Whitman National Forests. The Hells Canyon National Recreation Area (HCNRA) encompasses the river corridor and extensive nearby mountain and canyon areas. Much of the HCNRA has been designated as wilderness. The Snake River has also been designated as a wild and scenic river from Hells Canyon Dam downstream past the confluence with the Salmon River. There is minimal development in this segment. Land cover is entirely range and forested range.

The final segment of the middle Snake River reach extends from Hells Canyon downstream to the head of Lower Granite Reservoir near Asotin, Washington. This part of the corridor is all in private owner-

ship, except for scattered parcels of BLM and state–owned (both Idaho and Washington) land. Rangeland cover predominates in this segment as well. There is minimal road access and development until the river nears Asotin.

2.3.2.8 Clearwater River

The North Fork of the Clearwater River drainage around Dworshak Reservoir has a varied land ownership pattern. The upper end of the reservoir is surrounded by Federal lands within the Clearwater National Forest. Scattered tracts of national forest lands also occur along the east side of the reservoir and elsewhere in the drainage. The State of Idaho holds extensive areas of forest lands, including a large block around the Elk Creek arm and several other sizable tracts along the reservoir or nearby. Much of the privately owned acreage that is intermingled with the Federal and state lands is industrial forest land. Lands immediately surrounding the reservoir are held by the Federal government as project lands As indicated by the land ownership status, forestry is the primary land use around Dworshak Reservoir.

Downstream from Dworshak the North Fork and mainstem Clearwater flow through lands that are primarily in private ownership. The Nez Perce Indian Reservation includes most of this river corridor section, from approximately 2 miles (3.2 km) upstream of Dworshak Dam to about 4 miles (6.4 km) upstream of Lewiston. A minority of the total reservation acreage is in tribal ownership, however, and most of the river corridor land has been transferred to private hands. There are only a few small parcels of Federal and state lands in the corridor, including units of the Nez Perce National Historic Park.

Land cover in the corridor is primarily forested range in the upstream end and grassy range further downstream. There are concentrated urban land uses around Ahsahka and Orofino, plus some low–density residential use and pockets of development in several small communities between Orofino and Lewiston. U.S. Highway 12 and a railroad line parallel the Clearwater River through this entire reach.

2.3.2.9 Lower Snake River

The lower Snake River corridor is almost entirely in private ownership. The only public lands in this reach are Federal project lands administered by the Corps and isolated parcels owned by the State of Washington. The key state land units are Chief Timothy, Central Ferry, and Lyons Ferry State Parks.

The lower Snake River reservoirs generally fill the width of the canyon, leaving relatively little flat land that can be cultivated. There are some relatively small and isolated cropland areas on the valley floor and river terraces, particularly toward the western end of the reach. Grassland range cover is predominant within the corridor. The Lewiston–Clarkston area has a significant concentration of urban development at the eastern end of the reach, including residential, commercial, and industrial uses. Isolated pockets of developed land are located in small communities such as Almota, Ripaira, and Windust. Unlike many other reaches of the river system, much of the lower Snake River is not served by highways parallel to the river.

2.3.2.10 Lower Columbia River

The Lower Columbia reach extends generally from the head of McNary pool (Lake Wallula), near the Columbia–Snake River confluence downstream to the Pacific Ocean. Through most of this reach the Columbia forms the border between Oregon and Washington. This area has complex land ownership and use characteristics. It is the most heavily developed reach within the river corridor. Land ownership is primarily private, but there is a wide variety of public lands. There are a number of large corporate ownerships of irrigated land, primarily along the Columbia River in Gilliam, Morrow, and Umatilla Counties in Oregon, and Klickitat, Benton, and Walla Walla Counties in Washington (PNRBC, 1970). In other areas, the private lands are typically subdivided into small parcels, particularly in the more urbanized portions of the corridor.

Federal lands in this reach include Corps–administered project lands located along the four reservoirs

formed by McNary, John Day, The Dalles, and Bonneville Dams. The Mount Hood and Gifford Pinchot National Forests extend to or near the Columbia River on the Oregon and Washington sides, respectively. There are a number of parcels of BLM lands, primarily on the south side of the river from the Oregon/Washington state line down to about John Day Dam. BLM lands include the Horn Butte Curlew Area, Gov. Tom McCall Preserve at Rowena (managed by the Nature Conservancy), and several botanical and scenic areas within the Columbia River Gorge. Two military installations are located within the corridor but a few miles away from the river. These are the Umatilla Ordnance Depot, operated by the U.S. Army, and the Navy's Boardman Bombing Range. The NPS administers two small sites in the lower Columbia River reach, the Fort Vancouver National Historic Site and the Fort Clatsop National Memorial.

The lower Columbia reach also has a significant number and acreage of national wildlife refuges. The USFWS administers a total of eight national wildlife refuges in this part of the corridor. Relative to the SOR scope, the two key units are the McNary National Wildlife Refuge (NWR) on Lake Wallula and the Umatilla NWR on Lake Umatilla. Cold Springs NWR is located somewhat back from the river near Hermiston, Oregon. The remaining five refuges are the Pierce, Steigerwald and Ridgefield NWRs, in the middle part of the reach below Bonneville Dam, and the Columbia White-Tailed Deer and Lewis and Clark NWRs, located primarily on islands in the Columbia River estuary.

A key land management feature of this subregion is the Columbia River Gorge National Scenic Area. Designated by Congress in 1986, the Scenic Area extends along both sides of the Gorge for more than 75 miles (120.7 km), from the Deschutes River upstream of The Dalles to the Sandy River east of the Portland area. It includes a mixture of Federal, state, and private lands. Overall management responsibility is divided between the FS and the bi-state Columbia River Gorge Commission.

The lower Columbia River is bordered by a number of state wildlife areas and parks, particularly in Oregon. The Oregon Department of Fish and Wildlife manages four wildlife areas in this reach, including Irrigon and Willow Creek on Lake Umatilla. Oregon has a total of 25 state park units arrayed along the river, from Hat Rock on Lake Wallula to Fort Stevens where the river meets the ocean. Twenty-two of these parks are in the Columbia Gorge, including key units such as Mayer, Memaloose, Rooster Rock, and Crown Point. Several large tracts of state-owned land upstream from Astoria have been designated as the Clatsop State Forest.

The Washington side of the corridor in this reach has fewer state wildlife areas and parks, but more state forest acreage. There are nine Washington state parks, from Sacajawea on Lake Wallula near Pasco to Fort Canby at the ocean. The Washington Department of Wildlife manages two wildlife areas, McNary and Shillapoo-Vancouver. Extensive areas of state forest lands are managed by the Washington Department of Natural Resources. The largest concentrations of these lands are in the Columbia Gorge area, generally between the river and the Gifford Pinchot National Forest, and downstream in the Willapa Hills area of Wahkiakum County.

The lower Columbia River corridor has the most diverse land use of any of the river system sub-regions. The eastern portion of the corridor along the McNary and John Day pools is primarily surrounded by rangeland. There are concentrations of cropland where irrigation systems have been developed. Outside of the Tri-Cities urban area there is little development with only a few small towns occurring along the river.

Development is more common and land cover in undeveloped areas is considerably different in the Columbia Gorge part of the reach, which includes The Dalles and Bonneville pools. The cities of The Dalles and Hood River are sizable developed areas surrounded by extensive orchards producing crops of apples, cherries, pears, peaches, apricots, and other fruits. A number of smaller communities also line the river, including Cascade Locks in Oregon and

Bingen, White Salmon, Carson, and Stevenson in Washington. Elsewhere, the slopes of the Columbia River Gorge are primarily forested.

The river generally flows through mixed forest and cropland from Bonneville Dam to the Portland–Vancouver area. These two cities and their suburbs occupy a large urban expanse along more than 25 miles (40.2 km) of the river. From Portland downstream, the river corridor again comprises a mixture of primarily cropland in valley bottom areas and forests on adjacent uplands. There are a number of developed areas in this part of the lower Columbia. These include Woodland, Kalama, Kelso–Longview, Cathlamet, and Iwaco in Washington and Scappoose, St. Helens, Rainier, Clatskanie, and Astoria in Oregon.

The lower Columbia River corridor is heavily developed for transportation. In addition to the inland waterway and deepwater channel on the river, there are major highways and railroads along the river for virtually the entire length of the reach. In Washington, Interstate 5, U.S. Highways 12, 730 and 101, or State Routes 14, 4, 431, and 432 parallel the river in all but a few areas. The Oregon side of the river is served by U.S. 730 from the Washington line to Boardman, Interstate 84 from Boardman to Portland, and U.S. 30 from Portland to Astoria.

2.4 LAND TRANSPORTATION

The land transportation network that could be directly or indirectly affected by Columbia–Snake River operational changes is of specific interest for the SOR. As described in Section 1.3, this interest applies to the lower Snake River corridor and transportation facilities in the surrounding multicounty area. The affected environment for this issue includes railroads and several types of highways within the defined study area.

2.4.1 Highways

The highway network serving the study area includes interstate, U.S., state, and county highways, as shown in Figure 2–1. These highways are categorized in Table 2–3 as primary and secondary facilities. With respect to river system operations, the focus of this section will be on routes that are parallel to mainstem reservoirs for which drawdown is being considered, and those that could be affected by potential diversion of commodities from barge transportation to truck hauling.

Based upon preliminary review of the existing highway network serving the study area, the majority of the links in the network are currently serving low traffic volumes. Excluding Interstate 82 and 84 and some portions of U.S. Route 395 with four travel lanes, the majority of the remaining primary and secondary highways have two travel lanes. These highways generally serve rural areas with few large population concentrations.

2.4.2 Railroads

Based on origin–destination relationships for commodities shipped on the Columbia–Snake Inland Waterway, the area potentially affected by System Operating Strategy (SOS) alternatives includes primarily the grain growing areas of Washington, Oregon, Idaho, and Montana. These areas are served by the Burlington Northern Railroad (BNRR), the Union Pacific Railroad (UPRR), and several shortline operations. Among the latter, the Camas Prairie Railroad serves Idaho and Washington, and the Montana Rail Link serves Idaho and Montana. Figure 2–2 is a map of key rail lines in the study area.

In Washington, the BNRR and UPRR have an agreement to jointly manage the mainline track from Seattle to Portland. From Vancouver, Washington, the BNRR line runs along the north side of the Columbia River through the Tri–Cities to Spokane. It continues north to Sandpoint, Idaho, then runs southeast to Missoula, Montana, and on into the Midwest. The BNRR has crossings providing access to Oregon at Portland, Wishram, and Wallula. The

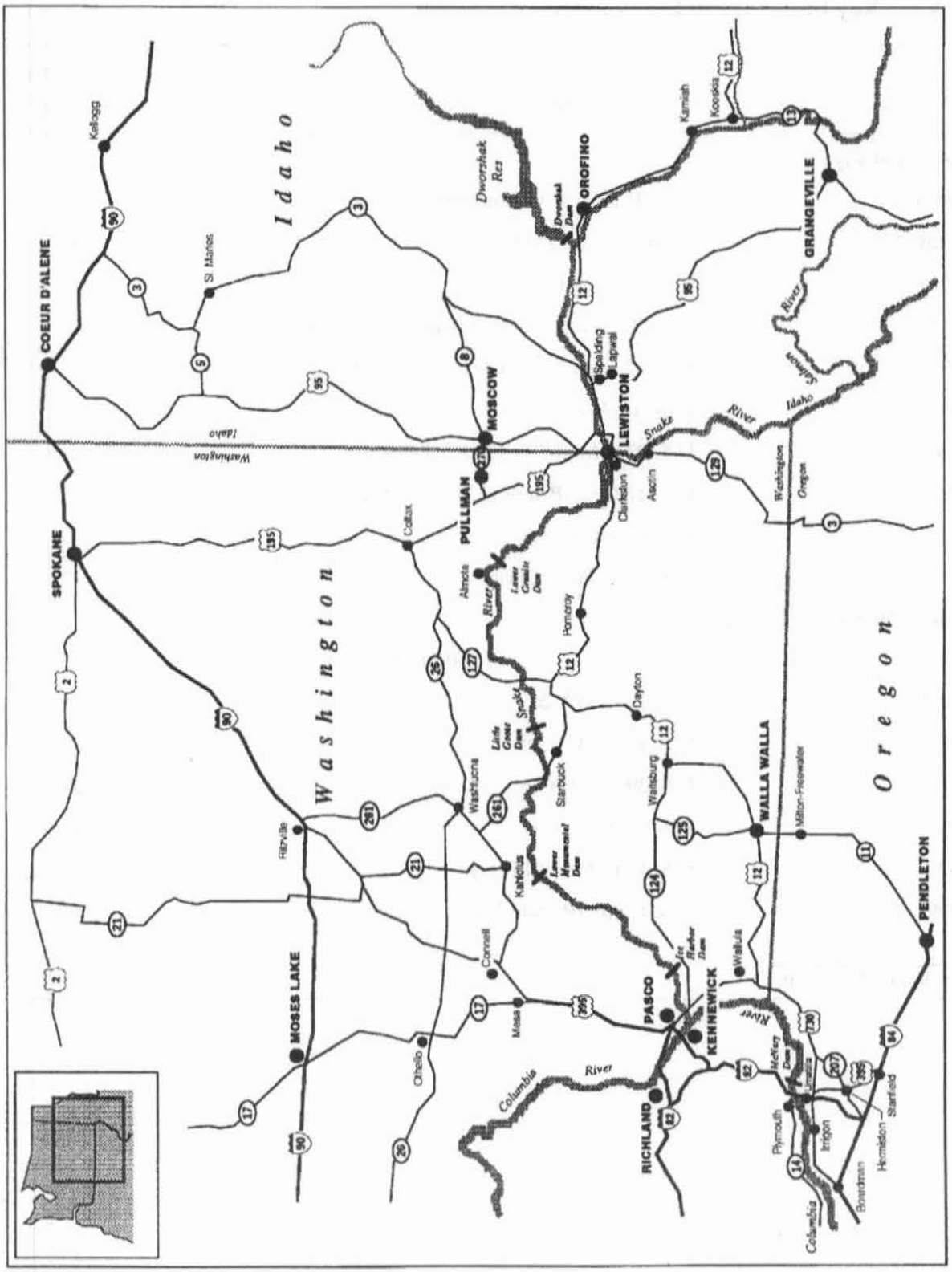

Figure 2–1. Study Area Highway Network

Table 2–3. Key Highways in Study Area

Highway	Segment/Location	Approximate Mileage[1/]
Primary Highways		
Interstate 84	U.S. 97 (Biggs) to Pendleton	105
Interstate 82	I–84 to U.S. 395 (Pasco)	30
U.S. 395/730	I–82 to U.S. 12	35
U.S. 12	U.S. 395 (Pasco, WA) through Lewis County, ID	200
U.S. 95	U.S. 12 (near Spalding) to Grangeville, ID	65
OR 11	I–84 to WA state line	36
WA 14	U.S. 97 (Maryhill) to I–82 (Plymouth)	80
WA 124	U.S. 12 (near Pasco) to U.S. 12 (Waitsburg)	45
WA 125	WA 124 to OR state line	6
WA 193	U.S. 12 to Port of Wilma	2
Secondary Highways		
U.S. 395	U.S. 12 (Pasco) to WA 260 (near Mesa)	30
U.S. 195	U.S. 12 to WA 26	45
WA 26	U.S. 195 to US 395	73
WA 260	U.S. 395 to WA 26	39
WA 261	WA 260 to U.S. 12	30
WA 127	U.S. 12 to Central Ferry	10
WA 129	U.S. 12 to OR state line	42

1/ 1 mile equals 1.6 km.

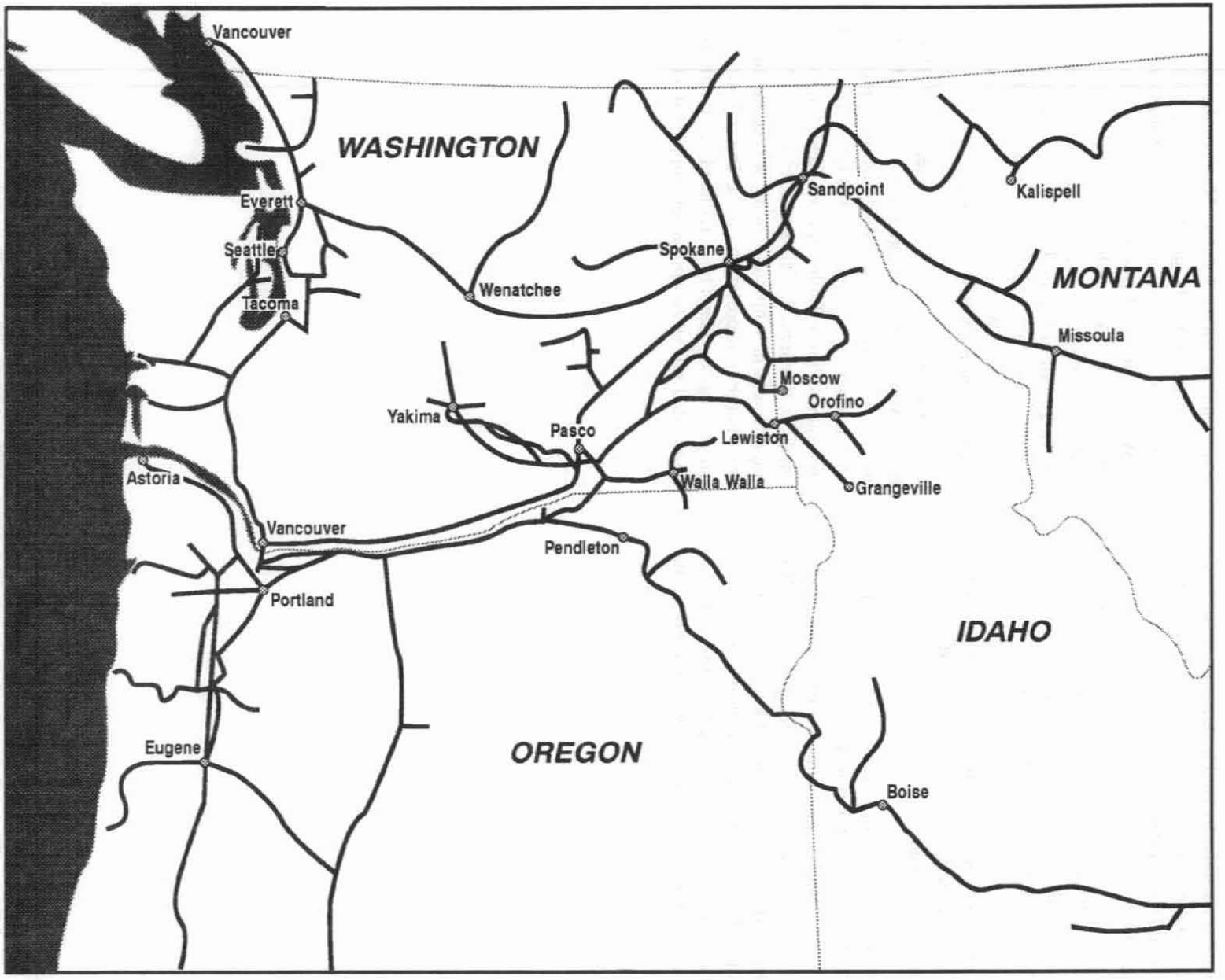

Figure 2–2. Study Area Railroads

UPRR runs along the south side of the Columbia River from Portland to Hinkle, Oregon, then runs south to Boise and on into the Midwest. Both the BNRR and the UPRR provide extensive trackage in all four states.

The Camas Prairie Railroad is a joint venture operated cooperatively by the BNRR and UPRR. Camas Prairie tracks connect Revling and Kamiah in Idaho through Lewiston to Riparia on the Lower Monumental pool in Washington. Montana Rail Link provides service from Sandpoint, Idaho, to Garrison, Montana.

Rail line abandonment has occurred extensively in the Pacific Northwest, particularly in Washington and Idaho. Since 1976, Idaho has had abandonment of 542 miles (872 km) of track, accounting for 20.6 percent of the 2,631 miles (4,234 km) in existence at that time (Henry, 1991). Washington lost 1,557 miles (2,506 km) of track during the same period. A number of other rail segments have been placed in Category 1 status with the Interstate Commerce Commission, which makes them a candidate for abandonment within 3 years. Much of the abandoned track served the grain–producing areas of these two states. Most notably, the Palouse region of Washington and Idaho has been affected by abandonment. One study indicated that 285 miles (459 km) (35 percent) of the original 825 miles (1,328 km) of rail in the Palouse area had been abandoned by 1987 (Idaho Transportation Department [ITD] and Washington State Department of Transportation [WSDOT], 1987).

Current abandonments include a section of BNRR line to Moscow, Idaho, and a section of two UPRR lines in Whitman County, Washington (approved for abandonment in October 29, 1990). A section of the Camas Prairie Railroad from Lewiston to Grangeville is threatened. The main reason for abandoning rail lines in Whitman County was competition from barge transportation on the Snake River. These abandonments have reduced or effectively eliminated rail as an option for shippers in certain areas.

CHAPTER 3

STUDY METHODS

This chapter provides a review of the methods used to develop the Land Use and Development appendix. The following discussions indicate how impact issues were identified and defined, existing conditions were inventoried, and impact analysis was conducted.

3.1 IDENTIFICATION OF SENSITIVE AREAS AND ISSUES

The land use issues associated with the Columbia River SOR are centered around two main concerns. As discussed in Section 1.2, these are potential effects on the use and development of lands along the river corridor, and potential direct and indirect effects on highways and railroads connecting cities and ports near the river system. These issues were identified and defined by the responsible SOR and contractor staff, based on evaluation of SOR scoping input and independent related information, and on consideration of review comments on the Draft EIS.

Development concerns reflected in the scoping input were polarized between those who thought that shoreline development should be encouraged for commercial and industrial uses and those who wanted to preserve the natural qualities of the river corridor. Similarly, there was concern over past river operations and the erosion along the river banks that has occurred. In reviewing these scoping comments, the land use study team recognized that some of the concerns went beyond the scope of the land use studies, or of the SOR itself. System operations effects on erosion were addressed through the SOR geology, soils, and groundwater studies (see Appendix L), and were not considered within the land use effort. Planning for or management of development within the river corridor, or preservation of corridor lands, are not a part of system operations and are not within the scope of the SOR. Nevertheless, the operations being considered could, in selected instances and locations, affect existing and future development in the river corridor. Therefore, the land use study team interpreted the scoping comments on development to include this issue. The team defined the geographic scope of this issue as the immediate river corridor, based on the possible extent of the potential direct (physical access) and indirect (visual) effects on land use and development. This is discussed in more detail in Section 3.2.

The second issue concerning land use that was raised during scoping is the transportation of commodities. A number of commentors voiced support for continued maintenance of barge transportation on the river system, and identified it as an important element of the regional economy. These concerns directly relate to the subject matter of the SOR navigation studies. However, the operations actions that would affect barge transportation would also have broader impacts on the land transportation network. The Corps' 1992 OA/EIS indicated that the mainstem reservoir drawdown measures that would interrupt navigation on the river could also cause structural damage to railroad and highway embankments and bridges that cross or parallel the reservoirs.

River system operations could limit the movement of barges transporting commodities on portions of the system at certain times. Producers who currently ship by barge could be forced to find alternate forms of transportation, most likely truck or rail. The 1992 OA/EIS also described how this mode switching could increase demands on highways and railroads located between the major towns and port areas along the river system. The land use study team, therefore, identified and defined the land transportation impact issues based on prior environmental analyses of system operations.

3.2 REVIEW OF EXISTING CONDITIONS

Developing the information on existing conditions presented in Chapter 2 required prior decisions about the geographic scope of coverage and the types of information sources to use. These procedural aspects of the land use studies are summarized below.

3.2.1 Geographic Scope

The geographic scope for the land use analysis was determined by the spatial characteristics of the two primary land use issues discussed previously. Because the two issues relate differently to the river system, each requires a specific geographic focus.

With respect to any influences that system operation may have on development along the river, the study area encompasses the river corridor along the entire Columbia River system to its mouth, within the limits of the SOR scope itself. To the extent that system operations to date have affected land use patterns, land uses within the river corridor have developed in compatibility with prevailing reservoir elevation patterns. Therefore, land use impacts could be expected only if there were significant changes in reservoir elevations. These changes would be physically evident only along the shoreline and in immediately adjacent areas, and they would only affect water-dependent uses. This impact relationship indicates that the focus of study could be limited to a narrow band along the river itself. In addition, however, the aesthetic consequences of reservoir operations could have indirect effects on land use by diminishing the desirability of some areas for selected uses. This type of effect primarily applies to areas where water views are significant factors in residential or commercial development.

Based on these considerations, the study team defined the specific geographic scope for the land use and development issue as the approximate viewshed or visual corridor for the river system. This concept defines a corridor of variable width depending upon the terrain characteristics that limit viewing distances to the river or reservoirs. The land use study team did not undertake field investigations to precisely delineate the visual corridor. Instead, the descriptions presented in Section 2.3.2 are based on map interpretation of the approximate locations of the flanking valley walls and conditions between those points.

The land transportation issue has two impact dimensions. Among the many system operating strategies under consideration, only those involving drawdown to elevations well below minimum operating pool (MOP) have the potential for direct physical impacts to highways and railroads. This circumstance limits the scope of study to the four lower Snake River projects. Further, drawdown operations could only damage rail and highway structures located along the immediate margins of the reservoirs or crossing the reservoirs. Consequently, Section 2.4 identifies road and rail structures that fall within these locational requirements.

Similarly, indirect impacts on the regional transportation network would occur only through operations that would interrupt barge service on the waterway, which again is limited to lower Snake River drawdown actions. The study team defined the geographic scope for this analysis by considering the types and destinations of shipments on the waterway and the extent of the tributary area served by the waterway. Columbia-Snake River barge traffic is heavily dominated by grain shipments, most bound for export from Columbia River deepwater ports. Most of the grain originates from producing areas within about a 50-mile (80-km) radius of the river, although some is shipped to Snake River barge terminals from as far east as Montana and North Dakota. If barge service were interrupted and these shipments were rerouted by other transportation modes, the affected routes would be located within the river tributary area and between this area and the primary export locations. Shippers would need to find alternate modes and routes to ship commodities from Lewiston to Portland or Seattle, for example. The geographic study area represented in Section 2.4 was defined so as to intersect the railroads and highways that would most likely be affected by these transportation decisions.

3.2.2 Information Sources and Data Development

The land use study team determined that existing land use conditions should be characterized based on existing, readily available data and reports, including prior specific studies of the river system and generally applicable regional inventories. The SOR is a programmatic process, and it is not necessary for the EIS to provide a site–or parcel–specific assessment of expected land use impacts. Therefore, the inventory of existing conditions can be done at a relatively small scale and general level of detail, and does not require precise mapping or field investigation.

The description of existing conditions presented in Chapter 2 is based on a relatively small number of key independent sources. These key sources included the following:

1. The Columbia–North Pacific Region Comprehensive Study of Water and Related Lands, prepared by the Pacific Northwest River Basins Commission. Appendix II and Appendix IV (PNRBC, 1969 and 1970, respectively) of the study report provided text descriptions and tabular and mapped data on land ownership and use, both on a subregional basis and aggregated for the region. The region addressed by this study is somewhat larger than the Columbia River Basin, but it includes all of the basin. The PNRBC reports are somewhat dated, but land use conditions have not changed dramatically since this comprehensive inventory was undertaken.

2. The Columbia Basin Water Withdrawal Environmental Review, prepared by the Corps (1979). Appendix A: Land Use of this study provided primarily descriptive information on historical development trends, land cover and cropping patterns, and state–level land use controls for individual subbasins and the Columbia River Basin as a whole.

3. The Idaho, Oregon, and Washington Atlas & Gazetteer volumes published by the DeLorme Mapping Company (1992a, 1991, and 1992b, respectively). These atlases include topographic maps of each state, based on the 1:100,000–scale map series published by the U.S. Geological Survey, and identify most named public land units as well as a variety of other cultural features.

4. The Atlas of the Pacific Northwest, published by Oregon State University Press (Jackson and Kimerling, 1993). This source has small–scale maps and discussions for numerous resource subjects covering Washington, Oregon, and Idaho. It was generally used to update or supplement information obtained from the first two sources identified above.

5. The 1992 OA/EIS (Corps et al., 1992) and the subsequent Interim Columbia and Snake Rivers Flow Improvement Measures for Salmon SEIS (Corps et al., 1993), both prepared by the Corps, BPA, and Reclamation. These documents identify transportation facilities and transportation–related land uses, and include information on general land use conditions, for most of the river system within the SOR scope.

In addition to these independent sources, data collected and developed by the SOR Recreation, Flood Control, Economics, Navigation and Irrigation/Municipal and Industrial Water Supply work groups overlapped somewhat with needs for the land use assessment, and provided additional information sources.

Procedurally, the land use inventory followed a simple approach involving literature review and map interpretation. The land use study team attempted to confirm or update inventory information from the older regional studies, and compared multiple sources addressing the same subject for consistency. In some cases information could be extracted directly from the sources, while in other cases minor processing or aggregation was required.

3.3 IMPACT ANALYSIS

The land use impact analysis included three separate components, based on the specific impact issues identified in Chapter 1. The analysis process for each component is summarized below.

3.3.1 Existing and Future Development

The analysis of potential impacts on existing and future development involved two basic procedural steps. These were to identify the target land uses that would most likely be affected, and to qualitatively assess the key dimensions of those impacts.

The land use study team identified target land uses based on intuitive assessment of potential impact mechanisms. As with other resource areas, river flows and reservoir elevations are the physical measures by which the SOS alternatives would manifest themselves. Target land uses are those that would be sensitive to flow or elevation patterns that are significantly different from those under which existing land use conditions have developed. Flows already vary considerably over the year at all locations within the system. Therefore, elevation patterns would actually be the key determinant of potential land use impacts.

In general, land uses that are either water–dependent or water–related could be affected by reservoir elevation patterns. Water–dependent uses are those that require direct physical access to the water, such as water transportation facilities or industrial operations that depend upon waterborne commerce. Water–related uses are those that are measurably enhanced by proximity to water, such as residential development that benefits from water views.

Storage reservoir elevations typically vary by a large magnitude from season to season. Any water–dependent uses on these reservoirs would likely have developed in recognition of large elevation fluctuations, and can function with significant seasonal limitations. The same is true for water–related residential or commercial lands uses that are sensitive to aesthetic conditions. For storage project areas, therefore, the impact analysis focused upon these types of land uses and on significant changes in typical elevation patterns.

The greatest potential for significant land use impacts applies to areas where reservoir elevations are typically very stable, specifically the run–of–river reservoirs.

Alternatives that require significant reservoir drawdown at projects where this does not normally occur could directly or indirectly influence adjacent land use and development. Based on the type and location of the SOS actions being considered, these impacts could occur on the lower Snake River reservoirs or at John Day. The primary land uses that could be affected include transportation facilities, industrial plants, and residential development. (Park and recreation uses could also be affected, but these are addressed in the SOR recreation studies.) Severe drawdowns could restrict boat access to ports or to industries that ship or receive goods by water. Cabins and homes on view property near affected reservoirs could experience degraded views of the water, changing land values and the potential for future development. In addition to these primary uses that could experience direct land use impacts, agricultural uses could be indirectly affected by drawdown. Depending upon the full nature of irrigation impacts and how increased irrigation costs were allocated, it is possible that land use patterns on irrigated lands adjacent to some of the reservoirs could be changed.

The second impact analysis step for this land use component involved qualitative assessment of the key impact dimensions. The primary activity for the assessment was to review the hydroregulation output on reservoir elevations. From these data the study team identified the size of any changes in typical elevation patterns, and when and for how long these changes would occur. They then evaluated this information in combination with the land use inventory data to determine the extent (geographic area) of the impacts. Because water transportation facilities represent the most sensitive type of land use, the impact conclusions for this appendix incorporate the expected response of barge operators and ship-

pers reported in Appendix O, Economic and Social Impacts.

3.3.2 Land Transportation

There are both direct and indirect land transportation impacts that could occur in the Columbia River Basin as a result of the system operation scenarios under consideration. These are distinct impact issues and required separate analysis processes.

3.3.2.1 Direct Land Transportation Impacts

As discussed previously, railroads and highways parallel to some reservoirs and bridges that cross the reservoir could be structurally damaged. As a result of existing operations and structure locations, these potential impacts would be limited to John Day and the lower Snake River reservoirs.

The transportation structures that would be subject to direct impacts were previously identified by the Corps in the 1992 OA/EIS (Corps et al., 1992) and in the System Configuration Study being conducted concurrent with the SOR. The SOR land use study team based its conclusions on impact likelihood, magnitude, and extent on these prior analyses and the results reported for the 1992 drawdown test of the Lower Granite and Little Goose projects.

3.3.2.2 Indirect Land Transportation Impacts

The assessment of indirect impacts on land transportation facilities followed a three–step process. The 1992 OA/EIS addressed this same issue and identified the types and locations of the potential impacts. Therefore, the land use study team reviewed the OA/EIS analysis as an initial step. The second step was to determine the likelihood of these impacts. This was based on the conclusions of the navigation analysis, as significant mode–switching by shippers would be required for these impacts to occur. For key alternatives, the navigation analysis considered the volume of shift by type of good and orientation, and likely alternative mode and destination. From this, the land use study team could address shipment volumes that could be rerouted to respective railroads and highways within the study area. In the third step (if necessary), these results can be compared to existing capacity, weight, and service levels to determine the degree of change represented by the additional land transportation activity. The magnitude of such impacts is determined by the context of operational and maintenance cost factors, such as weight loadings and resulting damages.

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 land use and development.

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 2c** Operate on system proportional draft as in SOS 1a	**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
	SOS 1b • Minimum project flow 3 kcfs • No refill targets • Summer draft limit of 5–10 feet	**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	

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 6b** 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 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
SOS 5c Operate on system proportional draft as in SOS 1a	**SOS 6d** Operate on system proportional draft as in SOS 1a	**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	

1 kcfs = 28 cms

1 ft = 0.3048 meter

Table 4–1. SOS Alternative–2

Actions by Project

HUNGRY HORSE

SOS 1	SOS 2	SOS 4
SOS 1a Normal 1983–1991 storage project operations	**SOS 2c** Operate on system proportional draft as in SOS 1a	**SOS 4c** • 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 • No maximum flow restriction from mid-Oct. to mid-Nov. • No draft limit; no refill target	**SOS 2d** Operate on system proportional draft as in SOS 1a	

ALBENI FALLS

SOS 1	SOS 2	SOS 4
SOS 1a Normal 1983–1991 storage project operations	**SOS 2c** Operate on system proportional draft as in SOS 1a	**SOS 4c** 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 No refill target	**SOS 2d** 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 6b** 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 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 5c Operate on system proportional draft as in SOS 1a	**SOS 6d** Operate on system proportional draft as in SOS 1a	**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 5	SOS 6	SOS 9	SOS PA
SOS 5b Operate on system proportional draft as in SOS 1a	**SOS 6b** 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 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.
SOS 5c Operate on system proportional draft as in SOS 1a	**SOS 6d** Operate on system proportional draft as in SOS 1a	**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.	

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
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 Operate on system proportional draft and provide flow augmentation as in SOS 2c	**SOS 6b** Operate on system proportional draft and provide flow augmentation as in SOS 2c	**SOS 9a** • 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	**SOS PA** • 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 Operate on system proportional draft and provide flow augmentation as in SOS 2c	**SOS 6d** Operate on system proportional draft and provide flow augmentation as in SOS 2c	**SOS 9b** • 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 Operate as in SOS 1a	**SOS 6b** Operate as in SOS 1a	**SOS 9a** Operate as in SOS 1a	**SOS PA** Operate as in SOS 1a
SOS 5c Operate as in SOS 1a	**SOS 6d** Operate as in SOS 1a	**SOS 9b** 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 6b** 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 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
SOS 5c • Operate to flood control during spring • Refill in June or July and maintain through August • Draft for power production during fall	**SOS 6d** Same as SOS 5b	**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	

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 2c** • Operate reservoirs within 1 foot above MOP from April 16 to July 31 • Same as SOS 1a for rest of year	**SOS 4c** Same as SOS 2c
	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 2d** 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 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 4c** Same as SOS 2c, except operate John Day within 2 feet of elevation 263.5 feet Nov. 1 through June 30
	SOS 1b Same as 1a, except no restrictions on Bonneville second powerhouse	**SOS 2d** Same as SOS 2c	

KAF = 1.234 million cubic meters

MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–6

SOS 5

SOS 5b

- 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

SOS 5c

Same as SOS 5b, except drawdowns are permanent once natural river levels reached; no refill

SOS 6

SOS 6b

- 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

SOS 6d

- 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

SOS 9

SOS 9a

- 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

SOS 9b

- 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 PA

SOS PA

- 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

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SOS 5

SOS 5b

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

SOS 5c

Same as SOS 5b

SOS 6

SOS 6b

Same as SOS 5

SOS 6d

Same as SOS 5

SOS 9

SOS 9a

- 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

SOS 9b

- 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

SOS PA

SOS PA

- 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

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 RIVER CORRIDOR USE AND DEVELOPMENT

The following discussion summarizes the expected effects of the SOS alternatives on existing and future development within the river corridor. The results are presented for the respective reaches or subregions of the river system within the SOR scope, as was done for existing conditions in Section 2.3. The impact conclusions for this issue are based on review of water–dependent and water–related development within the corridor and the degree of expected change from typical reservoir elevation patterns, as indicated by the hydroregulation model results. Detailed results from these models are presented in Appendix A.

4.2.1 Kootenai River

Lake Koocanusa is the largest lake within the Kootenai River subregion. The lake is located within the Kootenai National Forest and there are few private lands intermingled with the Federal lands along the reservoir. Virtually all of the private lands near the reservoir are separated from the lake by a strip of Federal land. These private lands are concentrated in the northern end of the reservoir within the United States, both on the east bank near Rexford and on the west bank around Olsen Hill. There are also several sections of private industrial forest land near the southern end of the reservoir, but these lands do not have water–dependent or water–related uses. Therefore, the potential for development–related impacts is limited.

Currently, there are eight privately owned cabins on Lake Koocanusa. Users of these cabins could be affected by low lake levels, especially if they occurred during summer months. Access to the lake would be more difficult because the cabins would be further from the lake and docks could be unusable at times during the recreation season. The exposed lakebed also would be unattractive to cabin owners. An unknown number of additional properties do not front on the lake but could be affected by diminished aesthetics as a result of greater shoreline exposure.

Pool elevations are normally at or near the full–pool level of 2,459 feet (750 m) during summer months. Hydroregulation model results show that SOS 1a and 1b elevations are normally at 2,459 feet (750 m), except during dry years such the early 1930s and 1940s. For example, the pool elevation in July of 1931 (a representative low–runoff year) is 2,387 feet (727.6 m), or 72 feet (21.9 m) below full. Similar drops in elevation at Lake Koocanusa would occur under SOS 2d, 5, 6, or PA. Under SOS 4c, 9b or 9c the reservoir would remain within 10 to 20 feet (.3 to .6 m) of full during low–runoff conditions. Conversely, the corresponding elevation for SOS 9a is 2,287 feet (697.1 m), or 172 feet (52.4 m) below full.

The above figures illustrate the range of summer pool conditions that could occur in dry years. On average, end–of–July elevations would be 2,450 feet (746.8 m) or above under SOSs 1, 2, 4c, 5, 6, and 9c; about 2,450 feet (746.7 m) under SOS 9b or PA; and 2,393 feet (729.4 m) under SOS 9a. Based on the average elevations and the frequency of very low summer pool levels, SOS 9a appears to be the only alternative that has a significant potential for long–term effects on land uses adjacent to Lake Koocanusa. SOS 9b or PA would result in average summer elevations that would probably cause minor to modest access inconvenience and aesthetic effects, but would not likely cause significant land use changes.

4.2.2 Flathead River

Hungry Horse Reservoir is completely surrounded by Federal forest land within the Flathead National Forest. There are no private lands or cabins located along the lake, and there does not appear to be any potential for future private development. Therefore, none of the SOS alternatives would be expected to adversely affect water-dependent or water-related land uses. Recreational use of the reservoir could be limited at times by low pool elevations, but this issue is addressed in Appendix J, Recreation.

4.2.3 Upper Columbia River in Canada

The hydroregulation model results do not indicate conclusively whether any of the SOS alternatives would measurably change flows and elevations on the portions of the river system located in Canada. The SOR lead agencies have assumed that the effects would not be great, and that the Canadian projects would continue to operate within their historical ranges. In addition, the upper Columbia River below Keenleyside Dam is a free-flowing reach in which flows normally vary considerably over the year; this reach does not include a reservoir at which significant changes in elevation patterns could occur. Consequently, none of the SOS alternatives would be likely to affect existing or future development within the river corridor.

4.2.4 Albeni Falls/Lake Pend Oreille

The elevation of Lake Pend Oreille can vary by up to 11 feet (3.4 m) as a result of operations at Albeni Falls Dam. The typical operating pattern is to draft the lake to or near the minimum elevation in the winter and maintain a full pool through the summer.

With few exceptions, the operations alternatives would continue this pattern, and would have no effects on existing or future development around Lake Pend Oreille. The exceptions to the current pattern are SOSs 4c, 9a, and 9b. SOS 4c involves a somewhat shallower winter draft in most years and a summer pool level approximately 2 feet (0.6 m) below full. SOS 9b would result in similar winter and summer elevations to those of SOS 4c. Winter elevations under SOS 9a would also be no less than 2,056 feet (626.7 m). However, this alternative involves summer drafts that would result in elevations ranging from 2,052 feet to 2,062 feet (625.4 to 628.5 m), and averaging 2,056 feet (626.7 m) at the end of August. In July and (particularly) August of most years, SOS 9a would result in pool elevations from 2 to 12 feet (0.6 to 3.7 m) below full.

The reduced draft in winter could be perceived as a minor improvement over existing conditions, or it could have no effect. The change in summer elevation would likely be perceived negatively, and could have a significant effect on existing and future development.

Large areas of the Lake Pend Oreille shoreline are in private ownership and development has occurred in several locations. Residences and commercial operations on the lake typically have docks and other structures for water-based recreation activities. These facilities are generally fixed in one place, rather than movable, because the owners have not had to accommodate fluctuating lake levels during the recreation season (see Appendix J for additional discussion).

The summer pool elevations associated with SOS 4c, 9a, or 9b would make many of these facilities unusable or of limited use during the recreation season. Depending upon site-specific physical conditions and the permitting policies of the responsible agencies, the expected response of lakeside property owners would be to simply extend their docks to provide full use with the lower summer pool. If the owners were generally able to restore their water access, the primary effect of this change would be to create a one-time nuisance and expense for shoreline property owners. In the unlikely event that water access could not be generally restored, the desirability of lakeside property would be significantly reduced by diminishing one of the primary attractions.

The lower summer pool level with SOS 4c, 9a, or 9b could also have some aesthetic effect on water-related land uses at Lake Pend Oreille. In most areas a 2- to 6-foot (0.6- to 1.8-m) decrease in water elevation would probably not cause extensive shoreline exposure, and would represent an insignificant visual effect. In shallower parts of the lake, however, it is possible that shoreline exposure would

be more noticeable to people using shoreline property. This effect could also be compounded by increased visual clutter and disturbance from extended docks.

The overall effect of a lower summer pool level on existing and future development around Lake Pend Oreille is difficult to predict or quantify, as it would largely depend upon the collective behavior of individual buyers and sellers in the local real estate market. If shoreline property owners were not able to restore acceptable water access, it is likely that SOS 4c, 9a, or 9b would at least tend to inhibit future development around the lake; the degree of such an effect cannot be determined at this time. It is possible, but less likely, that such access conditions would lead to abandonment of some existing lakefront properties.

4.2.5 Grand Coulee/Lake Roosevelt

Lake Roosevelt elevations have generally been stable and near full, between 1,285 and 1,290 feet (391.7 and 393.2 m), during the summer. The reservoir is commonly drafted significantly for flood control and power production in the winter and early spring, sometimes reaching the minimum elevation of 1,208 feet (368.2 m). Substantial reservoir fluctuations are therefore a normal occurrence for developed land uses near Lake Roosevelt, although local residents and proprietors probably expect a full pool in the summer.

Most of the SOS alternatives would generally maintain this elevation pattern, and have no identifiable effect on existing and future development. SOS 4c, which would generally reduce the depth and frequency of drafting in normal operations, might provide a minor intangible benefit for water–related land uses by reducing the overall extent of shoreline exposure viewed by residents and visitors.

Conversely, the flow augmentation actions included in some of the SOS alternatives could change drafting patterns and adversely affect nearby land uses. SOS 2, 9, or PA could result in additional spring drafts and/or failure to refill the reservoir in some years, which would cause a reduction in aesthetic values. The greatest potential for such changes would be with SOS 9a, for which reservoir elevations would average 1,265 feet (385.6 m) at the end of July and 1,249 feet (380.7 m) at the end of August. Corresponding elevations for SOS 9b would be 1,281 feet (390.4 m) and 1,271 feet (387.4 m), respectively. The remaining SOS alternatives would not result in average summer pool elevations that were significantly below full. Residents, visitors, and potential real estate purchasers might or might not perceive and react to such changes; there is insufficient information to predict their response. If the change were perceived and resulted in an adverse response, the desirability of properties near the reservoir for existing use or future development could be diminished by an unknown degree.

4.2.6 Middle Columbia River

The SOS alternatives under consideration do not involve any specific actions at Chief Joseph or any of the five Public Utility District (PUD) projects on the mid–Columbia River. Monthly average flows would be redistributed somewhat, but these projects would continue to operate within their normal pool ranges. Because operating patterns and elevations would not change significantly on any of the middle Columbia reservoirs, there would be no potential for land use impacts.

4.2.7 Middle Snake River

The Hells Canyon Complex in general and Brownlee Reservoir in particular is surrounded mostly by private lands, with some BLM lands. The primary land use within the river corridor is grazing, which would not be affected by any changes in reservoir elevations. Any land use impacts that might occur in this reach would be limited to possible future effects on the scattered parcels that might have potential for residential development.

Under recent operating conditions (SOS 1a), Brownlee Reservoir would typically refill to near full (2,077 feet [633 m]) by the end of June, be drafted up to 10 feet (3.0 m) in July to meet irrigation loads, then remain stable or increase slightly in elevation over the rest of the summer. Simulated reservoir elevations for the other SOS alternatives do not vary considerably from this pattern, remaining within about 5 to 10 feet (1.5 to 3.0 m) of SOS 1a elevations during the

summer months. Snake River flow augmentation measures adopted by the NPPC (or similar measures), which are incorporated into SOSs 2, 4, 5, 6, 9, and PA, would result in additional modest drafts in July and September. The probability of refill in July would be reduced somewhat and lower reservoir elevations would be maintained throughout the summer and fall. In degree, the greatest elevation changes would occur with SOS 9b or 9c. Both of these options would result in average reservoir elevations of 2,058 feet (627.3 m) at the end of July, 2,046 feet (623.6 m) at the end of August, and 2,036 feet (620.6 m) at the end of September. Under SOSs 2, 4, 5, 6, and PA, Brownlee would remain within about 10 feet (3 m) of full through June, July, and August. Impacts to private land uses along Brownlee Reservoir would not be significant, however, given the degree of change in elevations and the limited development near the project.

4.2.8 Dworshak/Clearwater River

Dworshak Reservoir would be affected by changes in operation with some SOSs that would significantly lower pool levels. Dworshak is primarily surrounded by private–and state–owned timber land. The southern portion of the lake is abutted by the Nez Perce Indian Reservation, and the northern tip of the lake is located within the Clearwater National Forest.

Under recent operations (SOS 1a), summer pool elevations typically would be near the full–pool level of 1,600 feet (487.7 m). Simulated elevations for a very low–runoff year fall to 1,493 feet (455.1 m) for SOS 1a in August. Compared to SOS 1a, elevations for SOS 1b tend to be up to 5 feet (1.5 m) higher at corresponding times, and the refill probability is slightly higher.

Reservoir elevations with the other SOS alternatives would vary considerably above or below this elevation pattern. The alternatives that would operate Dworshak for flow augmentation would significantly reduce refill probabilities and summer reservoir elevations. For example, SOS 2c would result in July elevations reaching as low as 1,531 feet (466.6 m), and averaging about 1,581 feet (481.9 m). End–of–July elevations would average about 1,573 feet (480 m) under SOS 9a or 9c, 1,552 feet (473 m) under SOS PA, 1,537 feet (468.5 m) under SOS 2d, and 1,524 feet (464.5 m) under SOS 9b. For some options Dworshak would not refill in any of the 50 water years. Conversely, Dworshak would refill in every year with SOS 4c or 6, and July elevations would average 1,600 feet (487.7 m) or slightly below.

The flow augmentation operations included in SOSs 2, 9, and PA would significantly change Dworshak elevation patterns, and could adversely affect land uses on the reservoir. The uses that would most likely be affected are log transportation and commercial recreation operations. Impacts on these uses are reported in Appendices H, J, and O.

4.2.9 Lower Snake River

Potential changes in project operations could affect existing and future development along the lower Snake River corridor. The lands immediately surrounding the four lower Snake reservoirs are Federal lands that were acquired for project construction and operation. However, most of the areas adjacent to the project lands are in private ownership and/or are used for a variety of agricultural, transportation, residential, and commercial purposes. These land uses would experience adverse impacts as a result of significantly lower pool elevations with some alternatives.

The lower Snake River drawdowns included in SOSs 5, 6, 9a, and 9c have the potential for significant direct land use impacts. While SOS 5 would involve much greater elevation changes than SOS 6, 9a, or 9c, from a land–use perspective these differences would not likely be significant; depending upon site–specific conditions, any long–term operation involving drawdown to elevations well below MOP could adversely affect certain land uses. The primary variable among the drawdown alternatives is whether all four lower Snake River projects (SOSs 5b, 5c, 6b, 9a, and 9c) or just Lower Granite (SOS 6d) would be affected. Land use impacts might also vary with the duration of drawdown, which would be for 2 months, 4.5 months, or all year (in the case of SOS 5c).

Walla Walla and Whitman counties and the cities of Lewiston, Clarkston, and Pasco have port districts with water–dependent land uses that are primarily industrial and commercial. Grain, chemical, and wood products companies are the primary users of the lower Snake River for navigation. The future viability of these land uses could become questionable under SOS alternatives incorporating drawdown, particularly for drawdowns lasting 4.5 months or all year.

The SOSs with seasonal drawdowns would expose varying areas of reservoir bottom lands for portions of each year. These lands are all Federally–owned project lands administered by the Corps. Alternative uses of these lands would not be feasible because of the recurring drawdown/refill cycle. However, this would not be the case for SOS 5c, which would permanently expose the original valley bottom area (as modified by sediment deposition over the years). SOS 5c would therefore "create" additional lands that would conceivably be available for new uses. These lands would presumably remain in Federal ownership, and any future uses would therefore need to be compatible with other project purposes. Recreation and wildlife habitat would likely be primary candidate uses for reservoir bottom areas exposed under SOS 5c.

Drawdown and natural river operations for the lower Snake River could, depending upon how they were implemented, result in indirect impacts to agricultural land uses near the Ice Harbor pool. The SOR irrigation analysis concluded that implementing such alternatives without mitigation for the increased pumping costs could cause irrigators to change their cropping patterns, on–farm management, and acreage in production. For example, some land could be shifted from irrigated agriculture to dryland farming if the cost increase were sufficiently high. If such agricultural shifts occurred and were extensive, they could result in changes in land use patterns near Ice Harbor. While this represents a potentially significant issue, the SOR agencies elected to defer detailed consideration of such indirect land use impacts. The SOS alternatives that could cause such impacts could not be implemented for several more years, and without considerable additional planning, design and NEPA compliance work. Without this additional information, any assessment of the probability, extent, and magnitude of indirect impacts on agricultural land use would be highly speculative and premature.

4.2.10 Lower Columbia River

The land ownership situation for the four lower Columbia River projects (McNary, John Day, The Dalles, and Bonneville) is similar to that on the lower Snake River. The immediate shoreline areas are Federally owned project lands. Adjacent river corridor lands are primarily in private ownership, although there are some significant Federal and state land units in this reach. There also are a number of local government parcels administered by port districts or counties. Downstream of Bonneville Dam, river corridor lands are virtually all in private ownership.

Potential direct land use impacts along the lower Columbia River are similar in nature to those described previously for the lower Snake River projects: commercial, residential, and land transportation land uses could be affected by low pool elevations. However, John Day is the only lower Columbia project where land use impacts might be expected to occur. None of the SOS alternatives include operational features that would change reservoir elevations at McNary, The Dalles or Bonneville outside of their normal ranges.

Under SOSs 5, 6, 9a, and 9c, John Day Reservoir would be drawn down to near elevation 257 feet (78.3 m) for 4 months during the late spring and summer. This is as much as 11 feet (3.4 m) below typical past operating levels at John Day during this time of year. A decrease in elevation of this magnitude could have variable effects on different land uses within the river corridor. Private residences with views of the lake would be negatively affected because shoreline areas would be exposed. Access to the lake could be more difficult in some cases, but could probably be restored through modifications to the public access facilities (see Appendix J, Recreation).

SOS PA presents a different case for John Day, because operation at MOP would be year–round rather than for 4 to 5 months. In this case, as with SOS 5c for the lower Snake River (see Section 4.2.9 above), a large area of the present reservoir bottom would be permanently exposed and potentially available for alternate use. Again, the exposed lands would be Federal lands within the project boundary. Some of these lands are administered by the Corps, while a sizable portion is within the boundaries of the Umatilla National Wildlife Refuge. Given the ownership situation of these reservoir lands, a limited set of options would likely be available for any future uses.

Similar to the Ice Harbor situation discussed in Section 4.2.9, SOSs that would operate John Day near MOP could have the potential for indirect land use impacts through effects on John Day irrigators. Again, the likelihood that increased pumping costs would result in cropping shifts that would change local land use patterns would depend upon how an alternative were implemented, and specifically upon whether the Federal government would provide mitigation for the irrigation impacts of operating near MOP. Mitigation that would be associated with SOSs 5, 6, 9a, and 9c has not been specifically identified, and the potential for indirect land use impacts resulting from agricultural changes is unknown for these alternatives. Consistent with NMFS' 1995 Biological Opinion, SOS PA provides that operating John Day near MOP year–round will occur at the earliest possible date after appropriate mitigation measures are assured. Therefore, although implementation of and mitigation for this operation depend upon future authorization and appropriation, the potential indirect land use impacts would not occur because irrigators would be insulated from the direct irrigation impacts.

4.3 DIRECT LAND TRANSPORTATION IMPACTS

SOS alternatives involving drawdown of Lower Granite or all four lower Snake River projects could have direct physical impacts on railroads and highways in the river corridor. In certain locations, both types of facilities are situated on embankments running along reservoir shorelines. A number of railroad and highway bridges also cross the lower Snake River reservoirs. System operation actions have the potential to weaken the structural stability and integrity of embankments and bridges, as discussed below.

Roads, bridges, and railroads that are parallel to the river or that cross the river could be structurally affected by drawdowns, if these structures are supported by reservoir embankments. Along Lower Granite and Little Goose Reservoirs, embankments for U.S. Highway 12 (from Alpowa to Red Wolf Marina); State Route 193 (from Red Wolf Marina Bridge to Steptoe Canyon on the north shore of Lower Granite reservoir) and State Route 129 (from the Southway bridge to opposite Hell's Gate Marina on the west shore of the Snake River) are all located within the confines of the two reservoirs and identified as potential problem areas during drawdown activities. Red Wolf Bridge in the Lewiston–Clarkston area is the only bridge identified as a potential hazard resulting from drawdown activities. Significant road systems do not run parallel to Lower Monumental and Ice Harbor Reservoirs.

Low reservoir elevations at Lake Roosevelt have the potential to disrupt service by the Keller and Inchelium ferries, which connect with highways in the area. This impact issue is addressed in Appendix H, Navigation.

4.3.1 Lower Snake River Highways

The Lyons Ferry Bridge on State Route 261 was constructed in 1968 during the relocation process for raising the Lower Monumental Reservoir. The piers are founded on bedrock, so increased river velocities and a lower pool elevation should have minimal impact. The Central Ferry Bridge on State Highway 127 across the Little Goose Reservoir was also built in 1968 for the relocation of highways in preparation for filling the pool. The piers extend to bedrock, which should decrease any potential impact when operating the pool at a lower elevation.

The remainder of the highway bridges are located in the Lewiston–Clarkston area. The Someday

Bridge, also referred to as the Red Wolf Bridge, crosses the Snake River and connects Clarkston, Washington, to the Port of Wilma on State Route 193. The bridge was designed and built in 1977. Three of the four piers are founded on bedrock or dense gravels and are below elevation 680 feet (207 m). The last pier is on a foundation of gravel at elevation 712 feet (217 m). Lowering the reservoir to near spillway crest height of 681 feet (208 m) would cause an estimated low river at approximately the 706–foot (215–m) elevation. Potential scour could be a problem, based on velocities from 7 to 10 feet per second (2.1 to 3.0 meters per second [mps]) and existing river topography.

The other bridges in the Lewiston–Clarkston vicinity were constructed before the raising of Lower Granite Reservoir. The piers are founded on bedrock or otherwise have construction histories that should not make them susceptible to scour from higher flow velocities.

For bridges, which might present a problem, protection for the supporting piers could be the placement of riprap, sheet pile and grout, or geotextile fabrics and grout. The choice, type, and complexity of protection must be evaluated to a higher degree before the drawdown occurs to guarantee the public's safety.

4.3.2 Lower Snake River Railroads

The Camas Prairie Railroad company operates rails that run to the north of Lower Granite and Little Goose Reservoirs. The BNRR runs along the northern shore and UPRR runs along the southern shore of Lower Monumental and Ice Harbor Reservoirs.

Lowering Snake River elevations to natural river (SOS 5) or spillway crest (SOS 6, 9a, or 9c) levels would expose a substantial portion of unprotected railroad embankment. The embankments are armored with riprap for protection against wave action and excessive scour, but the riprap only extends a little below minimal pool elevation. With a lower reservoir, wave action would erode the embankments and result in an unstable fill. With time, sloughing off of the fill would occur. As the erosion progressed, the design safety factor for the embankment would be diminished and the fill would fail.

If the damaged fill interfered with the passage of railroad traffic, use of the area would be restricted until the repairs are implemented. Because of the magnitude for installing protection of the embankments prior to lowering the reservoirs, the option of repairing the fills as they fail is probably more practical. Under this scenario, however, the public would be exposed to life–threatening events.

Protection of the embankments would require placement of additional riprap or geotextile fabric and grout, or the repair of the embankments as they are damaged. Approximately 1.2 million square feet (365,760 m^2) of riprap would be required for protection. The quantity accounts for only the protection of 5 feet (1.5 m) above and below the proposed drawdown pool elevation. During drawdown and when refilling the reservoirs, additional surface area on the embankments would be subjected to erosion. If lowering of the reservoirs became an annual event, eventually the entire slope of the embankment would need to be protected.

The Joso Bridge across the Snake River at Lyons Ferry appears to be founded on bedrock. Because the bridge was built before the raising of the pool, potential scour of the footings should not be a problem. The other Snake River railroad crossing is upstream of Lyons Ferry approximately 2.5 river miles (4.0 km). The Riparia Branch Bridge was designed and built by the Corps as part of the relocation of the Camas Prairie Railroad in 1965. The design drawings show piers to be excavated 12 inches (30.5 cm) into the bedrock. Therefore, increased flows should not cause scour or undermining of the footings.

The bridge located at Lewiston near the mouth of the Clearwater River was retrofitted in the 1970s for the filling of the Lower Granite reservoir. Original piers were founded on bedrock. Piers 3, 4, and 5 were modified and are supported on H–pile driven to bedrock. The H–pile for Pier 5 appears to have been enclosed within a sheet pile cofferdam, but Piers 3 and 4 are not confined and undermining is a possibility. The bottom of the concrete cap eleva-

tion for Pier 4 is approximately 696.5 feet (212.3 m). Protection for this bridge could be accomplished with placement of cofferdams around Piers 3 and 4 and sealing between the pile cap and bedrock with concrete.

4.3.3 John Day

John Day Reservoir is lined with highways and railroads. Roads that are constructed on embankments could be structurally damaged as a result of drawdowns. Roads that run along the reservoir are Interstate 84, Oregon 30, and Washington 14 (the Lewis and Clark Highway). The BNRR and UPRR run to the north and south (respectively) of the reservoir. The Corps' (1992) Interim Status Report for the System Configuration Study indicated that operating John Day at elevation 257 feet (78.3 m), as in SOS 5, 6, 9a, or PA, could trigger an active slide area that intersects State Route 14.

4.4 INDIRECT LAND TRANSPORTATION IMPACTS

Railroads and highways throughout the study area could experience indirect effects through potential diversion of cargo now carried by barge. To the extent that this involved large volumes of cargo, there could be constraints on capacity or damage to rail and highway facilities from increased weight loadings.

Indirect effects on area railroads are expected to be minimal under any of the SOS alternatives. Based on analysis of rail rates and service capability, the navigation analysis assumed that sufficient rail capacity existed to accommodate the affected tonnage that might be diverted to rail. In this case, such a diversion would constitute a revenue benefit to one or more railroads serving the area.

If a navigation interruption resulted in significant switching to other transportation modes, the primary impact from redistribution of trucking patterns would be increased truck traffic on well-maintained roads. Increased truck traffic might or might not generate additional tax revenues that would at least partially offset increased costs to maintain and repair the highway systems, depending on the tax structure of the affected jurisdictions. Therefore, the economic consequence of such events could be a transfer of costs among jurisdictions, locations, and transportation sectors.

The potential indirect effects on the highway network in each state are summarized below:

Idaho

None of the drawdown options would significantly affect the Idaho highway system. Imports and exports currently using the Port of Lewiston are already traveling to and from the port by trucks on the existing Idaho highway system for transfer to/from barges. The level of truck traffic on this portion of the Idaho system would not be increased due to lack of barge transfer on the Lower Granite pool.

The most likely highway impact of a temporary navigation closure on the lower Snake River would be to slightly decrease truck traffic on the access routes to the Lewiston-Clarkston area. Such a decrease would occur if some wheat and barley exports were shifted to rail facilities in Idaho, where rail can be used as a direct connection to Portland, Oregon. Some truck shipments from origins/destinations on the edge of the Columbia/Snake River service area could also shift to other routes and connections.

Oregon

None of the drawdown options should significantly affect the Oregon highway system. There could be some shift of truck traffic from the Lewiston-Clarkston area to the Pendleton area for railroad shipping or the Umatilla area for barge shipping. Truck traffic would shift from one highway to another, so no increased traffic-related impacts would occur. Additionally, the state of Oregon's taxing system for trucks is based on the tonnage of commodity moved, so the industry would pay additional taxes to compensate for any increased weight loading.

Washington

Any indirect highway impacts would be concentrated on the Washington State highway system, as drawdowns would preclude navigation only on the lower Snake River pools. The Columbia River pools would maintain navigation during the drawdown periods. Thus, there could be diversion to downstream pools with appropriate port facilities and to rail facilities with appropriate loading capacity, depending upon shipper response to the barge closure. This could extend existing truck traffic bound for Lewiston–Clarkston (such as trucks from Montana) and other lower Snake River ports to other pools that could accommodate the diverted tonnage of commodities. Some truck traffic could also be diverted to rail terminals with appropriate loading/unloading facilities.

Under SOSs 5, 6b, 9a, or 9c, the primary highway system identified in Section 2.4.1 could conceivably receive increased traffic. However, there would be less tendency for shippers to divert cargos from barge to truck transportation in the event of a 3–month navigation closure. Temporary storage with minor diversion to rail transportation might be a viable response in this case. If this were the shipper response, the same volume of truck traffic would continue to haul grain (primarily) from farms to storage and rail loading facilities, with only a minor redistribution on destinations.

A drawdown option for which only Lower Granite pool would be out of service for navigation (SOS 6d) could present a different response. Truck traffic currently headed for port facilities in the Lewiston–Clarkston area might instead be diverted downstream to the Little Goose pool, or possibly the Lower Monumental pool. This type of response would greatly increase the level of truck traffic, congestion and road damage at or near Almota and comparable downstream loading points.

This would create some traffic–related impacts on the existing state and county road systems. Most segments of the highway system in eastern Washington carry low average daily traffic (ADT) volumes. The truck volumes required to move grain diverted from the Lower Granite pool generally would not represent a significant increase in traffic on the highway system. A potential exception is the segment of U.S. 395 from Interstate 90 in Adams County to just north of Interstate 82 in Franklin County. This route is a 2–lane highway that currently carries a high proportion (approximately up to 30 to 35 percent) of truck traffic. Additional truck volume on this road from grain hauls would slightly increase the truck percentage. This would result in a slight reduction in the level of service for the traveling public on this portion of U.S. 395.

The primary potential traffic–related indirect impact on highways would be potential road damage from increased weight loadings. Washington State University has estimated additional maintenance costs associated with additional truck traffic at $0.07 per ton–mile for local roads and $0.05 per ton–mile for state and Federal highways (memo from T. White, U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon, March 4, 1994). Based on these unit costs, shipping volumes, and the road characteristics between the Lewiston area and Almota and Central Ferry, the Corps estimated that a 2–month spring drawdown of Lower Granite might result in additional road maintenance costs of approximately $415,000 per year, while costs for a longer spring–summer drawdown (as in SOS 6d) might exceed $1.0 million (Corps and NMFS, 1994).

CHAPTER 5

COMPARISON OF ALTERNATIVES

The primary purpose of Chapter 5 is to compare the land use effects across the SOS alternatives. This chapter also includes a discussion of potential mitigation measures for the alternatives, cumulative effects, and unavoidable adverse effects.

5.1 SUMMARY OF EFFECTS

Chapter 4 reported the results of the impact analysis for three land use issues. These issues are the potential for effects on use and development of lands in the river corridor, direct impacts on river corridor land transportation facilities, and indirect impacts to regional land transportation facilities. In all three cases, the analysis indicated that the potential for significant impacts was limited in most project areas and river reaches, and under most SOSs. These types of impacts would only be likely to occur under SOSs 5, 6, 9a, or 9c, as they would be triggered by drawdown operations on the lower Snake River.

Existing water–dependent land uses, particularly those related to water transportation, could be diminished in value and utility over the long term. Annual drawdowns would make these properties temporarily unusable in their present state of development. It is not known at this time whether this partial diminishment of use would be sufficient to result in shifts to other uses on the affected properties. Undeveloped land within the river corridor would also be less desirable for future development.

Drawdown operations have the potential to weaken the structural stability and integrity of railroad and highway embankments and bridges along the lower Snake River reservoirs. Specific probabilities cannot be assigned to these impacts, due to a lack of operating experience with such conditions, but there is some unquantified risk of significant damage to structures. There is also some potential for increased long–term wear on railroads and highways serving the lower Snake River region as a result of redistribution of commodity shipments.

As noted above, all three types of land use impacts would only occur under alternatives involving drawdown operations. While their likelihood is unknown, the impacts would be at least locally significant, and could have some effect on regional transportation patterns. These impacts would apply to Lower Granite Reservoir and the surrounding area under SOS 6d and would apply to the entire lower Snake River reach under SOSs 5b, 5c, 6b, 9a, or 9c.

5.2 MITIGATION

The nature of the potential land use impacts is such that effective and practical mitigation measures do not appear to be available. If river corridor lands became unusable or undesirable for their existing purposes, it would not be possible to create replacement lands. Exchanges for water–accessible lands in other locations could conceivably occur, but would seem to be of dubious value. The land uses that would be affected have been developed because of location factors, so shifting these uses to other locations would not be consistent with their original development purposes. In addition, under SOS 5b/c, 6b, 9a, or 9c there would be no alternate sites suitable for potential exchange on the entire lower Snake River.

Direct impacts to transportation structures could be mitigated through protective measures prior to drawdown actions, or by repair after damage occurred. Possible protective measures would include placement of additional riprap to stabilize or reinforce embankments; use of concrete, geotextile fabric, and grout to reinforce structures; or construction of cofferdams to protect bridge footings.

5.3 CUMULATIVE EFFECTS

The land use study team did not identify any local or regional factors that would indicate the potential land use impacts would have notable cumulative dimensions. Continued population and economic growth will lead to an increase in developed land area within the study area and the river corridor. This could result in more affected lands within the corridor in the future, and greater impacts. It is just as likely, however, that the growing base would tend to reduce the relative significance of individual sites that might be affected.

Past, present, and reasonably foreseeable future events likewise do not indicate that potential impacts to land transportation facilities would take on greater significance. Other sources of human–caused structural damage to embankments and bridges have not been identified. Highways in the affected area do not appear to be approaching their capacity limits.

5.4 UNAVOIDABLE ADVERSE EFFECTS

If use of river corridor lands were significantly impaired by drawdown operations, these effects would be unavoidable should a drawdown alternative be implemented. These effects would occur primarily at sites that depend on direct physical access to water, and the very nature of a drawdown operation would remove this access during the period of the action.

Damage to transportation structures would, to some degree, also be unavoidable adverse effects. Protective measures prior to drawdown should be able to prevent such damage in some locations. However, it would not be practical to reinforce all areas where damage could possibly occur, nor would it be possible to predict all locations where slumping, sapping, or other physical processes could lead to structural damage. Any damage attributable to increased loads from shifts in transportation modes and redistribution of truck traffic would also be largely unavoidable, as access to public highways is generally unrestricted.

CHAPTER 6

LIST OF PREPARERS

The SOR Land Use Technical Appendix was prepared by staff from Foster Wheeler Environmental Corporation (formerly Enserch Environmental Corporation), a consulting firm under contract to BPA, operating under the general direction of SOR lead agency staff. The individuals responsible for preparing this appendix are identified in Table 6–1, along with information on the training, experience, expertise and role in appendix preparation.

Table 6–1. List of Preparers

Name	Education/Years of Experience	Experience and Expertise	Role In Preparation
Linda Burbach BPA, NEPA Specialist	15 years	NEPA compliance, public involvement	Contract management, review
Robert Shank BPA, Resource Planner	M.R.P. Regional Planning B.S. Biology 11 years	NEPA compliance, land use, environmental, and recreation planning	Review
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Chris Lawson Enserch Environmental, Resource Planner	M.A. Geography B.S. Geography 16 years	Multidisciplinary environmental planning, studies, regulatory compliance	Project management, review
Patricia Reynolds Enserch Environmental, Resource Planner	B.A. Economics 2 years	Socioeconomics recreation and land use planning	Land use, transportation
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Stacie Seaver Enserch Environmental, Technical Editor	B.A. English 5 years	Technical writing and editing, document production	Editing Document production

CHAPTER 7

GLOSSARY

ADT: Average daily traffic

anadromous fish: Fish, such as salmon or steelhead trout, that hatch in freshwater, migrate, mature in the ocean, and return to freshwater as adults to spawn.

Bankhead–Jones Act of 1937: Authorized Federal purchase of privately owned farm lands that were submarginal and incapable of providing a livelihood for the owner.

BIA: Bureau of Indian Affairs

Biological rule curve: A reservoir operation guideline indicating monthly elevation targets intended to provide improved conditions for resident fish. Biological rule curves have been proposed for the Hungry Horse and Libby storage projects in Montana.

BLM: Bureau of Land Management

BNRR: Burlington Northern Railroad

BPA: Bonneville Power Administration

Canadian Entitlement Allocation Agreements: Contracts that divide Canada's share of Columbia River treaty power benefits and obligations among three participating public utility districts and BPA.

CDNRA: Coulee Dam National Recreation Area

CEAA: Canadian Entitlement Allocation Agreements

Columbia–North Pacific Region: The area which includes all of the Columbia River Basin within the United States plus western Washington and Oregon. It is essentially interchangeable with the Pacific Northwest region.

confluence: The junction of two streams

Coordination Act Report: A project–specific report addressing fish and wildlife resources affected by water resource projects, prepared by the U.S. Fish and Wildlife Service pursuant to the Fish and Wildlife Coordination Act.

Corps: U.S. Army Corps of Engineers

corridor: A narrow passageway, route, or strip of land. In this application, the visible area enclosed by the valley walls in a given river reach or reservoir.

Desert Land Act of 1877: Allowed each claimant 640 acres (259.1 hectares) (reduced to 320 acres [129.6 hectares] in 1891), providing 80 acres (32.4 hectares) were irrigated within 3 years.

direct effect: Effect that is caused by a specific action and occurs at the same time and place as the action.

DOE: U.S. Department of Energy

Donation Land Act of 1850: Allowed married settlers to acquire title to 640 acres (259.1 hectares) of land, providing that they occupied and cultivated the land for 4 years.

drawdown: The distance that the water surface of a reservoir is lowered from a given elevation as water is released from the reservoir.

EIS: Environmental Impact Statement

ESA: Endangered Species Act

Federal Reclamation Act of 1902: Provided for the Federal construction of irrigation works and set up a reclamation revolving fund to which certain revenues from western lands accrued.

Flow augmentation: Increase river flows above levels that would occur under normal operations by releasing water from storage reservoirs.

FS: U.S. Forest Service

Growth Management Act of 1990: Land use planning law adopted by Washington State requiring selected counties and cities to develop comprehensive plans.

HCNRA: Hells Canyon National Recreation Area

Homestead Act of 1862: Allowed individuals to claim 160–acre (64.8 hectare) tracts of land for subsistence and commercial from development.

hydroregulation output: Tabular data reporting results of river system operations simulated with a hydroregulation model. These typically address flows, elevations, power generation, and other variables.

HYDROSIM: Computer model developed by BPA; simulates the coordinated operation of the Columbia River system.

indirect effect: An effect caused by an action that is later in time or removed in distance but still reasonably foreseeable.

ITD: Idaho Transportation Department

KAF: thousand acre–feet

kcfs: thousand cubic feet per second

MAF: million acre–feet

MCM: million cubic meters

MOP: minimum operating pool

NEPA: National Environmental Policy Act

NMFS: National Marine Fisheries Service

Northwest Power Act: The Pacific Northwest Electric Power Planning and Conservation Act of 1980.

NPS: National Park Service

NRA: National Recreation Area

NWR: National Wildlife Refuge

OA/EIS: The Corps' 1992 Columbia River Salmon Flow Measures Options Analysis/Environmental Impact Statement.

ODOT: Oregon Department of Transportation

PNCA: Pacific Northwest Coordination Agreement

PNRBC: Pacific Northwest River Basin Commission

PUD: Public Utility District

Reclamation: Bureau of Reclamation

run–of–river project: Hydroelectric generating plants that operate based only on available steam flow and some short–term storage (hourly, daily, or weekly).

SEIS: Corps of Engineers' 1993 Interim Columbia and Snake River Flow Improvement Measures Supplemental EIS.

SOR: System Operation Review

SOS: System Operating Strategy

Timber Culture Act of 1873: Authorized any person who kept 40 acres (16.2 ha) of timber (subsequently reduced to 10 acres [4 ha]) in good condition to acquire title to an additional 160 acres (64.8 ha).

UPRR: Union Pacific Railroad

USFWS: United States Fish and Wildlife Service

Water Budget: A part of the Northwest Power Planning Council's Fish and Wildlife Program calling for a volume of water to be reserved and released during the spring, if needed, to assist in the downstream migration of juvenile salmon and steelhead.

Weeks Act of 1911: Authorized the Federal government to purchase cutover timberlands and to include them in national forests.

WSDOT: Washington State Department of Transportation

CHAPTER 8

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