



Chapter 3: The Affected Environment

3.1 Study Area

The environment potentially affected by the alternatives includes BPA's service area in the PNW, California and the Inland Southwest (ISW), and British Columbia (BC) (figure 3.1-1). Depending on the response to alternative BPA business policies—by BPA, its customers, other utilities throughout western North America, IPPs, and the region's end-use consumers—changes in generation resource or transmission development, conservation practices, or fuel use could affect a variety of air, land, or water resources.

This chapter describes elements of the environment which might be affected by impacts arising from the various market responses. For example, the descriptions of land uses, vegetation, and wildlife focus on the PNW, because it might be affected by changes in transmission facility development. The summary of air quality issues, by contrast, includes California and the ISW, where air emissions from thermal power plants might change in response to changes in the marketing of surplus PNW power.

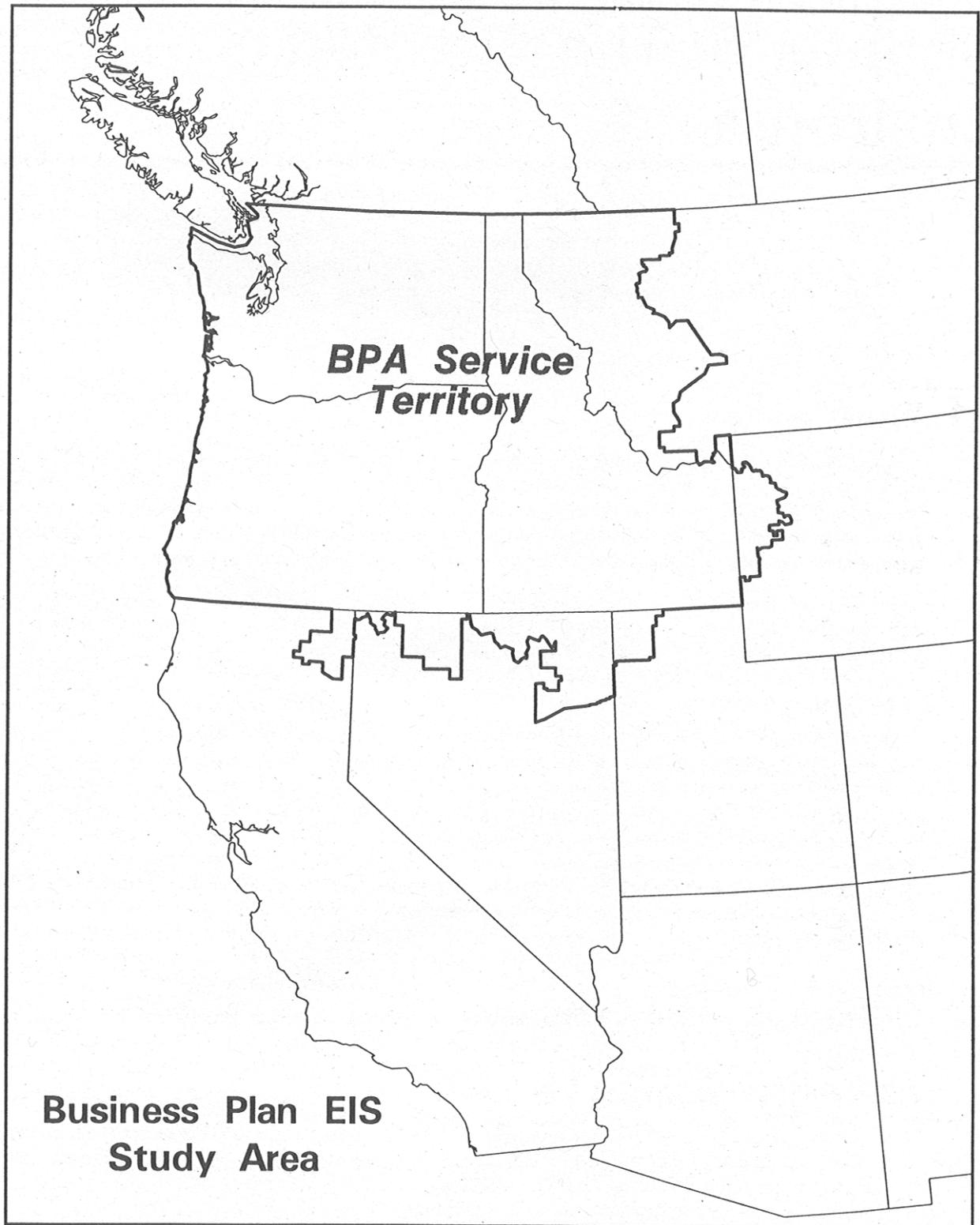
A general picture of the environment is presented below, consistent with the broad-based policy choices and analyses. The decisions to be based on this document are too general to lend themselves to site-specific predictions of adverse environmental impact. The analyses in this document can, however, indicate the *nature* of impacts and, in general, the *kinds of resources affected*. Much of the information is taken from other documents that provide more detail about specific elements of the environment. Source documents include the Resource Programs Final EIS (DOE, February 1993), the Non-Federal Participation in AC Intertie Final EIS (DOE, January 1994), the Delivery of the Canadian Entitlement Draft EIS (U.S. Entity, February 1994; Final EIS to be published Summer 1995), and the Initial Northwest Power Act Power Sales Contracts Final EIS (DOE, January 1992).

3.2 Geography and Land Use

3.2.1 Pacific Northwest

The Columbia-Snake River system, the Cascade and Rocky Mountain ranges, and Puget Sound and coastal areas define the geography and land uses of the study area in the PNW. The Columbia River Basin contains more than 670,000 square kilometers (km²) (258,000 square miles (mi²)) of drainage, including most of Washington, Oregon, and Idaho; Montana west of the Rocky Mountains; small areas of Wyoming, Utah, and Nevada; and southeastern BC. The rivers flow through scenic and recreation areas, irrigate agricultural land,

FIGURE 3.1-1
BUSINESS PLAN EIS STUDY AREA



provide power and a means to transport goods, and are important to commercial, tribal, and sport fishing interests.

Much of the western and higher-elevation parts of the region are forested, primarily with Douglas fir or varieties of pine. The higher rainfall west of the Cascades produces denser forests. Agriculture is centered in the Willamette Valley of Oregon, on the Columbia River Plateau, and along the Snake River. Rangeland covers substantial areas in the Snake River and Rocky Mountain regions. The largest urban/industrial centers are in the Interstate 5 corridor from Puget Sound to the southern Willamette Valley. The major population centers east of the Cascades are around Spokane, Washington; Boise, Idaho; and Missoula, Montana.

The study area is rich in visual beauty. Recreation is dispersed throughout the region's forests, mountains, coasts, and rivers. Depending on the state, one- to two-thirds of the land is publicly owned. Land managers include the Federal Government (U.S. Forest Service (USFS), Bureau of Land Management (BLM), USFWS, and the Departments of Energy and Defense, among others), state and local governments, and Indian Tribes. State and Federal governments have designated many special status areas, including national and state parks, wilderness areas, wild and scenic rivers, and national trails and historic sites. Other special status areas, including national forests, wildlife refuges and Indian reservations, provide for multiple uses.

3.2.2 British Columbia (BC)

The geography and land uses of BC, like those of the PNW, center on mountain and river systems. The 734 km (459 mi) of the Columbia River in Canada drain an area of 102,830 km² (39,550 mi²). The Kootenay and Peace Rivers are also important to the region. Regulation of these river systems by dams has reduced seasonal flow variations and, on the Columbia, reduced the occurrence and severity of floods. Dams on the rivers also produce power.

In general, land uses in BC include forestry, mining, and mineral processing, as well as some cattle ranching and tourism. Because much of the terrain is mountainous, there is little arable land, although agriculture flourishes in a few river valleys in the southern part of BC and in areas along the Peace River. The forest industry dominates the western portion of the province; the eastern part includes a broader mix of uses, such as agriculture, forestry, mining, oil and gas, and transportation. BC's waters produce a rich harvest of fish, including salmon. Water resource uses also include recreation, transportation, and power production.

3.2.3 California and the Inland Southwest (ISW)

The Southern Cascade Mountains and the Sierra Nevada form California's backbone, a barrier the length of the state that is crossed in only a few places. Elevations reach over 4,242 meters (m) (14,000 feet (ft)) above sea level at Mt. Whitney and Mt. Shasta. Most of the mountain ranges trend north-south and exert major influences on the climate of the region, with extremes in several areas.

To the west of the barrier lies the Great Valley and the California Coast Ranges. The valley contains major population centers and is a high-value agricultural area, heavily irrigated. The Coast Ranges, mostly lower than 1,500 m (5,000 ft) support commercial forestry, grazing, and specialty crops such as wine grapes. To the east of the Cascades and Sierras is a semi-desert region of plateaus, basins, plains, and isolated mountain ranges.

In the ISW, the Colorado River Basin is the major drainage, rising on the Continental Divide and ending at the Gulf of California. It contains major multipurpose dams, such as Hoover Dam, which provide electric power, water supplies, and recreation areas. The land is arid, except for the Rocky Mountains, which are moderately wet; most precipitation in the region occurs in the mountains. Land use includes mining and mineral processing, cattle ranching, and farming. Most agriculture depends on irrigation.

3.3 Existing Power System

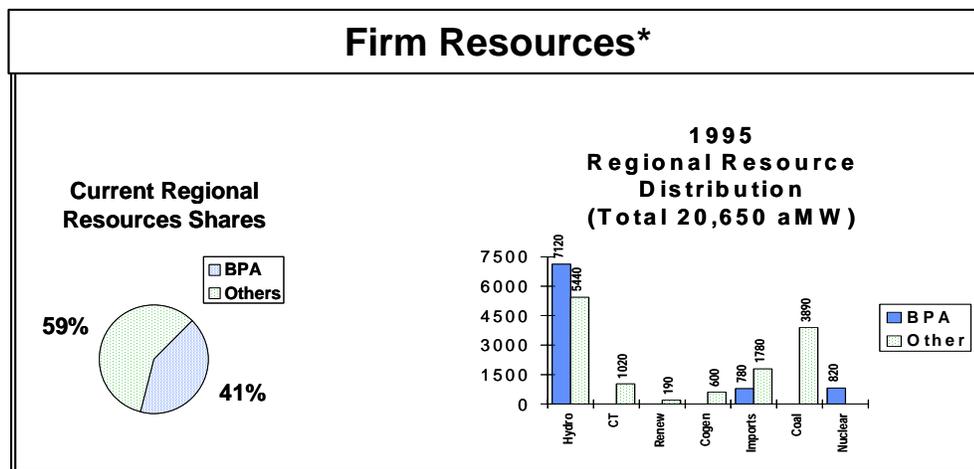
3.3.1 Generating Resources

3.3.1.1 Pacific Northwest

Hydroelectric projects produce about two-thirds of the total electricity used by the PNW. The 58 major hydroelectric dams, including 30 Federally owned dams, have a combined capacity of approximately 31,000 MW. In an average year, 16,400 aMW of hydropower is produced. In the United States, major Federal storage reservoirs exist behind Libby, Grand Coulee, Albeni Falls, Hungry Horse, and Dworshak Dams. The three Canadian Treaty dams (Mica, Keenleyside, and Duncan), built after the 1961 Columbia River Treaty, also provide substantial water storage for the Columbia River Basin.

Non-Federal generation includes 2,400 aMW of firm resources owned or contracted by publicly owned utilities (excluding power sale contract purchases from BPA) and 11,100 aMW of firm resources owned or contracted by IOUs. Figure 3.3-1 shows how existing resources are distributed between BPA and other utilities and among resource types.

FIGURE 3.3-1
Existing System Resources



* In the diagram above, "BPA" represents "Federal System" from the 1994 White Book; "Other" represents "Pacific Northwest Regional Area" minus "Federal System." From the White Book, the 60 aMW of "Small Thermal" under Pacific Northwest Regional Area resources was added to coal for Others above; the 1010 aMW of "Non-Utility Generation" were dispersed across the Others resources according to type; and the 830 aMW for the regional deficit was added to imports - 210 aMW BPA and 620 aMW Others.

The total usable storage capacity of the Columbia River system is about 52 cubic kilometers (km³) (42 MAF), or less than a third of average run-off. Half of that storage capacity is in Canada. The Canadian portion of the storage is operated by B.C. Hydro. The PNW and B.C. Hydro coordinate operation of the hydro system to increase flexibility and to enhance power production.

Electricity for the region is also produced at 14 coal units and 1 commercial nuclear plant. Out of a total of 4,448 aMW of thermal generation, 751 aMW, or 17 percent, is Federally owned; 280 aMW, or 6 percent, is owned by public agencies; and the remainder, 3,417 aMW, or 77 percent, is owned by IOUs. Another important part of the region's resource mix is energy conservation (see section 3.3.2). Conservation programs are designed to improve the efficient use of electricity across all broad end-use categories (residential, commercial, industrial, and agricultural sectors).

3.3.1.2 California and the Inland Southwest

Half of California's generating capacity consists of oil- and gas-fired power plants. The remainder includes hydro (about 20 percent), followed by nuclear, coal, geothermal, and cogeneration. Investor-owned and municipal utilities, the California Department of Water Resources, and the Western Area Power Administration (a Federal power marketing agency) together can generate 45,000 MW with their systems.

The peak load demands of the PNW and California occur at different times. The PNW peaks occur in winter, while California's demand peaks in summer. During the summer, the hydro-based systems in the PNW tend to have excess capacity which can be used to help meet California's peak demands. Similarly, California's thermal-based system tends to have excess capacity in the winter, which can be used to help the PNW meet its peak demands. BPA currently has several seasonal energy and capacity/energy exchange contracts with California utilities.

The ISW resource mix includes hydro, coal, gas, oil, and nuclear generation. Coal provides about 58 percent of the region's generation capacity. Oil- and gas-fired generation account for about 26 percent, hydropower produces about 17 percent, and the Palo Verde (Arizona) nuclear plants #1 and #2 account for 9.3 percent of the region's installed capacity.

3.3.1.3 British Columbia

B.C. Hydro, a provincial crown corporation, was established to generate, transmit, and distribute electricity. It serves almost 1.3 million customers in an area containing over 92 percent of BC's population. Remote communities which are not integrated into B.C. Hydro's transmission system are served by small local generating plants. West Kootenay Power Ltd., a private utility, serves approximately 98,000 customers directly or through wholesalers in the south-central interior of BC.

Hydroelectric generation accounts for about 90 percent of all electricity production. The only major thermal plant is a natural gas facility on Burrard Inlet near Vancouver, BC.

3.3.2 Energy Conservation

Utilities, government agencies, and consumers in the PNW have actively pursued conservation of electric energy for the past decade. The key areas of activity have been in the residential, commercial, industrial, and agricultural sectors. Energy conservation programs are generally categorized as energy resource acquisition programs, capability development, technical assistance, or research, development, and demonstration (RD&D). Acquisition programs purchase energy savings to help meet BPA's load obligations. Capability development programs develop and test administrative systems, incentives, quality and cost control procedures, and delivery approaches. Technical assistance programs support energy conservation through education and information-sharing activities. RD&D projects examine specific applications of new or improved technology and theories through highly structured investigation or experimentation.

Conservation resources have been captured through a variety of approaches, including codes and standards, BPA or utility-designed programs, and new approaches relying on retail, utility, and other third-party program

design and implementation. Table 3.3-1 lists the existing programs operated by BPA in the region. Many NW utilities also operate programs within the four end-use sectors.

Table 3.3-1: Current Conservation Programs Administered by the Bonneville Power Administration

Name	Type	Sector	Target Market
Energy Smart Design	Acquisition	Commercial	All Commercial Buildings All Technologies
Targeted Acquisition	Acquisition	All Sectors	Utilities
Energy Savings Plan	Acquisition	Industrial	All Manufacturing
Major Plants Test	Acquisition	Industrial	Large Customers
Weatherwise	Acquisition	Residential	All Existing
Super Good Cents	Acquisition	Residential	New Residential
Appliance Efficiency	Acquisition	Residential	New Appliances
Residential Construction Demonstration Project	RD&D	Residential	All Technologies
NW Energy Code Program	Acquisition	Residential	New Homes
Billing Credits	Acquisition	All Sectors	Utilities
Competitive Acquisition	Acquisition	All Sectors	General
Lighting Design Lab	Technical Assistance	All Sectors	Designers/Architects/ Engineers
Electric Ideas	Technical Assistance	All Sectors	General
State Technical Assistance Program	Acquisition	All	General
Chain and Franchise Pilot	Acquisition	Commercial	Multi-sited Businesses
WaterWise	Acquisition	Agricultural	Agriculture

3.4 Transmission System

BPA owns and operates approximately three-quarters of the bulk transmission capacity in the PNW. With this capacity, BPA delivers power to its customers and makes excess transmission capacity available to other utilities.

The Federal transmission system is comprised of about 23,680 km (14,800 mi) of high-voltage transmission lines, about 390 substations, and other related facilities. Included in this system are BPA's portions of the PNW/PSW Intertie which has a combined north-south capacity, on five high-voltage lines, of about 7,900 MW. (Capacity is somewhat less south to north.) BPA owns about 80 percent of the portions of the Intertie located north of California and Nevada. The PNW/PSW Intertie provides the primary bulk transmission link between the two regions.

BPA's transmission system also includes interconnections with BC at the international border. These lines, which comprise the Northern Intertie, have a total north-to-south transfer capability of 2,300 MW. After the Northwest Washington Transmission Project is completed, the lines will have a north-to-south capacity of approximately 3,150 MW. The interconnections allow the PNW and BC to undertake many mutually beneficial arrangements.

3.5 Current BPA Marketing

3.5.1 New Developments in BPA's Business Environment

The electric power industry is undergoing a dramatic reorganization. Following trends in telecommunications, air transport, and natural gas, the electric utility industry is headed toward a competitive market structure. Various factors are fostering market competition: electricity consumers' demand for more choices of service; low natural gas prices and technological developments that provide more generation and control alternatives; and new regulation, which gives consumers the right to choose among service alternatives. Growing numbers of IPPs, emerging plans for trading electricity contracts as commodities, opening access to wholesale wheeling as a result of EPA-92, and proposals from industrial interests for retail wheeling all mark the trend toward increased competition.

Since the release of the Draft Business Plan EIS in June 1994, there have been new developments in BPA's business environment.

- **Lower Natural Gas Prices** - Since the analytical section of the Draft BP EIS was completed, the long-term natural gas forecast has declined significantly. The Base Case natural gas forecast used in the Business Plan was \$2.41 per million British Thermal Units (MMBtu), with a 5.6 percent real average annual growth rate. Spot market prices for natural gas have ranged from \$1.00 to \$1.50/MMBtu during the winter of 1994-95. Current natural gas price forecasts are in the \$1.40 to \$1.60/MMBtu range, with the growth rate constant in real terms. Natural gas prices have dropped because competition has increased in the exploration and transmission sectors of the gas industry. The stock of proven and probable gas resources is relatively large, with more than 50 years of gas resources estimated, at current rates of production. The presence of Northwest Pipeline and Pacific Gas Transmission ensures that adequate pipeline capacity at reasonable costs will be available.
 - **Competitive IPP Industry** - Increased competition in the independent power industry has resulted in lower estimates of installed cost for CTs. In early 1993, when Clark County PUD issued a Request for Proposals (RFP) for resources, they received about 30 responses. One year later, when Snohomish PUD issued an RFP, they received about 60 responses. This large number of developers can only mean lower installed cost for GE Frame 7F (or equivalent) CTs. From the time Clark reviewed the responses to its resource RFP and the recent signing of the contract, the installed cost per kilowatt declined about 15 percent.
 - **Improved CT Performance and Efficiency** - Recent operating history of the latest generation of CTs has demonstrated availability factors in the 91 to 95 percent range. Fifteen years ago, CT heat rates were in the 13,000 to 14,000 Btu/kWh range and operated at about a 15 to 30 percent capacity factor. Gas and oil prices were also much higher, so that their primary use was for meeting the peak demands of electric utilities. Current versions of the GE Frame 7F have heat rates in the 7,000 Btu/kWh range, with lower heat rates promised in the near future by CT manufacturers. The units have also become much more durable, and many new installations are reporting availability factors in the 91 to 95 percent range. This compares to 65 to 70 percent for nuclear plants and 70 to 80 percent for coal plants.
 - **Lower CT Cost** - The combined effect of the factors above resulted in a drop in the real levelized cost of a CT of between 8 and 18 mills/kWh, depending on fuel forecasts. The BP Draft EIS estimated that the real levelized cost of a CT is 38 to 40 mills/kWh in 1993 dollars. The combined effect of the three items above has lowered the real levelized cost of a CT to between 22 and 32 mills/kWh, depending on gas price forecasts.
- Competitive Wholesale Market** - The market for wholesale power sales has become increasingly competitive, resulting in lower costs for firm power sales. The WSCC current estimate of summer peak load is about 109,000 MW. Summer peak capability is about 145,000 MW. The resulting reserve margin is between 30 and 40 percent. This large amount of

excess capacity, combined with low natural gas prices, the increase in PNW/PSW intertie capacity, and the gradual increase in access to transmission lines, has resulted in large amounts of surplus power available at very low prices, given the extended drought in the PNW.

- **Electricity Brokers** - Electricity brokers have aggressively pursued short- and long-term sales with BPA customers. Commodity trading firms such as Louis Dreyfus and new entrants such as Citizens Energy are putting together capacity, energy, reserves, and transmission from different sources to meet the needs of utilities throughout the United States. These companies and other utilities have aggressively sought contracts to supply BPA's customers with alternative sources of power. Clark PUD recently signed a short-term arrangement to purchase power until power from its CT is available in 1997. Clark no longer purchases firm power from BPA.
- **California Surplus** - California, once the primary market for BPA surplus electricity, now has a significant energy surplus, and sold large amounts of power to the Northwest during the last few years. The primary causes of this surplus are recession, steep reductions in the defense industry, large amount of high-cost Public Utilities Regulatory Policy Act (PURPA) resources, and strong incentives from demand-side management. The availability of this surplus reduces the availability of BPA to sell its own surplus power and keeps prices on the wholesale power market very low.

Today, BPA's customers must decide whether to continue their reliance on BPA as their sole or partial wholesale supplier or diversify their supply portfolios in anticipation of dramatic changes in the west coast electric power market.

3.5.2 Market Segments

As a wholesaler of power and transmission services, BPA has, in general, three classes of customers: utility firm requirements customers, DSIs, and surplus/nonfirm purchasers. BPA does not sell power to individual consumers, with the exception of the DSIs. (Table 3.5-1 characterizes the DSI customers.)

Utility firm requirements customers include full requirements and partial requirements customers. *Full requirements* encompasses primarily small or medium-sized public utilities with no generation of their own. They rely entirely on BPA to supply their power and transmission needs. A few own small amounts of generation, but the output of these resources is applied directly to serve their consumers' loads.

Under current BPA power sales contracts, *partial requirements* customers are also known as computed requirements customers. These utilities own or operate generation resources adequate to supply some or all of their consumer load. They may need to supply a portion of their load with power from BPA at certain times of the year; and/or they may have surplus generation to market to other utilities or large customers.

DSIs are the set of industries served directly by BPA rather than indirectly through a utility. Nearly all of the DSI load is aluminum smelters. Non-aluminum DSIs include chemical production, nickel, and paper plants.

Surplus/nonfirm purchasers include IOUs in the PNW, the Southwest, in Canada, and in other neighboring regions who purchase surplus power or transmission services from BPA or with whom BPA has seasonal exchange agreements.

3.5.3 Demand for Power

3.5.3.1 Pacific Northwest

Electric loads within the PNW vary according to geographic location and season. The Puget Sound-Willamette Valley region, where two-thirds of the population lives, uses the largest amount of electricity, much of it in winter for heating. East of the Cascades, the difference between winter and summer loads is less pronounced in some areas due to summertime irrigation and air conditioning loads. In fact, summertime loads of utilities serving heavy irrigation demands sometimes exceed those utilities' winter loads.

In the region as a whole, industrial users account for roughly 40 percent of electric consumption, commercial users for 20 percent, and residential users for over 30 percent. Over time, the region's hydro-based power has

become much less expensive than power from fossil fuels, which are used more in other regions. As a result, residential customers rely more on electricity for space and water heating. Although the region uses much less fossil fuel than the rest of the country, residential customers in the region use twice as much electricity for end uses.

Table 3.5-1: DSI - Aluminum Smelters, Loads and Revenues

Smelter Owners	City	Location		Technology	Production Metric Tons	# Potlines		Loads aMW		Revenue \$million/yr	
		State	Utility Area			BPA	Othe r	BPA	Other	BPA	Other
Alumax Intalco	Ferndale	WA	Puget Sound PL	Side-Wk, Pre-Bake	275,000	3		455		\$88.1	
Kaiser Mead	Mead	WA	Wash. Water Pwr	Center-Wk, Pre-Bake	200,000	8		390		\$75.7	
Col Falls Alum Co	Col Falls	MT	PacifiCorp	Vert-Stud, Soderberg	163,000	5		340		\$65.8	
Kaiser Tacoma	Tacoma	WA	Tacoma City Light	Horiz-Stud, Soderberg	73,000	3		150		\$29.0	
Columbia Alum Co	Goldendale	WA	Klickitat PUD	Vert-Stud, Soderberg	168,000	3		285		\$55.2	
Alcoa	Wenatchee	WA	Chelan PUD	Point-Feed, Pre-Bake	220,000	3	2	215	180	\$27.9	\$8.7
Northwest Alum Co	The Dalles	OR	N. Wasco PUD	Vert-Stud, Soderberg	82,000	2		160		\$31.0	
Reynolds Longview	Longview	WA	Cowlitz PUD	Horiz-Stud, Soderberg	204,000	6		420		\$81.3	
Vanalco	Vancouver	WA	Clark PUD	Center-Wk, Pre-Bake	115,000	5		225		\$43.6	
Reynolds Troutdale	Troutdale	OR	Portland Gen.Elec.	Center-Wk, Pre-Bake	121,000	5		250		\$48.4	
Region Total/Avg					1,621,000	43	2	2,890	180	\$546	\$8.7

Slightly less than half of PNW loads are served by BPA, which markets power from COE and BOR dams and one nuclear facility, WPPSS' Washington Nuclear Plant No. 2 (WNP-2). The public utilities and IOUs sell their own generated power or power from BPA to regional end-use consumers (those who use and do not resell the power). BPA's statutes require that it serve all customers' requests for service to loads within the region first, and that it give preference and priority in selling Federal power to public utilities and cooperatives before other customers. Only if more power is available than is marketable to serve load in the region, can the power be sold and transmitted outside the region. Figure 3.5-1 shows how BPA's firm loads are distributed.

Demand forecasts in the 1970s anticipated an energy shortage. New generating resources were planned and built into the early 1980s. When demand for electricity did not increase as expected and improved forecasts indicated smaller loads and firm power surpluses, the construction of the additional large-scale generating facilities slowed considerably and some projects were canceled. By 1990, regional demand balanced regional supply in the near term through 1994. Under BPA's medium forecast, the region will face deficit conditions through 2005. (See table 3.5-2.)

FIGURE 3.5-1
Existing System Loads

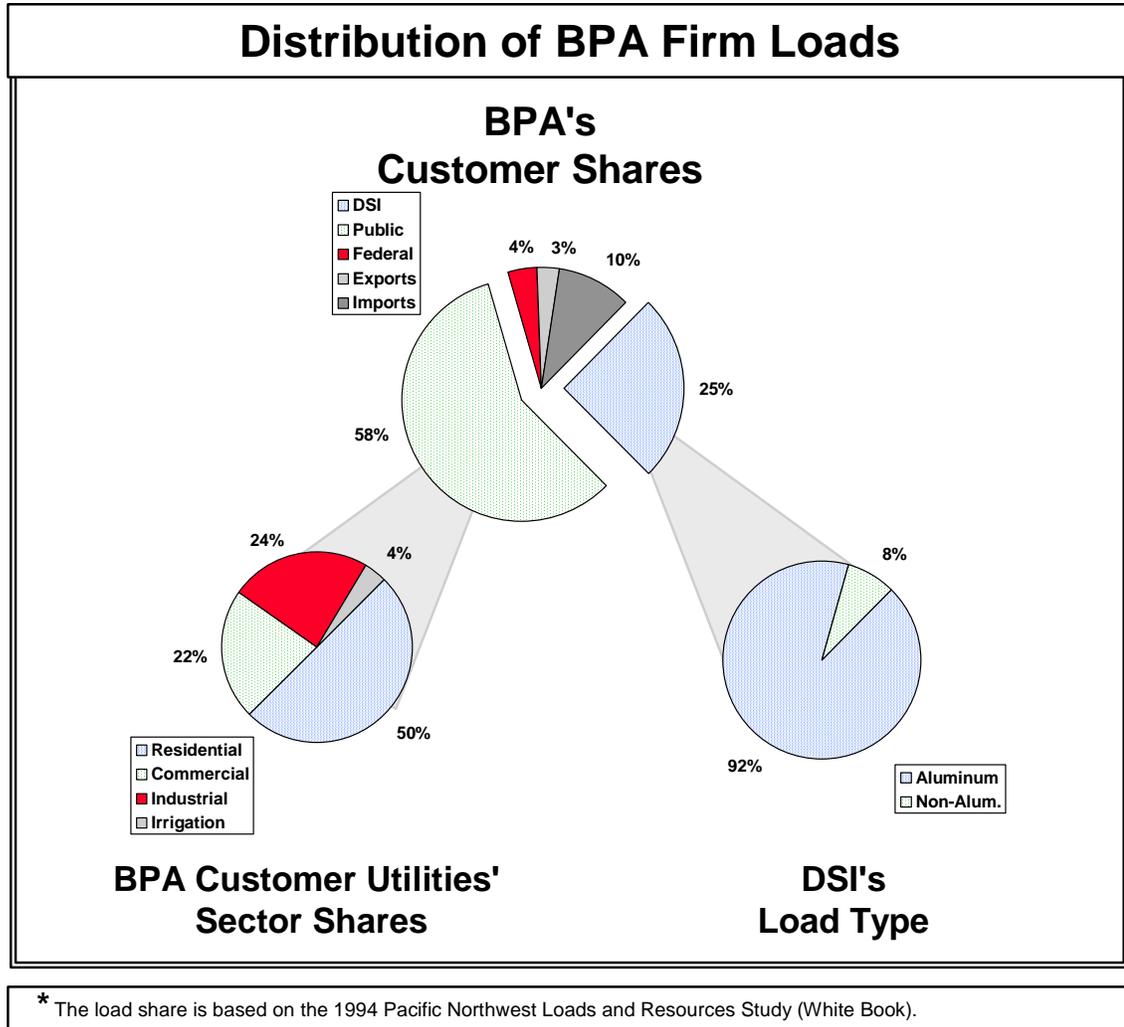


Table 3.5-2: Regional Firm Energy Surpluses/Deficits Assuming Existing Loads, Resources, and Contracts (Energy in Average Megawatts)

	Operating Year ¹									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Medium Loads	-834	-928	-1,040	-1,399	-1,770	-1,933	-2,290	-2,573	-2,899	-3,117

¹Operating Year is the 12-month period August 1 through July 31. For example, operating year 1995 is August 1, 1994 through July 31, 1995.

SOURCE: *Pacific Northwest Loads and Resources Study*. Bonneville Power Administration, Division of Resource Planning, December 1994.

3.5.3.2 California and the Inland Southwest

State-wide peaking electricity demand in California in 1990 was 45,710 MW. Roughly 90 percent of this demand was from three IOUs and the two largest municipally owned utilities.

The California Energy Commission (CEC) Electricity Report 90 forecasts that, between 1989 and 2009, statewide peaking electricity demand is expected to grow by about 2.3 percent annually, while energy loads are expected to grow at 1.8 percent. Individual growth rates projected for the large IOUs range from 2.2 to 2.6 percent annually for peak, and 1.7 to 2.4 percent for energy.

Individually, Pacific Gas and Electric (PG&E) expects to require 200 MW of capacity by 1999, increasing to 2,570 MW by 2009; Southern California Edison (SCE) expects to need 1,200 to 1,800 MW by 2001. San Diego Gas and Electric (SDG&E) has the most immediate need, requiring additional capacity in 1991 to meet its reserve requirement. By 2001, SDG&E projects a need for 1,513 MW. By 2009, this need could increase to 2,300 MW.

In the ISW, 1989 load was approximately 9,884 MW. Since total generating capacity is far greater than load in this region, this part of the Southwest is expected to be surplus over the next 20 years.

3.5.3.3 British Columbia

In BC, load for Operating Year (OY) 1989-90 was approximately 5,066 aMW. Load growth is projected to average 3.0 percent per year through OY 2009-10, but only 2.7 percent per year through OY 1999-2000. In the 1990s, conservation, improved system coordination, and resource efficiency gains are expected to help meet projected demand.

3.5.4 BPA Products and Rates

BPA provides Federal electric power to its preference customers (i.e., public bodies and cooperative utilities), to DSI customers (primarily aluminum smelters), and to other regional and extraregional customers. Electric power produced by both Federal and IOU-owned dams in the PNW is relatively inexpensive; thus, BPA's wholesale power and IOU retail rates have traditionally been low relative to wholesale rates in the rest of the United States. Although electric rates are low, electricity use per end-use consumer is higher than the U.S. average, so the overall electricity cost per end user is close to the national average.

BPA's statutes provide an exchange rate mechanism that equalizes, at the wholesale level, the rate paid by residential and small farm consumers of IOUs with the rates charged the publicly owned utilities. (The IOUs' systems include much more thermal generation than does the Federal Base System; hence, their average rates are higher.) This exchange mechanism is known as the Residential Energy Exchange.

Between 1979 and 1983, BPA's rates rose rapidly. These rate increases were due primarily to the inclusion of costs of the WPPSS nuclear plants 1, 2, and 3, and, to a lesser extent, by costs of programs mandated by the Northwest Power Act, such as the residential energy exchange, fish and wildlife, and conservation. Since

1984, rates have been relatively stable in nominal terms and declined in real terms after adjusting for inflation. However, in 1993, increasing costs forced BPA to implement a 15-percent rate increase.

3.6 Physical and Biological Environment

3.6.1 Biological Resources

3.6.1.1 Vegetation

Pacific Northwest

The northwest United States is among the more diverse regions of North America. It contains wet coastal and dry interior mountain ranges, miles of coastline, interior valleys, basins, and high desert plateaus. Moisture, temperature, and substrate vary greatly, as does the vegetation.

Douglas fir forests dominate the native vegetation from the coast to about 1,500 m (5,000 ft) up the moist western slopes of the Cascades. The drier east side of the Cascades supports yellow pine/lodgepole pine forests.

The forests of the western Cascade Mountains comprise the most densely forested region in the United States. These forests are the most extensive and largest temperate coniferous forests in the world. The climax forests of this area are almost totally dominated by coniferous species. Forestry, wildfires, and clearing for agriculture and other development have removed much of the original forest. Now most of what remains consists of younger, second-growth trees.

The Columbia Plateau—much of Washington and Oregon east of the Cascades and southern Idaho—is arid to semi-arid, with low precipitation, warm to hot summers, and cold winters. The region is dominated by shrubs and grasses. Juniper is an invading species. Forest vegetation is generally confined to areas with more than 38 centimeters (cm) (15 inches (in)) of annual precipitation, and in the higher elevations.

Much of this area has been changed by wildfire and grazing. The two dominant native shrubs are sagebrush and rabbit brush. Both can be eliminated from an area for decades by fire. The major perennial grasses are bunch grass and fescue. Neither is adapted to heavy grazing. Two alien species that are well adapted to the region and were able to invade areas that were burned or heavily grazed are cheatgrass and poa.

In the largely semi-arid climate of the Northern Rocky Mountains (western Montana, northern Idaho, and northeastern Washington), native vegetation consists of larch/white pine or yellow pine/Douglas fir forests.

British Columbia

The lands surrounding the headwaters of the Columbia and Peace Rivers in BC are heavily forested. Douglas fir is prominent in the Canadian Rocky Mountains, and the valley bottoms in most areas are characterized by stands of western hemlock. The south-central portions are characterized by relatively dense forests on north-facing slopes, with scattered clumps of pines and open grassland on south-facing slopes. The upland, sub-alpine zone includes Englemann spruce and lodgepole pine.

3.6.1.2 Fish and Wildlife

Wildlife

The fish and wildlife of the PNW are diverse, with creatures from large mammals to aquatic furbearers, fish, birds, insects, and reptiles all contributing to the ecological health of the region. Some arouse special interest

because of their economic and recreational value or because they are listed for protection by a state or the Federal Government.

Species considered important for recreation (hunting or watching) include mammals such as deer, elk, moose, pronghorn antelope, sheep, goats, and wild pigs; and all kinds of birds, including hunted species such as pheasants, geese, ducks, quail, and grouse.

Protected animals include carnivores such as the gray wolf and the grizzly bear, as well as Columbia white-tailed deer, pygmy rabbit, shrews, squirrels, gophers, chipmunks, a mouse, voles, and bats. Protected birds include Aleutian Canada goose, peregrine falcon, sharptail grouse, sandhill crane, eagles, and the spotted owl. Other species, including several turtles, butterflies, beetles, snails, salamanders, and snakes, are also on protected lists.

Wildlife of special interest in BC includes large populations of elk and deer, as well as mountain goats in higher elevations. Predators include the timber wolf, black and grizzly bears, and cougars. The area also supports raptors, including bald eagles, hawks, and falcons.

Fish

The PNW supports a large number of anadromous fish (species that migrate downriver to the ocean to mature, then return upstream to spawn). The principal anadromous fish runs in the Columbia Basin are chinook, coho, and sockeye salmon; and steelhead.

These fish are an important resource to the PNW, both for their economic value to the sport and commercial fisheries, and for their cultural and religious value to the region's Indian Tribes and others. Several anadromous species have been listed under the ESA as threatened or endangered, including Snake River sockeye and Snake River spring/summer and fall chinook. Recent petitions have requested the listing of over 175 stocks of coastal coho salmon.

Currently fish and wildlife agencies throughout the PNW are engaged in recovery efforts for listed and other weak salmon stocks. Because of the migratory nature of salmon, recovery efforts can have implications for operators of dams along a large portion of the Columbia/Snake river system. The effects of recovery efforts on river operations are addressed in the System Operation Review process being undertaken by BPA, the COE, and the BOR.

PNW waters, including reservoirs behind dams, also support varied populations of resident fish—fish that live and migrate in freshwater. Popular resident game fish in the region include westslope cutthroat trout, rainbow trout, Dolly Varden (bull trout), sturgeon, kokanee salmon, and smallmouth bass. The Kootenai River white sturgeon has been proposed for listing under the ESA.

Anadromous fish have been blocked from the Columbia River above Grand Coulee Dam. However, in Canada the Columbia and other rivers or reservoirs still support stocks of rainbow trout, Dolly Varden char, sturgeon, kokanee, cutthroat trout, burbot, and mountain whitefish, although loss of reproductive habitat in tributary streams, elimination of productive littoral areas, and blockage of migration routes are affecting these populations as well.

3.6.2 Water

3.6.2.1 River Uses

The two major Northwest rivers, the Columbia and the Snake, are very different now from when the region was first settled by non-Indian people. The large size and drop in elevation of the Columbia and Snake Rivers once created spectacular falls and annual flooding as snow melted in the mountains. However, over the last 50 years, the Snake and Columbia Rivers have been dammed to control flooding, provide irrigation and recreation, improve navigation, and produce electricity. The hydroelectric projects are operated to accommodate fish, wildlife, and recreation needs as well as power. Today there are 31 hydro projects in the

Columbia River Basin, including five major Federal storage reservoirs—Libby, Hungry Horse, Albeni Falls, Grand Coulee, and Dworshak.

The sometimes competing multiple uses are considered by the hydro project owners and operators (the COE and BOR), who develop project operating constraints, stringent annual planning criteria, and shorter-term constraints as needed. Flood control constraints vary by project and are adjusted by the COE based on projected runoff volumes. Flood control and navigation requirements are not violated except in emergencies. Special short-term requirements also may be imposed as necessary by the project owner/operator.

Predictable changes in elevations or flows are more likely to occur at storage hydro projects than at run-of-river projects. Reservoirs are operated on an annual drawdown and refill cycle to maintain a balance among multiple uses—flood control, power generation, recreation, and fisheries. Reservoirs are also operated on a daily and hourly basis to meet needs for power, minimum flows, project restrictions, and other short-term requirements. These day-to-day and hourly project operations are less predictable than longer-term operations. Run-of-river projects can store little or no water and are operated on a daily and hourly basis to meet power needs and other project restrictions.

Flood Control and Navigation

Flood control is a priority use for most of the dams on the Columbia and Snake Rivers and their tributaries. The COE is responsible for managing flood control for the floodplains surrounding these water systems.

The Columbia and Lower Snake Rivers also provide ship and barge transport of agricultural products downriver and of goods upriver to the interior of the region. These waterways are a primary transportation resource, as well as a major contributor to the region's economy. At those reservoirs where authority includes supplying water for navigation, a portion of the storage capacity is set aside to ensure that specified flows are maintained for that purpose.

Irrigation

The dams in the Columbia River Basin provide water and power for irrigation. The largest irrigation project in the Columbia River Basin is the BOR's Columbia Basin Project. The Grand Coulee Reservoir provides irrigation for the Columbia Basin Project. Most of the water for the Project—about 1.6 km³ (1.3 MAF) annually—is pumped from Grand Coulee (Lake Roosevelt) into Banks Lake, which serves as an equalizing reservoir. Because the pumps in Lake Roosevelt are located at a fixed elevation in the pumping plant, low reservoir elevations can hinder or prevent pumping. Pumps located at other reservoirs can be adjusted to accommodate fluctuations in water levels.

Irrigation withdrawals for the region above The Dalles Dam total 43 km³ (35 MAF). Returns through groundwater and runoff result in a net withdrawal of 17 km³ (14 MAF). Irrigation water returning to the river increases turbidity and concentrations of agricultural chemicals.

The Yellowstone River in Montana, the Green River in Wyoming, the Skookumchuck River in Washington, and the Columbia River in Oregon supply water to cool existing PNW thermal plants.

Recreation

In the PNW, Federal hydro projects provide numerous opportunities for recreation at the storage reservoirs and the areas downstream. Boating, swimming, water skiing, and fishing are typical water-related activities; other recreational opportunities include camping, picnicking, sightseeing, hiking, and hunting. The Columbia River Gorge has become a world-class destination for wind surfing. Many recreational activities are influenced by changes in reservoir elevation and downstream flows caused by operation of the hydro system (see section 4.3.4.3).

3.6.2.2 Water Quality and Use

Nuclear, coal, oil, and gas-fired generating plants use water for cooling. Water is taken from rivers, aquifers, coastal waters, or reservoirs, and is recycled within the plant or returned to its source. In general, the PNW enjoys excellent water quality, but stringent protection is required. The Clean Water Act requires states to establish designated uses for which each body of water in the state must be maintained. Each state must also establish pollution level criteria to maintain the designated use. In addition, the Environmental Protection Agency (EPA) has established regulations that require at a minimum that, where attainable, all designated uses specify that water is fishable or swimmable.

The four PNW states have over 340,000 km (212,000 mi) of rivers and streams and several million acres of lakes, reservoirs, and freshwater wetlands. Point sources of pollution include power plants and municipal and industrial sources; nonpoint sources are primarily forestry and agricultural practices and mining. These pollution sources increase sediment loads in streams and rivers, contaminate aquatic life with chemicals and heavy metals, and increase nutrient levels.

3.6.3 Air Quality

3.6.3.1 United States

Pollutants of concern in this analysis are those produced by extracting, processing, transporting, and burning oil and gas to produce electric power. Principal pollutants produced are oxides of sulphur (SO_x), oxides of nitrogen (NO_x), particulates, hydrocarbons, ozone, carbon monoxide (CO), and lead. Of these, particulates, CO, and NO_x are common emissions from electrical generation relying on gas-fired combustion. Combustion generating plants may also emit heavy metals, radionuclides, and hazardous compounds.

Several gases absorb infrared radiation emitted from the earth and thus prevent heat loss to space. These gases, which may contribute to the recent global warming trend, are commonly referred to as “greenhouse” gases. They include: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), non-methane volatile organic compounds, and stratospheric ozone-depleting substances such as chlorofluorocarbons.

National primary ambient air quality standards have been established for a set of air pollutants known as the criteria pollutants (sulfur dioxide (SO₂), nitrogen dioxide (NO₂), particulate matter of 10 microns or less (PM-10), lead, ozone, and CO). Primary air quality standards were established to protect human health. There are also secondary ambient air quality standards for particulate matter and SO₂. These secondary standards are more stringent than the primary standards and are set to protect public well-being. Secondary standards protect against such things as decreased visibility and crop damage.

Air quality is a concern in certain defined air basins—usually in and around large urban areas—and around certain existing generating plants. In these areas, more stringent controls are required for existing facilities, and any new major project must satisfy additional restrictions. Nonattainment areas have air pollution concentrations that do not comply with a portion of the National Ambient Air Quality Standards. In addition, California has adopted its own Clean Air Act which established the most stringent air quality standards in the Nation. Much of California currently violates both national and urban California air quality standards.

Pollutants of particular concern in this EIS and locations within the study area that have been in non-attainment in the recent past are as follows:

- Carbon Monoxide (CO)
Major population centers of each state
- Nitrogen Dioxide (NO₂)
South Coast Air Basin in California
- Atmospheric Ozone
Portions of Oregon, Washington, California, and Arizona (some areas are in violation longer or more often than others—typically, urban areas)

Although CO₂ and other greenhouse gases concern many scientists and other people, no standards currently exist nor are concentrations monitored. President Clinton has committed the U.S. to reducing its greenhouse gas emissions to 1990 levels by the year 2000. In late October 1993, the Clinton administration issued The Climate Change Action Plan, which outlines 50 voluntary initiatives to reduce greenhouse gas emissions to 1990 levels. Among other things, the Plan calls for a voluntary “Climate Challenge” program for utilities, which encourages a number of actions, including conservation, renewable energy, energy efficiency, and natural gas use.

Detailed information about generating technologies and their associated emissions, as well as details of Federal and California air quality standards, are found in both the Resource Programs EIS (DOE, February 1993) and in the Non-Federal Participation in AC Intertie Final EIS (DOE, January 1994) and their appendices.

3.6.3.2 British Columbia

Air quality over BC is generally in the “good” to “fair” ranges, with only occasional episodes of air pollution in the “poor” range and no episodes in the “very poor” range. (Greater Vancouver Regional District Air Monitoring System, 1988) Emissions of CO and NO_x make up the majority of pollutants in urban areas, while particulate matter from wood-burning appliances makes up the bulk of air pollution in rural areas.

3.7 Cultural Resources

Cultural resources are the nonrenewable evidence of human occupation or activity as reflected in any district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature that was important in human history at the national, state, or local level. Often these resources, especially Indian burials and ancient habitations, are found along rivers and streams and near reservoirs. Cultural resources that could be affected are located throughout the study area.

3.8 Socioeconomic Conditions

3.8.1 Population

In the PNW, population centers around Seattle/Tacoma and Spokane (WA), Portland/Vancouver (OR/WA), Eugene/Springfield (OR), Boise/Nampa/Caldwell (ID), and Missoula (MT). Estimates indicate that the population in Washington grew from about 4.13 million in 1980 to about 4.87 million in 1990, a 17.8 percent net increase and an annual rate of growth of 1.6 percent. Washington's population is forecasted to grow to 5.96 million by 2003, averaging 1.6 percent growth per year. Oregon's population increased from about 2.63 million in 1980 to an estimated 2.85 million in 1990, an 8.1 percent net increase and an average annual growth rate of 0.8 percent. Oregon's population is expected to continue to grow by an average of 1.6 percent per year, reaching about 3.48 million people by 2003. Idaho's population increased from about 944,100 in 1980 to slightly over 1.01 million in 1990, a 7.1 percent net increase and an average annual growth rate of 0.7 percent. Idaho's population is expected to reach 1.26 million by 2003, growing by an average of 1.7 percent per year. Western Montana increased from 294,800 in 1980 to 305,000 in 1990, averaging 0.3 percent increase per year. Western Montana's population is expected to increase at a faster rate, averaging 1.4 percent per year through 2003, reaching 367,200.

In California, population is concentrated in Los Angeles, San Diego, San Francisco, San Jose, and Sacramento. The much smaller population of the ISW is clustered in the Salt Lake City, Phoenix, Tucson, Albuquerque, Santa Fe, Las Vegas, and Reno metropolitan areas. The population of the region as a whole was

36,264,000 in 1990, with nearly 29,500,000 in California. (California State Department of Finance, Demographic Research Unit)

Population in BC is centered in the Lower Mainland around Vancouver, Victoria, and a few smaller centers. The population of the province has grown from about 2.5 million in 1976 to about 3 million in 1990 (Canadian Consulate General, Office of Tourism). B.C. Hydro has projected an annual population growth of about 1.6 percent through 1999 and 1.3 percent for the following 10 years.

3.8.2 Industry and Economy

3.8.2.1 Pacific Northwest

Over the past 13 years, the economy of the PNW has evolved from resource-based to a more diversified economy with growing trade and service sectors. In 1980, resource-based industries accounted for 30.6 percent of manufacturing employment; by 1993, their share had fallen to 24.2 percent. The manufacturing share is forecasted to decline further through 2003, reaching 19.2 percent. High technology industries' (aerospace and electronics) share of total manufacturing employment has grown from 33.7 percent in 1980 to 38.6 percent in 1993 and is expected to increase to 41.6 percent by 2003. Overall, the manufacturing share of the regional nonfarm employment was 19.4 percent in 1980, falling to 15.5 percent in 1993. This share is forecasted to decline further to 13.3 percent by the year 2003.

The lumber and wood products industry still plays an important role in the region's economy, with 2.6 percent of the total regional employment, but this sector's share has declined from 4.4 percent in 1980. This industry's share is forecasted to decline further, to 1.6 percent by 2003, due in part to supply constraints. Food processing has fallen from 2.5 percent of total employment in 1980 to 2.0 percent in 1993. This share is forecasted to decline further, to 1.7 percent by 2003. This loss of employment share has been due to an increase in the relative size of the employment base and productivity gains brought on by plant upgrades and other efficiencies. Transportation equipment, primarily Boeing, has declined from 3.7 percent of total employment in 1980 to about 3.2 percent in 1993. This industry's share is expected to decline further, reaching 2.8 percent by 2003. Energy-intensive aluminum production is economically important to the region, but the level of employment in this sector is relatively small (0.5 percent of total employment in 1993).

While the manufacturing share fell over the past 13 years, the nonmanufacturing share of total employment rose from 80.6 in 1980 to 84.5 percent in 1993. The nonmanufacturing share is expected to increase further over the forecast period, reaching 86.7 percent by 2003. A rise in wholesale and retail trade and services accounts for most of the gain. Employment in trade grew from 24.0 percent of total employment in 1980 to 24.7 percent in 1993, and is forecasted to increase further to 25.5 percent by 2003. The services sector grew from 18.8 percent of total employment in 1980 to 24.9 percent in 1993 and is expected to reach 27.9 percent by 2003. The region's growing trade with California and the Far East also broadened its economic base.

Twenty-five percent of U.S. exports to Asia and 30 percent of all U.S. exported goods are handled through PNW ports. In fact, the Ports of Seattle and Tacoma are the fourth and sixth largest ports in the world, respectively.

The advantage of low-cost energy relative to other areas has strengthened the region's economic base. Given the availability of natural gas from Canada and the region's hydro base for electricity, the PNW has a long-term energy advantage. On average recently, the region's electricity prices ran 40 percent lower than the national average, and natural gas prices were 10 percent less.

The region can still be hard-hit by high interest rates and their dampening effect on housing, the biggest source of demand for the region's lumber and wood products. However, more diversity and efficiency in industries in the region means more resistance to severe fluctuations now than in the past. Continued high levels of international trade should help offset the negative impact of periodic national business cycles, and the nonmanufacturing service sector of the region's economy is expected to continue to grow faster than total employment.

California, with over 29 million people in 1990 (more than 10 percent of the nation's total population), represents an important market for the PNW. The tourism industry, fueled by the scenic coast, Columbia River Gorge, and Hells Canyon, provides economic stimulus in less populated regions and helps stimulate activity in the service and trade sectors. Agriculture also is a substantial industry in the region, employing about 276,000 in 1990, down from about 285,000 in 1980. The decline in agriculture employment is part of the shift toward a less resource-dependent economy, and also is due to growing productivity in the farm sector.

3.8.2.2 California and the Inland Southwest

California has a rich endowment of natural resources, amenities, and climate. The state is a major source of the nation's fruits and vegetables. Its agricultural sector ranks first in the nation in cash value and produces virtually every crop grown in temperate zones. Lumber production is second only to Oregon, and its mining production ranks among the top three states. Employment in manufacturing industries is the leading source of personal income, followed by government, wholesale and retail trade, and service occupations. Parts of the economy have been in a downturn due to defense budget cutbacks. The entertainment industry, although it has declined somewhat since World War II, is still a significant part of the state's economy, while tourism is one of the fastest growing sectors.

The economy of the ISW is based on mining and ore processing, manufacturing, services, agriculture, and tourism.

3.8.2.3 British Columbia

The economy of BC as a whole, and especially the areas through which the Columbia and Peace Rivers flow, is heavily resource-based. Forestry, mining, and mineral processing industries are important sources of income and employment. In many cases, these industries rely on the river system either for power or transportation. The river systems also are closely tied to another important economic base—tourism and recreation. Petroleum and natural gas production also are important to the economy.

There is abundant hydroelectricity, natural gas, and coal to serve the needs of both domestic and export customers (BC Ministry of Energy, Mines, and Petroleum Resources). However, high unemployment (currently 8.3 percent, seasonally adjusted) has resulted from economic dependence on natural resources (Labor Force Annual Averages, 1990, 71-220). Nonetheless, with an ample and diverse energy supply, a carefully developed infrastructure, and easy access to world markets, BC is poised for future development.