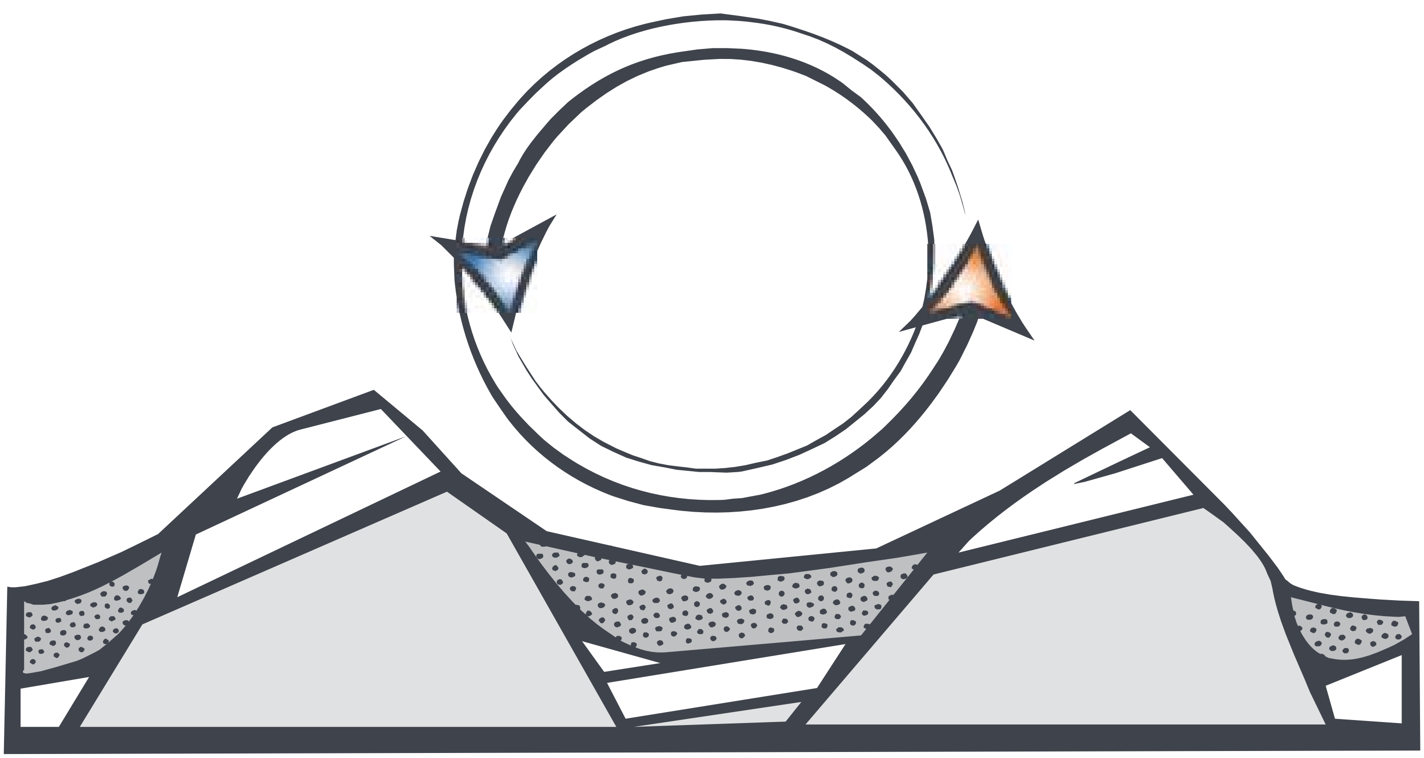

Chapter 5

Cumulative Impacts

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CHAPTER 5
CUMULATIVE IMPACTS AND OTHER CONSIDERATIONS

5.1 INTRODUCTION

The analysis presented in this chapter, as required by Council on Environmental Quality regulations (40 CFR 1500-1508), addresses the potential cumulative impacts associated with Alternatives B (Proposed Action) and C (Leasing On Lands near Transmission Lines). Impacts associated with allocating public and NFS lands as open or closed to geothermal leasing and amending land use plans is placed into a broader context that takes into account the full range of impacts from reasonably foreseeable future actions in the 12-state project area. The Council on Environmental Quality regulations state that the cumulative impact analysis should include the anticipated impacts to the environment resulting from "the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time" (40 CFR 1508.7).

Sections 5.2.2 through 5.2.5 describe the methodology, regions of interest, time frame, and reasonably foreseeable future actions for the cumulative impact assessment. Section 5.3 describes the types of actions and trends occurring on all (federal and nonfederal) lands in the project area. The cumulative impact analyses for each resource and resource use is presented in Section 5.4. Analysis on other type of impacts is provided in Section 5.5, unavoidable impacts; Section 5.6, short-term uses and long-term productivity; and Section 5.7, irreversible and irretrievable commitment of resources.

5.2 WHAT IS THE PROCESS OF ASSESSING CUMULATIVE IMPACTS?

The cumulative impact analysis in the following sections builds upon the analyses of the direct and indirect impacts of Alternatives B and C, which are presented in Chapter 4. In addition to those incremental impacts of Alternatives B and C, the cumulative impact analysis considers other past, present, and reasonably foreseeable future actions' impacts on natural resources, ecosystems, and human communities in the 12-state project area.

5.2.1 What is the Methodology?

The cumulative effects analysis focuses on the natural resources, ecosystems, and human communities that could be affected by the impacts from Alternatives B and C (allocating public and NFS lands as open or closed to geothermal leasing and amending land use plans), in combination with other past, present, and reasonably foreseeable future actions, regardless of who undertakes them.

The Council on Environmental Quality discusses the assessment of cumulative effects in detail in its report, "Considering Cumulative Effects under the National Environmental Policy Act" (Council on Environmental Quality 1997). Based on this report's guidance, the following methodology was developed for assessing cumulative impacts:

1. The geographic scope (i.e., regions of influence) is defined for the analysis. The regions of influence encompass the areas of affected resources and the distances at which impacts associated with Alternatives B and C may occur. The regions of influence are discussed in Section 5.2.3.
2. The time frame for the analysis is defined. The temporal aspect of the cumulative impacts analysis generally extends from the past history of impacts on each resource through the anticipated life of the project (and beyond, for resources having more long-term impacts). The time frame of the actions to be evaluated in the cumulative analysis is presented in Section 5.2.4.
3. Past, present, and reasonably foreseeable future actions are identified. These include projects, activities, or trends that could impact human and environmental resources within the defined regions of influence during the defined time frame. Past and present actions are generally accounted for in the analysis of direct and indirect impacts for each resource and are carried forward to the cumulative impacts analysis. Foreseeable future actions are described by type in Section 5.3.
4. The baseline conditions of resources are characterized. Baseline characteristics are described in the affected environment sections for each resource in Chapter 3.
5. Direct and indirect impacts to resources are characterized. Direct impacts are caused by implementing an alternative, and they occur at the same time and place as the alternative. Indirect impacts are caused by the alternative but occur later in time or farther in distance from the alternative and are still reasonably foreseeable. These impacts are

detailed in the environmental consequences sections of Chapter 4 for each resource.

6. The potential impacting factors of each past, present, or reasonably foreseeable future action or activity are determined. Impacting factors are the mechanisms by which an action affects a given resource. Both Alternatives B and C would also generate factors that could impact resources; these individual contributions form the basis of the cumulative impacts analysis.
7. The cumulative impact assessment focuses on past, current, and reasonably foreseeable future actions, including commercial uses, regardless of who undertakes them and regardless of where they are located in the 12-state project area. In other words, the assessment considers other uses on all lands in the 12-state project area regardless of land ownership. The descriptions of the other reasonably foreseeable future actions considered (Section 5.2.4) address all lands and, as such, the data include public and NFS lands. The data do not specifically break out public and NFS lands.
8. Cumulative impacts on resources are evaluated by considering the impacting factors for each resource and the incremental contribution of Alternatives B and C to the cumulative impact. The cumulative impacts for each resource are presented in Section 5.4.

In cases where the contributions of individual actions to an impacting factor were uncertain or not well known, a qualitative evaluation of cumulative impacts was necessary. A qualitative evaluation covers the locations of actions, the times they would occur, the degrees to which the impacted resource is at risk, and the potential for long-term and/or synergistic effects.

5.2.2 What are the Regions of Influence?

The regions of influence encompass the geographic areas of affected resources and the distances at which impacts associated with Alternatives B and C may occur. The regions of influence encompass the geographic areas of affected resources and the distances at which impacts associated with Alternatives B and C may occur. To determine which other actions should be included in a cumulative impacts analysis, the regions of influence must first be defined. These regions should not be limited to only the locations of the Alternatives B and C, but they should also take into account the distances that cumulative impacts may travel and the regional characteristics of the affected resources.

Because this PEIS addresses allocating public and NFS lands as open and closed to geothermal leasing and amending land use plans at a programmatic level, the region of influence for each resource evaluated by the cumulative impacts analysis is, unless otherwise noted, the 12-state project area. Of all the geothermal uses, commercial electrical generation would have the greatest impacts (see Chapter 4). In general, most commercial electrical generation in the near term would occur in northern Nevada, northeastern and southern California, Oregon, Idaho, and along the Cascade mountain range.

5.2.3 What is the Time Frame of the Action Alternatives?

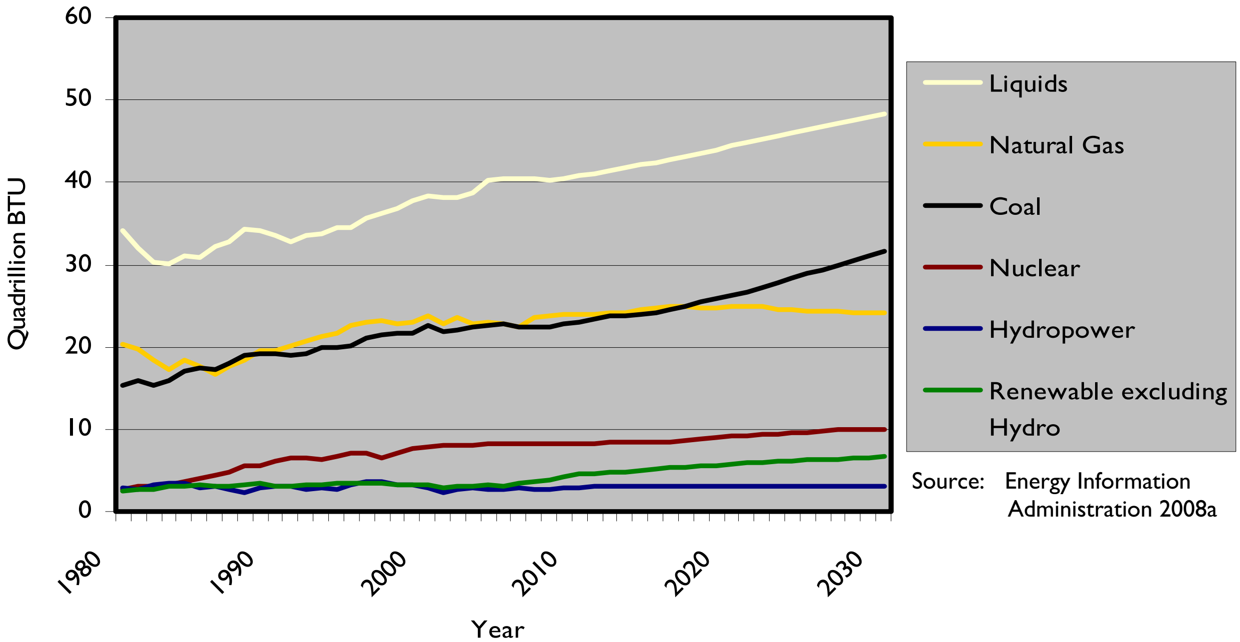
The time frame of the cumulative impact analysis incorporates the sum of the effects of Alternatives B and C in combination with other past, present, and future actions, because impacts may accumulate or develop over time. The future actions described in this analysis are those that are "reasonably foreseeable;" that is, they are ongoing (and will continue into the future), are funded for future implementation, or are included in firm near-term plans. The reasonably foreseeable time frame for future actions evaluated in this cumulative analysis is 20 years from the allocation of lands available for geothermal leasing and completion of land use plan amendments. While it is difficult to project reasonably foreseeable future actions (or trends) beyond a 20-year time frame, it is acknowledged that the effects identified in the cumulative impacts analysis will likely continue beyond the 20-year horizon.

5.2.4 What are the Reasonably Foreseeable Future Actions?

Reasonably foreseeable future actions include projects, activities, or trends that could impact human and environmental receptors within the defined regions of influence (Section 5.2.3) and within the defined time frame (Section 5.2.4). The reasonably foreseeable future actions in this section consider other uses on all lands in the 12-state project area regardless of land ownership. The data include public and NFS lands and do not specifically break out public and NFS lands.

Trends in energy supply and demand are affected by many factors that are difficult to predict, such as energy prices, US and worldwide economic growth, advances in technologies, and future public policy decision both in the US and in other countries (Energy Information Administration 2007b). Figure 5-1 depicts US energy consumption by fuel type from 1980 through present, and predicts future energy consumption trends through 2030.

Figure 5-1
US Energy Consumption by Fuel Type from 1980 – 2030
(Quadrillion Btu)



5.3 What are the Types of Major Actions?

The following section provides a description of the types of major actions and trends occurring on federal and nonfederal lands in the project area.

5.3.1 Oil and Gas Exploration, Development, and Production

Oil and gas provides 62 percent of the nation's energy and almost 100 percent of its transportation fuels (BLM 2005c). The majority (over 60 percent) of oil and gas consumed in the US is imported.

Natural Gas

The US consumes approximately 21.6 billion cubic feet of natural gas annually, accounting for 22 percent of the nation's total energy consumption (Energy Information Administration 2008f). Of the US' total consumption, approximately 19 percent is imported (Energy Information Administration 2008f). Table 5-1 shows natural gas production in the project area between 2001 and 2006. During this period, gas production increased in half of the ten project area states with such production, and it decreased in the other half. This resulted in an overall increase in project area gas production by almost seven percent. This is higher than the US average, which decreased by about four percent during the same six-year period. Gas production increased significantly in Colorado (47.1 percent), Montana (39.4 percent), and Wyoming (29.2 percent) (Energy Information Administration 2008c).

Table 5-1
Annual Natural Gas Production in the Project Area, 2001–2006 (million cubic feet)

	Gas Production (mmcf) [1]						
State	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Percent Change**
US Total	**24,500,779**	**23,941,279**	**24,118,978**	**23,969,678**	**23,456,822**	**23,507,471**	**-4.1%**
Alaska	3,427,779	3,477,438	3,578,305	3,644,084	3,642,948	3,205,751	-6.5%
Arizona	307	301	443	331	233	611	99.0%
California	414,838	397,021	368,440	348,827	352,044	349,137	-15.8%
Colorado	825,378	945,659	1,021,294	1,089,622	1,143,985	1,214,396	47.1%
Idaho	0	0	0	0	0	0	0.0%
Montana	81,802	86,424	86,431	97,838	108,555	114,037	39.4%
Nevada	7	6	6	5	5	5	-28.6%
New Mexico	1,712,390	1,655,906	1,616,179	1,644,738	1,656,850	1,619,528	-5.4%
Oregon	1,112	837	731	467	454	621	-44.2%
Utah	301,422	293,063	284,359	290,586	311,994	356,038	18.1%
Washington	0	0	0	0	0	0	0.0%
Wyoming	1,634,987	1,747,476	1,836,115	1,929,040	2,003,826	2,111,766	29.2%
Project Area Total	**8,400,022**	**8,604,131**	**8,792,303**	**9,045,538**	**9,220,894**	**8,971,890**	**6.8%**

[1] MMCF = million cubic feet
Source: Energy Information Administration 2008b

Crude Oil

The US consumes almost 20.7 million barrels (707 million gallons) of crude oil per day, accounting for 40 percent of the nation's total energy consumption, the largest share of any fuel type (US Government Printing Office 2008, Energy Information Administration 2008f). Of the US' total consumption, almost 60 percent is imported (Energy Information Administration 2008f). In 2006, the 12 western states that make up the project area accounted for approximately 37 percent of the crude oil supply produced in the US. Table 5-2 shows crude oil production in the project area between 2001 and 2006. During this period, crude oil production decreased in six of the nine project area states with such production, resulting in an overall decrease of oil production for the project area by almost 13 percent. This is slightly greater than the US average, which decreased by about 12 percent during the same six-year period. Oil production increased significantly in Colorado (41.6 percent), Montana (127.8 percent), and Utah (17.4 percent) (Energy Information Administration 2008c).

Table 5- 2
Annual Crude Oil Production in the Project Area, 2001–2006 (in thousand barrels)

	Oil Production (bbl)[1]						
State	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Percent Change**
US Total	2,117,511	2,097,124	2,073,453	1,983,302	1,890,106	1,862,259	-12.1%
Alaska	351,411	359,335	355,582	332,465	315,420	270,486	-23.0%
Arizona	59	63	47	52	50	55	-6.8%
California	260,663	258,010	250,000	240,206	230,294	223,449	-14.3%
Colorado	16,520	17,734	21,109	22,097	22,823	23,390	41.6%
Idaho	0	0	0	0	0	0	0.0%
Montana	15,920	16,855	19,320	24,724	32,855	36,262	127.8%
Nevada	572	553	493	463	447	426	-25.5%
New Mexico	68,001	67,041	66,130	64,236	60,660	59,818	-12.0%
Oregon	0	0	0	0	0	0	0.0%
Utah	15,252	13,676	13,096	14,629	16,651	17,910	17.4%
Washington	0	0	0	0	0	0	0.0%
Wyoming	57,433	54,717	52,407	51,619	51,626	52,904	-7.9%
Project Area Total	**785,831**	**787,984**	**778,184**	**750,491**	**730,826**	**684,700**	**-12.9%**

[1] (bbl) = Barrel: A unit of volume equal to 42 US gallons
Source: Energy Information Administration 2008c

Factors associated with oil and gas exploration that can produce impacts may include:

- Exploratory drilling;
- Construction of well pads;
- Well installation;
- Spills/releases;
- Pipeline and utility corridors;
- Access roads and helipads;
- Compressor stations; and
- Site reclamation and rehabilitation.

Factors associated with oil and gas production that can produce impacts may include:

- Production and processing plants;
- Refineries;

- Carrier pipelines;
- Spills/releases;
- Power plants; and
- Access roads.

Oil Shale

Oil shale is a sedimentary rock that releases petroleum-like liquid when heated. The mining and processing of oil shale is more complex and expensive than conventional oil recovery; however, increasing oil prices and advances in technology are making it a more feasible energy option (US DOE and BLM 2007). Over 50 percent of the world's oil shale resource estimate is from the US (BLM 2005c). The Green River Formation, a geologic unit that underlies portions of Colorado, Utah, and Wyoming in the project area, contains the largest oil shale deposits with an estimated 1.5 trillion barrels of oil (BLM 2005c). The federal government owns approximately 72 percent of the US acreage containing oil shale deposits (BLM 2005c). The BLM is currently preparing a PEIS analyzing the amendment of land use plans in Colorado, Utah, and Wyoming, to allow BLM to consider applications to lease oil shale and tar sands for development (BLM 2007m). Factors associated with oil shale mining and processing that can produce impacts may include:

- Surface mines;
- Underground mines;
- In situ retorting;
- Processing plants (rock crushing and retorting);
- Refineries;
- Solid waste (overburden, waste rock, spent shale, and tailings); and
- Site reclamation and rehabilitation.

Tar Sand Deposits

Tar sand deposits comprise another oil-yielding resource under western federal land, primarily in eastern Utah. These deposits are a combination of clay, sand, water, and bitumen that can be mined and processed to produce oil (US DOE and BLM 2007). Deposits could yield 40 to 76 billion barrels of oil (BLM 2005c). The BLM is currently preparing an PEIS analyzing the amendment of land use plans in Colorado, Utah, and Wyoming, to allow BLM to consider applications to lease oil shale and tar sands for development (BLM 2007m). Factors associated with tar sands mining and processing that can produce impacts may include:

- Surface mines;
- Underground mines;

- In situ recovery (e.g., steam injection);
- Extraction plants;
- Solid waste (overburden, waste sand, spend sand, tailings);
- Refineries; and
- Site reclamation and rehabilitation.

5.3.2 Coal and Other Mineral Exploration, Development, and Production (Extraction)

Factors associated with coal and other mineral exploration and development that can produce impacts may include exploratory drilling and trenching and access road and helipad construction. Factors associated with coal and other mineral production (extraction) that can produce impacts may include:

- Surface mines;
- Underground mines;
- Access roads;
- Processing (beneficiation) plants;
- Transportation (e.g., railroads);
- Solid waste (overburden, waste rock, and tailings); and
- Site reclamation and rehabilitation.

Leasable Minerals, Including Coal

Leasable minerals include oil and gas; oil shale; geothermal resources; coal; potash; phosphate; sodium; native asphalt; gilsonite; sulfur in New Mexico; gold, silver, and quicksilver in certain private land claims; and silica deposits in certain parts of Nevada (BLM 2006c). They are leased on public lands under the Mineral Leasing Act of 1920. Leases to these resources on public lands are obtained through a competitive bidding process.

Coal

The US produces approximately 1.2 million short tons and consumes approximately 1.1 million short tons of coal annually, accounting for almost 23 percent of the nation's total energy consumption (Energy Information Administration 2008f). Wyoming is the largest coal-producing state. In the US, coal is used almost exclusively to generate electricity, and coal plants account for over 53 percent of all US electricity generation (BLM 2005c). Table 5-3 shows coal production in the project area in 2000 and 2006. During this period, coal production decreased in five of the eight project area states that produce coal. However, this was offset by substantial increases in Colorado (almost 25 percent) and Wyoming (almost 32 percent), resulting in an overall increase in

Table 5-3
Coal Production in the Project Area, 2000–2006 (million short tons)

State	**2000**	**2006**	**Percent Change**
US Total	**1,073.6**	**1,162.8**	**8.31%**
Alaska	1.6	1.4	-12.50%
Arizona	13.1	8.2	-37.40%
California	0	0	0.00%
Colorado	29.1	36.3	24.74%
Idaho	0	0	0.00%
Montana	38.4	41.8	8.85%
Nevada	0	0	0.00%
New Mexico	27.3	25.9	-5.13%
Oregon	0	0	0.00%
Utah	26.7	26.1	-2.25%
Washington	4.3	2.6	-39.53%
Wyoming	338.9	446.7	31.81%
Project Area Total	**479**	**589**	**22.86%**

Source: Energy Information Administration 2008d, 2008e

coal production in the project area by almost 23 percent. This is four-fold greater than the US average, which increased by about eight percent during that same six-year period (Energy Information Administration 2008d, 2008e).

In the project area, there are seven states containing coal leases on public or NFS lands (Alaska, Colorado, Montana, New Mexico, Utah, Washington, and Wyoming). In these seven states, there are 269 coal leases covering 429,976 acres on public or NFS lands (BLM 2005c). Total short tons of coal produced from these lands totals 10.2 quadrillion Btus (BLM 2005c).

Locatable Minerals

The BLM administers mineral estate on almost 700 million acres of lands in the US, including its own lands, as well as other lands, such as NFS lands. Economic production of mineral resources on these lands includes locatable, leasable, and salable solid minerals.

Locatable minerals can be obtained by filing a mining claim and include both metallic minerals (e.g., gold, silver, lead) and nonmetallic minerals (e.g., fluorspar, asbestos, mica, gemstones). They are defined under the General Mining Law of 1872. Locatable minerals are those that are neither leasable minerals nor saleable mineral materials. Hardrock (locatable) minerals include, but are not limited to, copper, lead, zinc, magnesium, nickel, tungsten, gold, silver, bentonite, barite, feldspar, fluorspar, and uranium (BLM 2006c). In 2007, there were

341,012 active mining claims on file with the BLM, with the highest number (197,843) in Nevada (BLM 2006c). This represents a 70-percent increase from 2006 and a 50-percent increase from 2001 (US DOE and BLM 2007).

Saleable Mineral Materials

Saleable mineral materials include common varieties of sand, gravel, stone, pumice, pumicite, cinders, and ordinary clay. Use of salable minerals on public lands requires either a sales contract or a free use permit. The BLM may issue free use permits to a government agency or a nonprofit organization. The Forest Service administers the disposal of salable minerals from NFS lands.

5.3.3 Renewable Energy Development

Renewable energy resources are naturally replenished in a relatively short period of time and include geothermal energy, hydropower, solar energy, wind energy, and biomass. Renewable energy is used for electricity generation, heat in industrial processes, heating and cooling buildings, and transportation fuels. In 1850, about 90 percent of energy consumed in the US was from renewable energy resources. Now the US is heavily reliant on nonrenewable fossil fuels: coal, natural gas, and oil. In 2006, almost seven percent of all energy consumed, and about nine percent of total electricity production, was from renewable energy sources. In 2004, electricity generation accounted for about 70 percent of total renewable energy consumption. Industrial process heat and building space heating accounted for 25 percent of renewable energy use, and the remainder was used as vehicle fuels (Energy Information Administration 2008g, 2008i).

Geothermal Energy

Chapter 1 describes geothermal energy generation and use.

Hydroelectric Power

Hydropower is the largest renewable energy source used by the electric power sector. In 2006, the US consumed 2.9 quadrillion Btu of conventional hydroelectric power, approximately 42 percent of all renewable energy consumption (US Government Printing Office 2008). It is used almost exclusively to generate commercial electricity. Factors associated with hydropower energy development that can produce impacts may include dams and diversion structures and generating stations.

Solar

Solar energy can be converted into other forms of energy, such as heat and electricity. In 2004, about one percent of all renewable energy consumed in the US was from solar energy sources (Energy Information Administration 2008i). In 2004, over 90 percent of solar energy was consumed by the residential sector (Energy Information Administration 2008g). Factors associated with solar energy development that can produce impacts may include vegetation clearing, fencing around the solar collecting facilities, construction activity, access roads, and transmission lines.

Wind

Wind energy is mainly used to generate electricity. In 2004, just over two percent of all renewable energy consumed in the US was from wind energy sources (Energy Information Administration 2008i). In 2004, all wind energy was consumed by the electric power sector (Energy Information Administration 2008g). Factors associated with wind energy development that can produce impacts may include:

- Vegetation clearing and excavation;
- Construction of meteorological towers;
- Construction and operation of turbine towers;
- Access roads;
- Electrical substations and transformer pads; and
- Ancillary facilities (e.g., control building and sanitary facilities).

Biomass

Biomass is organic material made from plants and animals and contains stored energy from the sun. Examples of biomass fuels are wood, crops, manure, and some garbage. When burned, the chemical energy in biomass is released as heat. In 2004, approximately 46 percent of all renewable energy consumed in the US was from biomass/waste energy sources (Energy Information Administration 2008i). In 2004, biomass/waste energy was consumed by several sectors, including electric power, industrial (electric and nonelectric), commercial, residential, and transportation (Energy Information Administration 2008g). Factors associated with biomass energy development that can produce impacts may include harvesting, access roads, transmission lines, and air pollution.

5.3.4 Nuclear Electric Power

A nuclear power plant operates by producing heat by fissioning or splitting uranium atoms. That heat boils water to make steam that turns a turbine-generator. Nuclear power accounts for approximately eight percent of the nation's total energy consumption (Energy Information Administration 2008f) and about 19 percent of the total electricity generated in the US (Energy Information Administration 2008j).

5.3.5 Transmission and Distribution Systems

Rights-of-way for electric, oil, and gas transmission, as well as roads, telephone/telegraph lines, water pipelines, and communication sites, cross multiple federal and nonfederal lands in the project area. Federal agencies authorized to grant rights-of-way for electric, oil, and gas transmission include the BLM, FS, National Park Service (electric only), USFWS, US Bureau of

Reclamation, and US Bureau of Indian Affairs. About 90 percent of the oil and gas pipeline and electricity transmission rights-of-way in the western states cross federal lands, the majority of which are managed by the BLM or FS (National Energy Policy Development Group 2001). The demand for additional energy and electricity is projected to increase the number of rights-of-way across public and NFS lands in the years to come (National Energy Policy Development Group 2001). Factors associated with utility corridors that can produce impacts may include:

- Carrier pipelines;
- Oil and gas pipelines;
- Fuel transfer stations;
- Spills/releases;
- Transmission lines;
- Substations; and
- Access roads.

5.3.6 Transportation

Transportation systems in the project area are extensive and include interstate and US highway system roads, county roads, bridges, tunnels, Indian reservation roads, defense access roads, federal lands roads, and public authority-owned roads serving federal lands. Railways also transport commodities such as coal. Factors associated with transportation facilities development that can produce impacts may include:

- Highways, roads, and parkways;
- Railroads (coal transport); and
- Hazardous material releases.

5.3.7 Major Uses of Federal and Nonfederal Land

Major uses of federal and nonfederal land that can include factors that may produce impacts include:

- Forest land;
- Grassland pasture and rangeland;
- Cropland;
- Special uses (parks and wildlife areas);
- Other uses (including commercial); and
- Urban land.

As shown in Table 5-4, the major uses of federal and nonfederal land in the US in 2002 were forest-use land, grassland pasture and rangeland, cropland, special uses (parks and wildlife areas), miscellaneous other uses, and urban land. Much of the land (32 percent) in the 12-state project area is used as grassland pasture and rangeland, followed by forest-use land (26 percent) and special uses (almost 21 percent) (USDA, Economic Research Service 2008).

Table 5-4
Major Land Uses by State in 2002 (in 1,000 acres)

State	Crop land[1]	Grassland pasture and range[2]	Forest-use land[3]	Special uses[4]	Urban	Other land[5]	Total land in 12-state project area[6]
Alaska	90	1,295	90,475	143,262	167	130,760	366,049
Arizona	1,235	40,533	17,608	11,373	1,080	897	72,726
California	10,655	21,729	33,780	21,558	5,095	6,997	99,814
Colorado	12,044	28,158	18,925	6,022	814	417	66,380
Idaho	6,408	20,984	16,824	6,175	263	2,305	52,958
Montana	18,118	46,361	19,184	6,863	168	2,458	93,153
Nevada	884	46,448	8,636	6,882	367	7,088	70,289
New Mexico	2,671	51,676	14,978	6,449	484	1,410	77,668
Oregon	5,311	23,239	27,169	3,946	662	1,112	61,438
Utah	2,044	24,339	14,905	4,958	444	5,882	52,572
Washington	7,983	7,369	17,347	6,839	1,367	1,682	42,588
Wyoming	2,860	44,323	5,739	6,416	109	2,697	62,144
Total	70,303	356,454	285,570	230,743	11,003	163,705	1,117,779
Percentage of Total Project Area	**6.29%**	**31.89%**	**25.55%**	**20.64%**	**0.98%**	**14.65%**	

Source: USDA, Economic Research Service 2008

[1] Total acreage in the crop rotation.

[2] Grassland and other nonforested pasture and range in farms excluding cropland used only for pasture, plus estimates of open or nonforested grazing land not in farms.

[3] Excludes an estimated 98 million forest acres in parks and other special uses of land.

[4] Transportation, recreation, and other special uses of land.

[5] Areas in miscellaneous uses not inventoried, and marshes, open swamps, bare rock areas, desert, tundra, and other land generally of low value for agricultural purposes.

[6] Approximate land area established by the Bureau of the Census in conjunction with the 2000 *Census of Population and Housing*.

5.3.8 Grazing and Rangeland Management

As shown in Table 5-5, grazing land is comprised of grassland pasture and rangeland, cropland, and forest land-grazed. In 2002, grazing land comprised about 43 percent of the 12-state project area's land (USDA, Economic Research Service 2008). Cropland pasture is the smallest, but generally the most productive, component of grazing acreage, accounting for less than one percent of the project area. New Mexico, Wyoming, and Nevada have the greatest percentage of grazing land. Factors associated with livestock grazing that can produce impacts may include resource conservation (during nonuse periods) and rangeland improvements (e.g., water pipelines, reservoirs, and fences).

Table 5-5
Grazing Land by State in 2002 (in 1,000 acres)

State	Cropland Pasture	Grassland and other pasture and range	Forest land grazed	Total Grazing Land	Percent of Total Land Area
Alaska	9	1,295	147	1451	0.40%
Arizona	214	40,533	11,709	52456	72.13%
California	1,345	21,729	12,070	35144	35.21%
Colorado	1,835	28,158	10,516	40509	61.03%
Idaho	770	20,984	4,432	26186	49.45%
Montana	1,726	46,361	6,620	54707	58.73%
Nevada	314	46,448	6,887	53649	76.33%
New Mexico	837	51,676	9,482	61995	79.82%
Oregon	1,003	23,239	11,558	35800	58.27%
Utah	602	24,339	9,596	34537	65.69%
Washington	499	7,369	3,879	11747	27.58%
Wyoming	913	44,323	3,543	48779	78.49%
Total	**10067**	**356454**	**90439**	**456960**	**43.29%**

Source: USDA, Economic Research Service 2008

5.3.9 Fire Management and Timber Production

Prescribed burns are used for fire management on federal and nonfederal lands in the project area. Factors associated with fire management that can produce impacts may include access roads and air pollution.

Forest lands are managed for commercial timber production and ecological stewardship. About 33 of the US is comprised of forest land (749 million acres); of this, about one-third (246 million acres) is owned by the federal government (US DOE and BLM 2007). As shown in Table 5-6, as of 2002, about 48 percent (358 million acres) of US forest land was located in the 12-state project area. About 27 percent (137 million acres) of US timber land was located in the project area, of which about 81 million acres are federally owned (USDA, Economic Research Service 2008).

Table 5-6
Forest Land by Major Class by State in 2002 (in 1,000 acres)

State	Timberland			Reserved timber-land and other forest land[1]	Total forest land		
	Federal	Non-Federal	Total		Federal	Non-Federal	Total
Alaska	4,750	7,114	11,865	115,004	63,423	63,446	126,869
Arizona	2,438	1,089	3,527	15,901	10,192	9,235	19,427
California	10,130	7,651	17,781	22,451	22,371	17,862	40,233
Colorado	8,020	3,587	11,607	10,030	15,075	6,562	21,637
Idaho	12,596	4,227	16,824	4,823	17,129	4,517	21,646
Montana	12,506	6,679	19,184	4,108	16,512	6,781	23,293
Nevada	265	99	363	9,841	9,608	596	10,204
New Mexico	2,829	1,530	4,359	12,323	9,522	7,159	16,682
Oregon	14,194	9,637	23,831	5,819	17,741	11,910	29,651
Utah	3,586	1,097	4,683	10,994	11,913	3,764	15,676
Washington	6,104	11,244	17,347	4,443	9,422	12,369	21,790
Wyoming	4,093	1,647	5,739	5,256	8,832	2,163	10,995
Project Area Subtotal	81,511	55,601	137,110	220,993	211,740	146,364	358,103
US	**109,717**	**393,823**	**503,540**	**245,388**	**246,425**	**502,497**	**748,922**

Source: USDA, Economic Research Service 2008

[1] Includes forest land in parks, wildlife areas, and other special uses.

Major timber products include roundwood, lumber (softwood and hardwood), plywood, turpentine, rosin, pulpwood, and paperboard. Factors associated with commercial timber production that can produce impacts may include timber and vegetation harvesting and access roads.

5.3.10 Recreation

In addition to recreation visits to public and NFS lands, the public also recreated on lands managed by the National Park Service, USFWS, state wildlife agencies, state parks, and other federal, state, and local agencies. Factors associated with recreation that can produce impacts may include:

- Visiting scenic and historic places;
- Cross-country and downhill skiing;
- Hunting and fishing;
- All-terrain vehicle use;
- Camping, hiking, and picnicking;

- Viewing wildlife; and
- Scenic driving.

5.3.11 Remediation

The US EPA includes on its National Priorities List the national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the US. These sites may present a significant risk to public health and/or the environment. The National Priorities List is intended primarily to guide the US EPA in determining which sites warrant further investigation. There are 235 National Priorities List sites in the project area, with an additional 15 proposed sites. These include sites in each project area state, as follows: Alaska (five); Arizona (eight with one additional site proposed); California (94, with an additional 2 proposed); Colorado (17 with an additional three proposed); Idaho (six with an additional three proposed); Montana (14 with an additional one proposed); Nevada (one); New Mexico (13 with an additional one proposed); Oregon (12); Utah (15 with an additional four proposed); Washington (48); and Wyoming (two) (US EPA 2008e). Factors associated with remediation activities that can produce impacts may include abandoned mine lands and hazardous material sites.

5.3.12 Population Trends

As discussed in Section 3.18, Socioeconomics, the West is the fastest growing region in the US. Between 1990 and 2006, the project area's population grew at an average rate of 1.8 percent. The largest population growth occurred in Nevada with a 4.7-percent increase, while the lowest growth occurred in Montana, with a 0.7-percent increase. Relatively high growth rates in the remaining states were estimated for Arizona (3.3 percent), Utah (2.7 percent), Idaho (2.6 percent), and Colorado (2.4 percent). Close-to-average growth occurred in New Mexico (1.8 percent), Oregon (1.8 percent), and Washington (1.7 percent), with lower-than-average growth rates in the remaining states. Factors associated with population trends that can produce impacts may include:

- Agricultural, residential, and commercial property development adjacent to federal lands;
- Urbanization; and
- Resource use (e.g., water).

5.4 What Are the Cumulative Impacts?

Neither allocating lands open or closed to geothermal leasing nor amending land use plans, as identified under Alternatives B (Proposed Action) and C, would contribute to cumulative impacts on resources or resources uses in the project area. However, issuing geothermal resource leases is a commitment of the resource for future exploration, development, and production. Therefore, an analysis of these potential impacts is required to assess the likely impacts of a leasing decision along with the potential additive impacts from leasing throughout the entire project area.

The magnitude of actions on public and NFS lands considered in this analysis is great, information about how many future projects may actually be undertaken is lacking, and information about the likely locations of future development is unknown. As such, the cumulative effects discussed in this section are general in nature. The resource discussions below are intended to put potential future geothermal development into context with impacts of known ongoing and planned activities, and to highlight issues that will be considered in future, site-specific NEPA actions. Unless otherwise noted, the magnitude of cumulative impacts between Alternatives B and C are negligible.

5.4.1 Land Use, Recreation, and Special Designations

The contribution to cumulative impacts of geothermal projects on public and FS lands would be small or negligible unless a significant permanent, uncompensated loss of the current productive use of a site occurred, or if future uses were precluded. Geothermal leasing and development requires a relatively small footprint and the land required is not completely occupied by the plant. As a point of reference, base on the upper range of the RFD for geothermal electrical generation, up to 89,000 acres could be disturbed for development compared to the 17 million areas of public land that have other commercial uses (this does not include NFS lands or livestock grazing or mining activities) (BLM 2005c).

Given the small footprint, geothermal development (direct and indirect) is generally compatible with many other land uses, including livestock grazing; recreation; wildlife habitat conservation; and oil, gas, and wind generation. The small number of workers at a geothermal power plant (e.g., about 155 people/year during the peak construction period for a 50MW plant, and about 20 workers during operations) would not likely add to cumulative impacts to land use or land disturbance that are occurring or have occurred from ongoing and past activities.

While geothermal is compatible with other land uses and not all geothermal development would occur on federal lands, it is undeniable that any power generation facility constructed where none previously existed would alter the view of the landscape (i.e., recreation setting), and thereby affect the recreation experience. However, given the relatively small area needed to develop geothermal operations, impacts on the recreation setting and experienced by recreation users would be minimal.

As outlined in Alternatives B and C, geothermal leasing would not be allowed for many specially designated areas, including wilderness (see Chapter 2). Some areas, such as ACECs could allow geothermal leasing. These areas have been determined to have special resource values that are compatible with controlled mineral development; hence most of these areas are also open to other fluid mineral activities. Stipulations, conditions of approval, and BMPs would minimize any impacts in these areas. Management of special designations is governed by site-specific management direction to protect the special resource values. This gives local authorized officers the information and discretion on how to manage leases to minimize local and cumulative impacts. Cumulative impacts would be expected in areas of high mixed mineral development (e.g., oil/gas and geothermal development); however, the collocation of these mineral sources is rare.

5.4.2 Geological Resources and Seismic Setting

Cumulative impacts to geologic resources or seismic characteristics from geothermal exploration, drilling and development are expected to be minor. Alternatives B and C include many BMPs to mitigate impacts from drilling and earthmoving activities. Any impacts that might occur would be minimal and largely limited to the project site. The construction of new access roads, improvements to existing roads and bridges, and installation of wells and facilities would involve cut and fill operations. If large amounts of fill material would be necessary, increased demands could occur to off-site supplies of sand, gravel, and crushed rock. If multiple construction projects were developed within a single area, local supplies of required fill material, particularly gravel or crushed rock, could be reduced to the point of impacting the needs of roadways and other construction projects. Local changes in topography could be caused by construction of roads, well pads, pipelines, and the power plants. Cumulatively, up to 89,000 acres of land could be disturbed by geothermal leasing and development in planning area for the next 30 years; however, much less land would be utilized for operations. Given the type of development envisioned, it is not likely that seismic events would be triggered as a result of leasing and subsequent development.

5.4.3 Energy and Minerals

An increase in development of geothermal resources would have a cumulative impact of reducing the demand for nonrenewable energy. Based on the RFD, there is the potential to triple the megawatts produced with geothermal resources, which would offset power demand from coal, oil, and gas. Geothermal development is compatible with many other lands uses, however, cumulatively it could result in some competition for water rights and energy developments in the same area.

5.4.4 Paleontological Resources

Disturbances from geothermal drilling and utilization, combined with other surface-disturbing development activities, could uncover or destroy paleontological resources. However, the proposed stipulations and BMPs addressing cultural resources and the proposed exclusion of many NLCS lands would limit the potential impacts. Likewise, monitoring by a qualified paleontologist would also be a site-specific requirement in areas where any excavation would occur in formations of moderate to high resource potential and would reduce any cumulative impacts.

5.4.5 Soils

Geothermal energy exploration, development, and utilization would have a minor cumulative impact to soil compaction and soil erosion from wind and water. These impacts would be short-term and generally during the exploration and construction activities when soils are disturbed. These impacts would have a cumulative effect when located in areas with ground disturbing uses, such as livestock grazing and roads.

In total, up to 89,000 acres of land could be disturbed by geothermal leasing and development in planning area for the next 30 years; however, much less land would be utilized for operations. This is a relatively small area when compared to the all the acres on federal land that have other activities; well over 17 million acres (US BLM 2005c). Stipulations and BMPs applicable to activities taking place on slopes would minimize these impacts.

5.4.6 Water Resources

Drilling, well testing, construction, and geothermal production would require the consumption of water. Any additional consumption of water would have a cumulative impact when joined with other water use projects, such as agriculture, municipal wells, and water transfers. The actual consumption of water by energy facilities can be mitigated (for example, water can be reused) so as to minimize this potential cumulative impact. There is a potential for energy facilities to concentrate in areas abundant with the resource. In such areas, there is a greater potential to contribute to cumulative depletion of water resources. Groundwater depletion is not one of the issues addressed in the proposed lease stipulations, except indirectly through the requirement for compliance with applicable laws and regulations. The state engineer is responsible for assigning water rights and managing groundwater resources. Any added use of groundwater in areas where demand for water is nearing the available supply, could contribute to cumulative impacts on groundwater. Use of closed system geothermal facilities (e.g., binary plant) would minimize any depletion as no water is directly consumed during operation.

5.4.7 Air Quality and Climate

While geothermal energy generates minimal emissions compared to fossil fuels, the exploration, development, and operation of this renewable resource would be responsible for minor amounts of air pollutants. Most of the emissions associated with geothermal development would be during exploration, drilling, and construction activities and include particulate material (dust) and emissions from vehicles and equipment. When combined with other projects near geothermal developments, there would be a minor localized increase in emissions; however, over the long-term geothermal electrical generation may have a beneficial cumulative impact by offsetting the need for energy with higher emissions, such as coal, oil, and gas.

5.4.8 Vegetation

There would be a minor cumulative impact to vegetation from geothermal leasing. As a result of subsequent exploration, drilling, and development disturbance (including roads, transmission lines, and pipelines), there is the potential for nonnative and invasive species to dominate sites. For example cheatgrass is a concern in much of the areas that have a high potential for geothermal development, especially in the Great Basin. The facilitation of seed dispersal could result from construction equipment transporting invasive species from the construction areas to adjacent lands along access roads and main roads. In addition, exploratory drilling or uncontrolled releases, spills, seepages, or well blowouts could result in the addition of toxic, mineralized, or saline geothermal waters to the soil, streams, ponds, or wetlands. This contamination could adversely impact vegetation growth and distribution, particularly for sensitive riparian and wetland vegetation. There could be the long-term conversion of habitat types, like from sagebrush to grassland. Many of these impacts would be minor on a site-by-site basis, but if geothermal development is consolidated with other developments, the cumulative impact could effect the functioning of local ecosystems.

5.4.9 Fish and Wildlife

The potential cumulative effects to vegetation would impact native fish and wildlife as habitats are fragmented, degraded, or destroyed from development. Industrial activities, such as geothermal development, can substantially modify or eliminate habitat within and near the development footprint, although not all species are harmed by conversion of land to more intensive uses. Numerous species are adaptable to changes in their environments. While the footprint of geothermal developments are relatively small, if many are located close together or near other activities (e.g., oil wells), there would be a cumulative effect via habitat fragmentation. While much of the development is expected to be located in remote areas, the creation of new access roads, pipelines and transmission lines would also contribute to fragmentation and serve as a vectorm for invasive species. Conditions of approval and BMPs are applied at the permitting phases of geothermal development to minimize these impacts; however, fragmentation is unavoidable.

5.4.10 Threatened and Endangered Species and Special Status Species

Loss of habitat is also an important factor contributing to the increase in the number of species listed as threatened or endangered in recent years. Stipulations and permitting requirements, including Section 7 consultation, would minimize the risk of directly taking listed species, but there could be a cumulative effect from removal of small patches of habitat that can add up to a notable acreage. Sage grouse is one special status species that would be negatively affected by extensive development due to the potential cumulative loss of habitat. Stipulations and BLM s would minimize this impact, but because much of the higher temperature resources are located in the Great Basin, there would be some loss to sagebrush habitat.

5.4.11 Wild Horse and Burros

Impacts to wild horse and burros would occur from the loss of vegetation for grazing, loss of water supplies, loss of herd management area capacity, and the disruption to wild and horse and burro practices where multiple projects are located in herd management areas. Geothermal developments would remove some forage, although the overall footprint is minimal. Geothermal developments tend to congregate in areas where the resource is present, so wild horse and burros could be displaced from some areas. This cumulative effect would only be realized where there is a high potential for development and there are larger populations of horse and burros, such as northern Nevada.

5.4.12 Livestock Grazing

Impacts to livestock grazing would occur from the loss of forage for grazing, loss of AUM capacity, and the disruption to livestock grazing practices where cumulative project overlay allotments. Geothermal developments would remove some forage, although the overall footprint is minimal, and could lower the AUM capacity in areas with livestock operations.

5.4.13 Cultural Resources

Disturbances from geothermal drilling and utilization, combined with other surface-disturbing development activities, could uncover or destroy cultural resources. However, the proposed stipulations and BMPs addressing cultural resources and the proposed exclusion of many NLCS lands would limit the potential impacts.

5.4.14 Historic and Scenic Trails

Historic and scenic trails on federal lands are generally managed as a special designation. The proposed closure of trails to leasing and additional stipulations would preserve the setting of the trail system. Geothermal developments that are visible to remote trail sections would have direct impacts; however, geothermal developments in more developed areas would potentially contribute a minor cumulative impact.

5.4.15 Visual Resources

There could be a minimal cumulative impact to visual resources from geothermal drilling and utilization. The heights, type, and color of drilling equipment and power plants, together with their placement with respect to local topography (i.e., on valley floor or open basin), are factors that would contribute to visual intrusion on the landscape. Also, the potential need for additional transmission lines to connect electrical production facilities to the regional power grid could contribute to cumulative impacts. Flexibility in locating power plants and other large structures to avoid cumulative impacts to important (e.g., VRM Class I or II) viewsheds should be considered during the permitting process.

5.4.16 Socioeconomic and Environmental Justice

As noted above (Section 5.4.1 – Land Use) geothermal developments tend to be generally compatible with other land uses and require a relatively small amount of land in typically remote locations. Therefore, geothermal development on federal lands would have a relatively small cumulative impact on other uses of public and FS lands. Consequently, potential conflicts with other traditional uses of public and FS lands, such as mining, oil and gas development, and agriculture, would likely be minimized. In addition, many of the activities associated with traditional uses of public and FS lands have either existed for long periods of time, or the location of any potential new developments would be predictable given the distribution of natural resources and areas of scenic beauty. Conflicts with forestry and recreation could therefore also be minimized. Beneficial cumulative impacts associated with geothermal energy development on federal lands would be likely include the creation of new jobs; increased regional income, sales and income tax revenues; and royalty income to the federal and local governments.

Potential cumulative impacts on environmental justice as a result of geothermal leasing and development could occur if projects produced environmental and health impacts. As discussed above, geothermal development has relatively minor air emissions, has controlled hazardous waste stream, is generally located in remote locations, and provides economic opportunities. Proposed stipulations and BMPs, should ensure that adverse impacts to populations are minimized. Therefore, cumulative impacts on environmental justice issues would be negligible.

5.4.17 Noise

Site-specific and sporadic increases in noise pollution would occur during exploration and development activities. Noise levels generated by drilling and construction equipment would be variable and depend on the type, size, and condition of equipment used and the equipment operating schedule. Most locations of geothermal energy projects on public and FS land would likely be at distances far enough away from receptors that noise levels would not increase above existing background levels at the receptor location. Drilling and construction equipment could generate noise levels of 80 to 90 dB(A) at a distance of about 50 ft (15 m). Because the estimated noise level of the two noisiest pieces of equipment operating simultaneously would not exceed the EPA noise guideline level of 55 dB(A) at a distance of about 1,640 ft (500 m) from the source, cumulative impacts would not be expected to occur to local residents living near public and FS lands. Local residents near access roads and well sites could experience intermittent noise from construction vehicles during the daytime period. Noise generated during operations would be from the power plants and vehicles of well field workers. Noise generated by power generation, substations, transmission lines, and maintenance activities during the operational phase would approach typical background levels for rural areas at distances of 2,000 ft (600 m) or less; therefore, the sphere of noise impact is limited in scope and would not be expected to result in cumulative impacts to local residents.

5.4.18 Health and Safety

The combination of hazardous materials to develop and operate geothermal energy facilities with other reasonably foreseeable land use activities is expected to be negligible. Compared to other federal land uses, such as oil, gas, and coal extraction, geothermal facilities do not manage large amounts of hazardous materials. All projects would have to comply with state and federal requirements pertaining to the use, storage, transport, and disposal of debris and hazardous materials and wastes; thereby minimizing cumulative impacts. There is a potential for hazardous waste spills (fuel, drilling muds, etc.), but the spills would be contained through use of lease terms and BMPs and would not be at a large enough geographic scale as to cumulatively combine with hazardous spills that could occur with other projects.

5.5 What Unavoidable Adverse Impacts might be Caused by Designating Lands for Geothermal Potential and Amending Land Use Plans?

Designating lands for geothermal leasing potential and amending land use plans would not result in any unavoidable adverse impacts. Subsequent development and operation of geothermal facilities could have such impacts. These would be assessed during the permitting review process and on a site-specific basis. If geothermal leases were developed, the following general adverse impacts would be expected:

- Long-term loss of vegetation, habitat, and soil. The BMPs and stipulations in the PEIS would minimize these effects.
- Short-term and intermittent noise impacts from construction and maintenance activities. Operations would have minimal noise impacts.
- Possible loss of some recreational opportunities from energy infrastructure, although new roads could provide access for additional recreational opportunities.
- Long-term visual impact from power plants and infrastructure.
- Short-term impact to ground water during drilling and before well casing, if drilling promotes a pathway between separate (e.g., deep and shallow) aquifers.

5.6 The Relationship Between Local Short-Term Uses of the Environment and Long-Term Productivity

This section discusses the relationship within each action alternative (Alternatives B and C) between the short-term use of the environment and the maintenance and enhancement of long-term productivity. For this PEIS, short term refers to the steps needed to develop a geothermal resource (exploration, drilling, testing, and construction). Generally it is during this time that the most extensive environmental impacts would occur. Long term refers primarily to the 20-30 year time frame considered within this PEIS. This time frame includes the production and utilization phase of geothermal leasing project.

The exploration and testing phase of geothermal leasing is designed to determine the nature and extent of the geothermal resources. Generally, the active portion of this phase is of short duration (less than two years). Where such exploration proves unsuccessful, these lands would not be used for subsequent development and production. Instead, these lands would be restored as much as possible to their original condition upon completing exploration and testing activities.

If geothermal activities progress beyond the exploration and testing phase into long-term productivity, the lands could be affected to a greater extent. This would depend on the degree of development (i.e., surface disturbance) and the geothermal resource potential. The short-term uses of the environment associated with the action alternatives are associated with the development (construction) activities described in Chapter 2 (under typical operations and the reasonably foreseeable development scenario) include effects to the natural environment, cultural resources, recreation, and socioeconomic resources. These short-term effects can be compared to the long-term benefits of the proposed action, such as clean, renewable energy production for a growing regional population and economy.

Over the long-term, while geothermal plants are in production, these new plants would be producing a low-cost, clean source of renewable energy for use in the project area and other western states. While in production, each plant would provide employment opportunities for citizens of surrounding communities. The sale of this new energy would be a new source of revenue for the counties within which they located. In addition, geothermal energy development offsets the use of irretrievable resources such as coal and oil, which would result in less pollution, fewer green-house gas emissions, less dependence on foreign trade, and possible reduction in the trade deficit.

5.7 What Irreversible and Irretrievable Commitment of Resources would be Involved with Implementation of the Alternatives?

This section describes the irreversible and irretrievable commitments of resources associated with implementing the action alternatives (Alternatives B or C). Resources irreversibly or irretrievably committed to a proposed action are those utilized on a long-term or permanent basis. Irreversible resource commitments occur when there is unavoidable destruction of natural resources that could limit the range of potential uses of that particular environment. Irreversible commitments apply primarily to nonrenewable resources, such as cultural resources, and also to those resources that are renewable only over long periods of time, such as soil productivity or forest health.

Irretrievable resource commitments occur when use or consumption of the resource is neither renewable nor recoverable for future use. Irretrievable commitments apply to loss of production, harvest, or use of natural resources. These include the use of nonrenewable resources such as metal, fuel, and other natural or cultural resources considered non-retrievable, in that they would be used for the proposed action when they could have been conserved or used for other purposes.

No irreversible commitments of resources would result from geothermal leasing. However, if any of the reasonably foreseeable development scenario facilities were to come on-line together in a resource area and were concentrated within a small geographical area, there could be some irreversible and irretrievable commitments of local geothermal resources. Over time, the geothermal resource temperature would decrease to the point that it would no longer be economically feasible to use as a heat source for generating electrical power. The following is a brief summary of the resources that could be expected to have irretrievable consequences:

- **Hydrology and Water Quality.** Because of the large volume and long duration of geothermal fluid production, the production stage of resource development is likely to have to the greatest potential for impact to hydrologic resources. These impacts could occur in terms of changes to the hydraulics of the geothermal and groundwater reservoirs and spent geothermal fluid disposal. Hydraulic head pressures in the geothermal and adjacent groundwater reservoirs could change during production. The result could include reduction in spring discharge rates and lowering of water levels in wells. Disposal of spent fluids by injection could also affect hydraulic heads and could introduce low-quality fluids to groundwater pathways that discharge at springs or wells. This could also affect the quality of available water. Surface disposal of spent fluids could create large pools of low-quality water. Changes in spring flow and development of spent fluid-holding ponds could induce changes to wetlands-supported ecosystems and habitats. As a result, hydrologic impacts associated with geothermal development could have secondary impacts in the plant and animal community supported by natural or created wetlands.

- **Noxious Weeds.** Introduction of noxious weeds by construction and support vehicles into previously clean areas would be probable during all phases of geothermal development. The development phase would present the greatest opportunity for noxious weed introduction and proliferation. Once introduced, control or eradication of noxious weeds could be difficult.
- **Visual Resources.** Any changes in the characteristic landscape of the affected areas due to geothermal energy development could be visible for many years. Succession in the Basin and Range geomorphic province is very slow due to the lack of rainfall. Rehabilitation techniques could use non-indigenous plant species, thus changing the character of the area. The amount of contrast would vary by area, rehabilitation techniques, and the success of those techniques. All landscapes are unique in their own right, and any change or loss of scenic values is irretrievable. Those losses become more significant in areas of unique or outstanding scenic quality.
- **Threatened, Endangered, and Special Status Species.** Loss of any species is irretrievable. Protection of threatened, endangered, and special status species is governed by federal and state statute. To minimize the effects on threatened, endangered, and special status species, the lessee would be required to complete a site-specific NEPA analysis outlining their proposed action and alternatives, and the direct and indirect impacts of their proposed action, on any threatened, endangered, and special status species prior to any occupancy and surface disturbance.
- **Geology and Minerals.** The principle commitment of resources in implementing the proposed action would be the depletion of thermal energy and water from the geothermal reservoirs tapped for energy use. To minimize this effect, the super-hot water extracted from the subterranean geothermal reservoirs through production wells is injected back into the reservoir for reheating and reuse. Over time, these resources (heat and water) could be depleted to the point that the power generating plant would no longer be economically productive.
- **Cultural Resources.** Destruction and/or loss of cultural resources are irretrievable. Federal and state statutes govern the protection of cultural resources. To minimize the effects on cultural resources, the lessee would be required to complete a site-specific NEPA analysis outlining their proposed action and alternatives, and the direct and indirect impacts of their proposed action on the cultural resources within the lease area, prior to any occupancy and surface disturbance.

- **Hazardous Materials/Waste and Solid Waste.** If handled improperly, hazardous materials/waste and solid waste have the potential to create irretrievable consequences. The storage, use, and disposal of hazardous materials/waste and solid waste are governed by federal and state statute. To minimize the effects hazardous materials/waste and solid waste, the lessee would be required to complete a site-specific NEPA analysis outlining their proposed action and alternatives, and the direct and indirect impacts of hazardous materials/waste and solid waste associated with their proposed action, prior to any occupancy and surface disturbance.