DES 08-22

DRAFT

Programmatic Environmental Impact Statement for

Geothermal Leasing

in the Western United States

Volume III: Appendices

May 2008

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DES 08-22

DRAFT

PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR

GEOTHERMAL LEASING IN THE WESTERN UNITED STATES

VOLUME III: APPENDICES

MAY 2008

US DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

US DEPARTMENT OF AGRICULTURE
UNITED STATES FOREST SERVICE

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LIST OF ACRONYMS

ACEC - Area of Critical Environmental Concern

ADR - Alternative Dispute Resolution

ANCSA - Alaska Native Claims Settlement Act

ANILCA - Alaska National Interest Lands Conservation Act

APD - Application for Permit to Drill

AUM - Animal Unit Month

BLM - United States Department of the Interior, Bureau of Land Management

BMPs - Best Management Practices

C - Celsius

CA - Conservation Agreement

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act

CEQ - Council on Environmental Quality

CFR- Code of Federal Regulations

COAs - Conditions of Approval

CRMP - Cultural resources Management Plan

CS - Conservation Strategy

CSU - Controlled Surface Use

CX (or CE) - Categorical Exclusion

DEQ- Department of Environmental Quality

DM - Departmental Manual

DNA - Documentation of Land Use Plan Conformance and National Environmental Policy Act (NEPA) Adequacy

DN/ROD - Decision Notice/Record of Decision

DOI - Department of the Interior

DR - Decision Record (for an EA)

EA - Environmental Assessment

EFH - essential fish habitat

EIS - Environmental Impact Statement

EPAct of 2005 - Energy Policy Act of 2005 (Public Law 109-58, August 8, 2005)

ESA - Endangered Species Act

F - Fahrenheit

FACA - Federal Advisory Committee Act

FLPMA - Federal Land Policy and Management Act of 1976 (43 United States Code 1701 et seq.)

FOIA – Freedom of Information Act

FONSI - Finding of No Significant Impact

FS - United States Department of Agriculture, Forest Service

FWS - Fish and Wildlife Service

GIS - Geographic Information System

GHG – Green House Gas

GWh – Gigawatt hours

IBLA - Interior Board of Land Appeals

ITAs - Indian Trust Assets.

IMP - Interim Management Policy

IOU – Investor Owned Utilities

KGRAs - Known Geothermal Resource Areas

LAC - Limits of Acceptable Change

LUP - Land Use Plan

MFP - Management Framework Plan

MOU - Memorandum of Understanding

NEPA - National Environmental Policy Act of 1969

NFMA - National Forest Management Act of 1976

NFS - National Forest System

NGD - No Ground Disturbance

NHPA - National Historic Preservation Act

NLCS- BLM's National Landscape Conservation System

NMFS - National Marine Fisheries Service

NOA - Notice of Availability

NOAA - National Oceanographic and Atmospheric Administration

NOI - Notice of Intent

NPS - National Park Service

NRCS – National Resources Conservation Service

NREL - US DOE National Renewable Energy Laboratory National Renewable Energy Laboratory

NRHP - National Register of Historic Places

NSO - No Surface Occupancy

OSHA - Occupational Safety and Health Administration

OHV - Off-Highway Vehicle

PAC - Provincial Advisory Council

PEIS - Programmatic Environmental Impact Statement

PFYC – Potential Fossil Yield Classification

PM_{10} - Particulate Matter Less than 10 Micrometers in Diameter

$PM_{2.5}$ - Particulate Matter Less than 2.5 Micrometers in Diameter

POD - Plan of Operation and Development

Ppm - Parts per Million

RAC - Resource Advisory Council

RFD - Reasonably Foreseeable Development

RMP - Resource Management Plan

RNA - Research and Natural Area

RPS - Renewable Portfolio Standard

ROD - Record of Decision (for an EIS)

ROS - Recreation Opportunity Spectrum

ROW - Right of Way

SHPO - State Historic Preservation Office

SMS - Scenery Management System

T&E - Threatened and Endangered

TL - Timing Limitation

TMDL -Total Maximum Daily Load

US - United States

USC - United States Code

USDA - United States Department of Agriculture

US DOE - United States Department of Energy

US DOI - United States Department of the Interior

US EPA - United States Environmental Protection Agency

USGS - United States Geological Survey (USGS)

USFWS - United States DOI, Fish and Wildlife Service

VRM - Visual Resource Management

WGA - Western Governors Association

WSR - Wild and Scenic River

WSA – Wilderness Study Area

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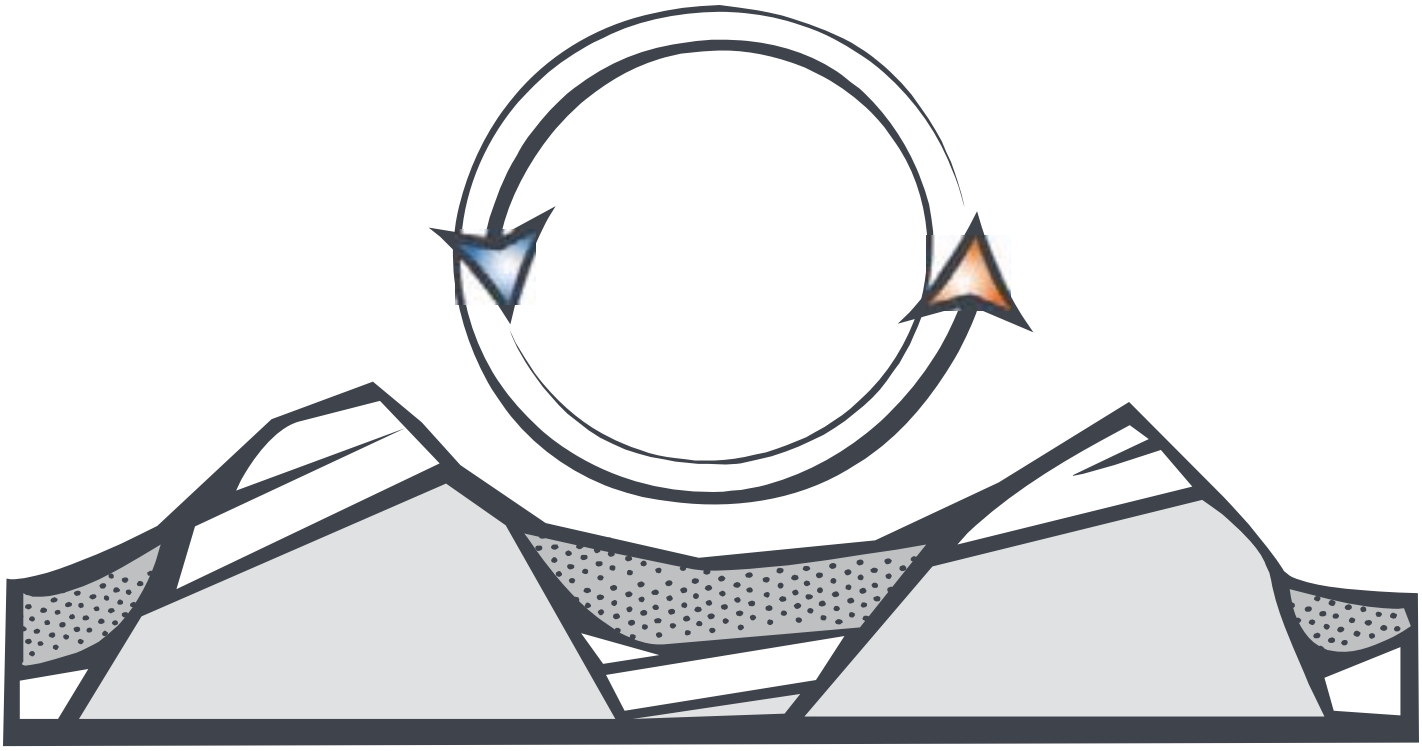

Appendix A

State of the States
State of the Tribal Lands
for Geothermal Resources and Permitting

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APPENDIX A
STATE OF THE STATES AND STATE OF THE TRIBAL LANDS FOR GEOTHERMAL RESOURCES AND PERMITTING

This appendix details the current status of geothermal resources and development for each of the 12 western states covered in this PEIS: Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming. The current state of geothermal resources is also discussed for tribal lands. Information is provided for specific tribes when available and is organized by the state in which tribal lands are located. Information includes Known Geothermal Resource Areas (KGRAs) and regions of potential geothermal resources, existing operations and current research, proposed plans for exploration and near-term development, difficulties of geothermal development relevant to each state, and state classification and agencies responsible for overseeing development. Statistics on current geothermal electrical production and estimates of potential electrical energy output per state are also included. Additional requirements and considerations for pursuing geothermal resource development on tribal lands follow the state status section.

ALASKA

Resource Geography

Alaska has four distinct geothermal resource regions: The Aleutian Volcanic Arc (which includes the Aleutian Islands as well as the Alaska Peninsula and Cook Inlet volcanoes), The Central Alaskan Hot Springs Belt (CAHSB), The Wrangell Volcanic Cluster, and The Alaskan Panhandle (Kolker 2007). The CAHSB has low to moderate temperature resources while the Aleutian Volcanic Arc holds high-temperature geothermal systems (Crimp 2006). The Wrangell Volcanic Cluster may have the potential for geothermal energy development: The Eastern Copper River Basin (ECRB), close to the western part of the Wrangell volcanoes, has been the subject of geothermal exploration because it contains mud volcanoes, unusual features associated with pressurized groundwater and/or hydrothermal aquifers. Little is known of the potential of the Alaskan Panhandle as no exploration of sites (beyond temperature measurements and aquatic geochemical surveys) has been performed (Kolker 2007).

Utilization

Initial exploration efforts occurred during the 1970s and 80's to help define resource locations but inadequate funding stalled more substantive development. Currently field investigations are on-going to characterize and further identify geothermal areas, particularly near the Chena Hot Springs Resort, where the state's only current geothermal power plant (a two-unit binary system) came on-line in 2006 providing power to the resort and as a demonstration plant. The Chena Hot Springs plant is unique in that it is capable of producing power from a low-temperature aquifer (demonstrating the recent advances made in geothermal technology) (USDOE 2007a).

Geothermal energy is not presently used for large-scale electricity production. Direct-use applications such as building heating are common throughout the state and many surface resources have been developed for recreational purposes. The most difficult challenges facing geothermal power plant development in Alaska are the remote locations of known or potential geothermal resource areas, placing potential generation facilities far from existing transmission lines and resulting in high capital costs to build power plants.. A high-temperature (above 302 degrees Fahrenheit [°F], 150 degrees Celsius [°C]) hydrothermal reservoir identified on Unalaska Island has been considered for the development of a 15 MWe (megawatts electric) power plant to supply the city of Unalaska and Dutch Harbor, one of the nation's most active seaports. In addition, the State of Alaska is proposing approximately 36,057 acres in 16 tracts on the south flank of Mount Spurr for geothermal exploration and development (Mount Spurr Geothermal Lease Sale No. 3). The area lies entirely within the Kenai Peninsula Borough, approximately 40 miles west of the village of Tyonek and about 80 west of Anchorage (Diel, 2008).

However, the challenges of transmitting the electricity over the terrain separating the energy source from the city, coupled with subsidies for diesel generation, have necessitated additional feasibility studies to implement geothermal power (USDOE 2007a).

Technical Capabilities

Alaska universities, state agencies, and private firms contribute technical capabilities to the local and national geothermal communities. The University of Alaska has participated in various research and exploration projects throughout Alaska, including the investigation of the Chena Hot Springs area (USDOE 2007a).

Electrical Power Generation and Capacity

Alaska has an installed geothermal electricity production capacity of 0.45 megawatt (MW) with a running capacity of 0.40 MW, all of which comes solely from the Chena plant. Four projects are in development, with a total potential capacity of 45.6-60.6 MW; 20 MW in the short-term (2015), 50 MW in the long-term (2025) (Richter 2007). The USGS estimates Alaska's geothermal resources hold the potential for 189 MW in electrical power production (USDOE 2007a).

Tribal Lands

The NANA Regional Corporation is currently conducting a Geothermal Assessment Program Feasibility Study to assess potential for power generation on Native Alaska lands in the NANA region (NANA 2007). Source: NANA regional Corp website:

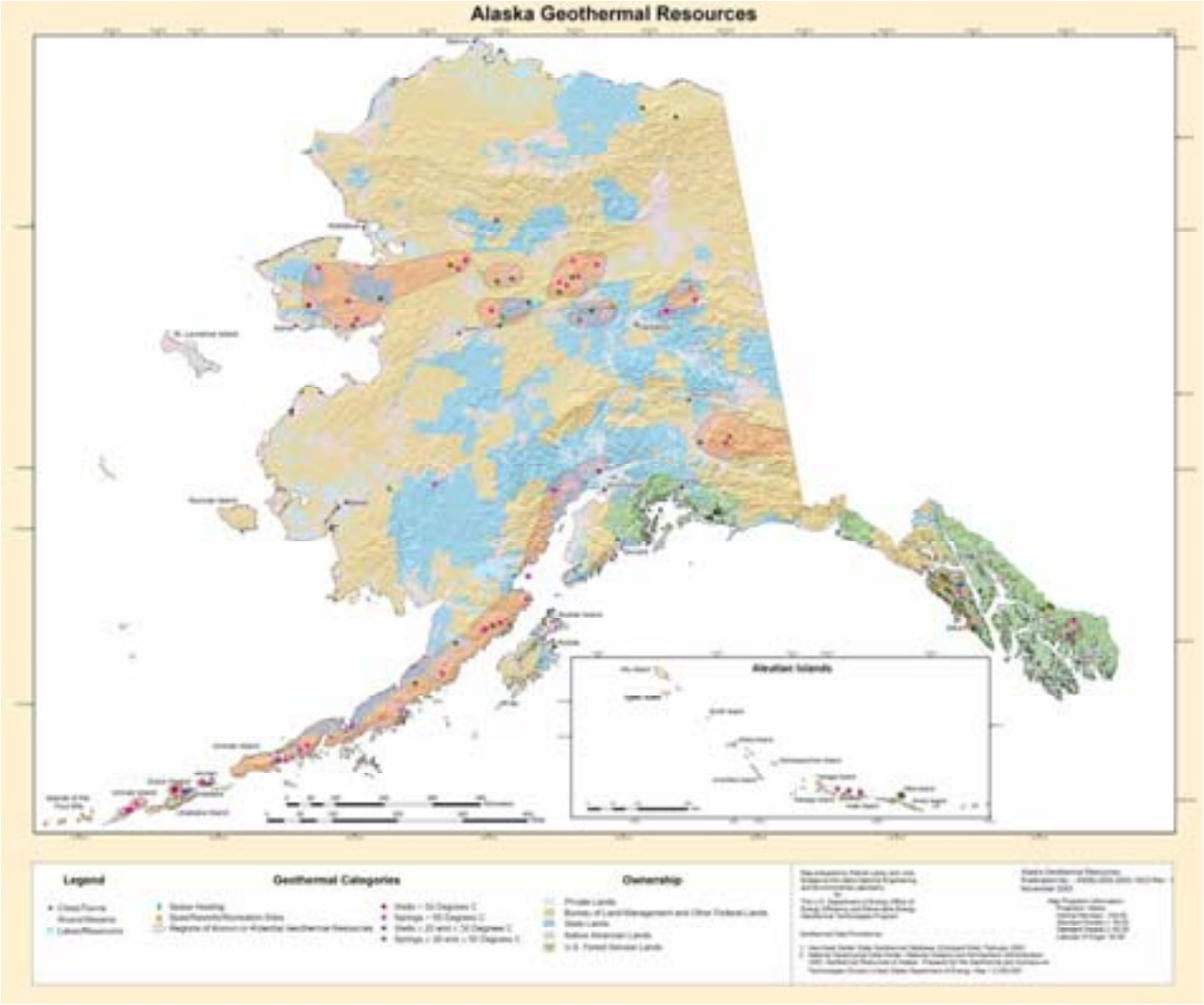
http://www.eere.energy.gov/tribalenergy/pdfs/0711review_nana.pdf

Laws and Regulations

Alaska classifies geothermal resources as Mineral (though waters below 120°C are available for appropriation as groundwater and are subject to ground water law statutes), and the state claims ownership of all geothermal resources, including those under private lands. The state gives the landowner preferential right to prospecting permits and/or leases.

The Alaska Department of Natural Resources, Division of Oil and Gas, is responsible for the development of the state's geothermal resources (Battocletti 2005). Alaska has established a Geothermal State Working Group with leadership from the Alaska Energy Authority. The Alaska group brings together state and regional energy professionals to promote the increased utilization of the state's geothermal resources (USDOE 2007a). The state presently has no renewable portfolio standard (RPS) or renewable energy standard (RES) (Richter 2007). Alaska has no state funding allocated specifically for geothermal resource development. The state has not passed greenhouse gas (GHG) reduction legislation but established a Climate Impact Assessment Committee in

2006 to examine and prepare recommendations regarding potential future GHG legislation (Camp 2007). The Alaska State Chamber of Commerce published a document in January 2008 in support of a state-wide energy policy that includes the study and development of Alaska's geothermal resources (ACC 2008).



(Laney, 2003a, http://geothermal.id.doe.gov/maps/ak.pdf)

ARIZONA

Resource Geography

High-temperature geothermal resources have yet to be discovered in Arizona; most known resources of any temperature are located south of the Colorado plateau. Three locations: Buckhorn Baths in Apache Junction, Castle Hot Springs in the Bradshaw Mountains, and Childs on the Verde River exhibit potential for geothermal resources and may warrant exploration (ADC 2008), while geothermal development plans for the counties of Cochise, Graham, Greenlee, Maricopa, Pima, Pinal, Santa Cruz and Yuma were completed in the 1970s (USDOE 2007a).

Utilization

Current development focuses on direct, recreational, and therapeutic use, particularly aquaculture, agriculture and spas. Indirect-use research is on-going: A United States (U.S.) Department of Energy (DOE) grant to drill an exploration well near Clifton Hot Springs in Greenlee County was awarded to the joint groups of Arizona Public Service (APS), Northern Arizona University, Arizona State University, New Mexico University and the Ormond Group (USDOE 2007a). The water temperature ranges from 158-180° F (302-356° C) (ADC 2008). Researchers anticipate this area has the potential to generate 20 MW of electric power (USDOE 2007a). A geothermal power plant has been in planning for several years at this site, but confirmation drilling is required before construction can begin. Northern Arizona University also received US DOE funding to perform geophysical and geochemical testing in the previously unexplored areas of San Francisco Volcanic Field (north of Flagstaff) (ADC 2008, Fleischmann 2007).

Technical Capabilities

There are several agencies, universities, and private companies assisting in the efforts to further explore Arizona's geothermal capabilities. This collaboration includes: Vulcan Power, Northern Arizona University, Arizona State University, New Mexico University, Arizona Public Service, and the Ormond Group. Northern Arizona University (NAU) is also participating in outreach efforts to educate Arizona's population regarding geothermal resources in addition to it's San Francisco research (USDOE 2007a).

Electrical Power Generation and Capacity

No geothermal plants exist in the state as of present. One project (Clifton Hot Springs) is currently in development, with a projected potential of 2-20 MW, 20 MW short-term and 50 MW long-term (Richter, A., 2007). Overall geothermal electricity generation potential for the state is estimated at five million MWh (Megawatts produced per hour)/year (Nielsen 2002).

Tribal Lands

Tribal lands in Arizona make up roughly 27 percent of the state's land. No geothermal direct use facilities are known to be operating on these lands. Those who work with tribes in Arizona assert that continued education and public involvement are essential if tribal leaders will pursue geothermal projects (Fleischmann 2007). Maps and data for geothermal resources on tribal lands in Arizona are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_arizona.html (USDOE 2007b). Tribes for which information is available are listed in table A-1 below.

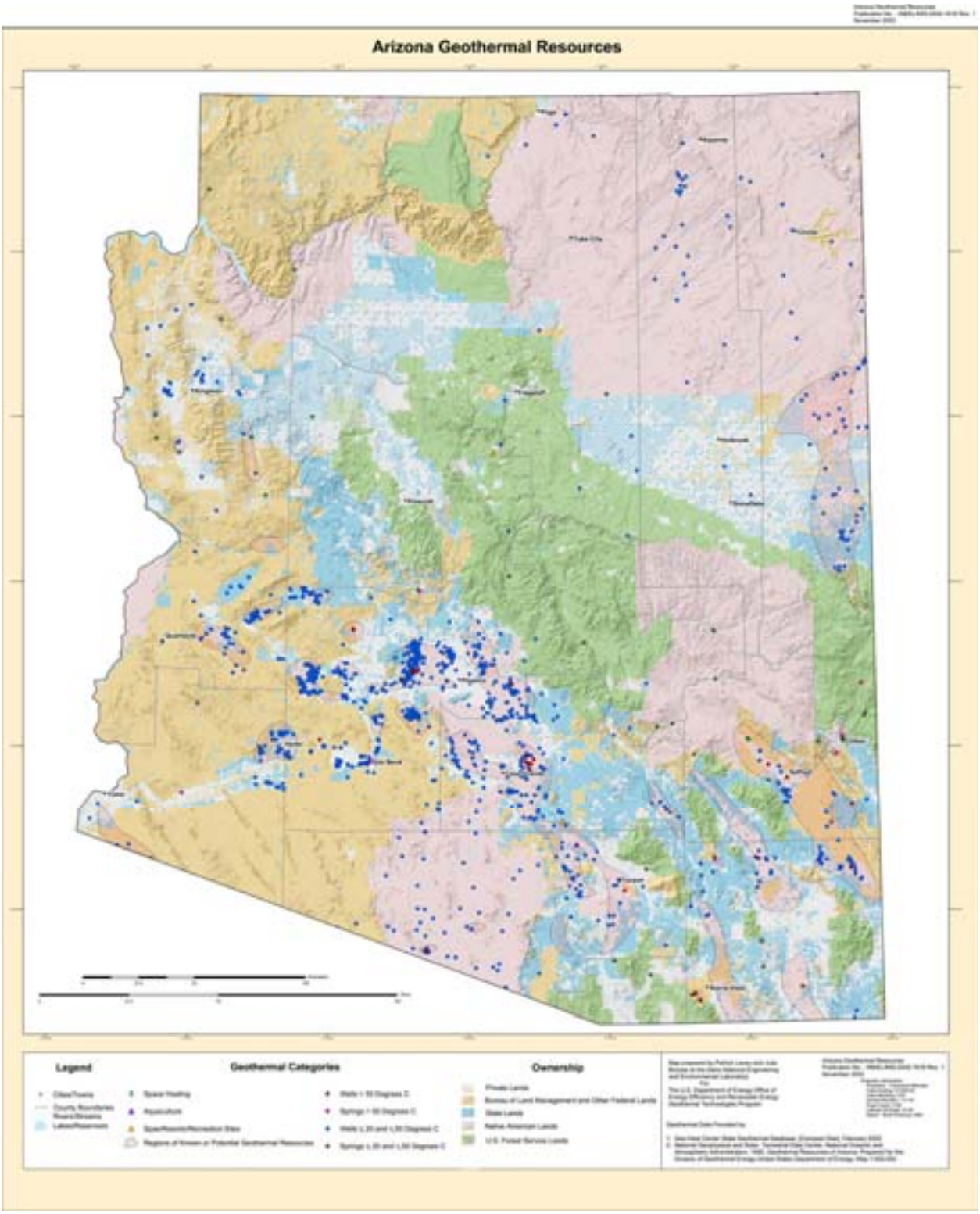
Table A-1: Tribes with Potential Geothermal Resources in Arizona
Ak Chin Indian Community of the Maricopa Indian Reservation
Kaibab Indian Reservation
Tohono O'odham Nation
Cocopah Tribe
Maricopa Indian Community of the Salt River Reservation
Tonto Apache Tribe
Colorado River Indian Tribes of the Colorado River Indian Reservation
Maricopa Indian Reservation
White Mountain Apache Tribe of the Fort Apache Reservation
Fort Apache Reservation
Navajo Nation:
Four Corners Region lands (Northeast Arizona, Northwest New Mexico, and Southeast Utah)
North Central Arizona and Central Utah lands
East Central lands in Arizona
Four Corners Region lands (Northeast Arizona, Northwest New Mexico, and Southeast Utah)
Southeastern lands in Arizona
Southwestern lands in Arizona
Yavapai-Apache Nation
Fort McDowell Yavapai Nation of the Fort McDowell Indian Reservation
Paiute Indians of the Kaibab Indian Reservation
Yavapai-Prescott Tribe of the Yavapai Reservation
Fort Mojave Indian Tribe
Pascua Yaqui Tribe
Fort Yuma Indian Reservation
Quechan Tribe of the Fort Yuma Indian Reservation
Gila River Indian Community of the Gila River Indian Reservation
Salt River Pima -Maricopa Indian Community of the Salt River Reservation
Havasupai Tribe of the Havasupai Reservation
Salt River Reservation
Hopi Tribe of Arizona:
San Carlos Apache Tribe of the San Carlos Reservation
Northern lands
Eastern lands
Southwestern lands
Hualapai Indian Tribe of the Hualapai Indian Reservation:
San Juan Southern Paiute Tribe
Northern lands
Southern lands

Laws, Regulations, and Incentives

The State of Arizona classifies geothermal resources as *sui generis,* indicating that they are not covered by a 'Use Class' – effectively in a class of their own. The state claims ownership of all geothermal resources on state lands, and reserves the right to lease or withhold these state lands for the purpose of leasing (Battocletti 2005).

Several state agencies are involved with any potential geothermal project: The Arizona Department of Environmental Quality (DEQ) is responsible for the disposal of waters associated with geothermal projects. The State Department of Water resources must be consulted to obtain well construction permits and to secure water rights, and the Department of Commerce Community Planning Office should be contacted regarding planning and zoning issues across the state (Battocletti 2005). Arizona's Geothermal Working Group has established two primary tasks: collecting data on all of the current state geothermal applications and documented resources, and identifying future energy development activities that will be the most beneficial to the state (USDOE 2007a).

Arizona has set a RPS of seven percent by 2017 and 15 percent by 2025 (60 percent of which will come from solar and 30 percent of which will be distributed energy). The RPS for geothermal electrical and geothermal heat pumps is 15 percent by 2025 (Richter 2007). There is currently no state funding or incentive for geothermal development (U.S. Department of Energy, 2007). The state has GHG reduction targets aiming for year 2000 GHG levels by 2020 and 50 percent below 2000 levels by 2040, and is considering legislation to set these targets (Camp 2007).



(Laney 2003b, http://geothermal.id.doe.gov/maps/az.pdf)

CALIFORNIA

Resource Geography

California has several high potential geothermal areas, and much of the state, with exception of the Central Valley and the far northwest corner, displays potential for geothermal resources (USDOE 2007), 25 known geothermal resource areas exist in the state, (CEC 2008) including north of Santa Rosa at the Geysers, in the northeastern part of the state, in the Owens Valley and eastern Sierras, the Mojave Desert, and at the Salton Sea and Imperial Valley in Southern California (CDC 2008, CEC 2008, USDOE 2007a).

Utilization

California currently leads the nation and world in geothermal electricity generation, with seven percent of the state's total power production output coming from geothermal resources (USDOE 2007a). Six counties produce geothermal resources hot enough for electrical power generation (CDC 2008). The state has over 600 active, high-temperature geothermal wells (with fluids over 212° F, 100° C) and 230 injection wells (CEC 2008).

There are 15 electrical power projects in various stages of development (with a total MW potential of 921.3-969.3) and the Western Governor's Association Geothermal Task Force projects up to 2,400 MW of additional power production capacity for potential near-term development (Richter 2007). Direct use of geothermal power in California is expanding and consists of aquaculture, agriculture, recreation, and food dehydration (CDC 2008). The largest concentration of geothermal aquaculture facilities in the US is in Imperial Valley (Rafferty 1999).

Technical Capabilities

California universities, state agencies, and private firms contribute technical capabilities to the local and national geothermal communities. The California Energy Commission maintains databases of geothermal resource information, and produces numerous reports on state resources and development opportunities (USDOE 2007a).

Electrical Power Generation and Capacity

Approximately 40 percent of total world-wide geothermal plant production takes place in California, largely due to the presence of The Geysers, a collection of 41 geothermal power plants located north of San Francisco, which is the world's largest producer of geothermal power. Additional plants are located in the Imperial Valley (east of San Diego), at Coso Hot Springs near Ridgecrest, at Amedee/Wineagle near Susanville, and at the Mammoth Lakes area in Long Valley (USDOE 2007a).

California has a literature-cited installed geothermal power capacity of 2,492.10 MW with a current running capacity of 2030.47 MW. 14, 379 GWh (gigawatt

hour) of geothermal energy is produced annually from 49 plants (composed of 67 units total). These plants include binary, dry steam, single flash, double flash, dual flash, hybrid-biomass/geothermal and dry team-low pressure reaction types (Richter 2007) and include sites at Amedee, Casa Diablo, East Mesa, Glass Mountain, Heber, Honey Lake and Salton Sea, in addition to those previously mentioned (USDOE 2007a). The same literature cites short-term projected geothermal electricity generation potential for the state as 2,375 MW, with long-term as 4,703 MW (Richter 2007), while other literature estimates the state overall electricity generation potential at 59 million MWh/year (Nielsen 2002). Recently, development has been limited or stalled by transmission issues and delays resulting from federal and state permitting regulations. However, geothermal power production capacity is increasing in California (Fleischmann 2007).

Tribal Lands

Maps and data for geothermal resources on tribal lands in California are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_california.html (USDOE 2007c).Tribes for which information is available are listed in table A-2 below.

Table A-2: Tribes with Potential Geothermal Resources in California

Agua Caliente Band of Cahuilla Indians of the Agua Caliente Indian Reservation	Alturas Indian Rancheria of Pit River Indians
Auburn Rancheria	Augustine Band of Cahuilla Mission Indians
Barona Reservation	Bear River Band of the Rohnerville Rancheria
Benton Paiute Reservation	Berry Creek Rancheria of Maidu Indians
Big Lagoon Rancheria of Smith River Indians	Big Pine Band of Owens Valley Paiute Shoshone Indians
Big Sandy Rancheria of Mono Indians	Big Valley Band of Pomo Indians of the Big Valley Rancheria
Bishop Reservation	Blue Lake Rancheria
Bridgeport Paiute Indian Colony	Buena Vista Rancheria of Me-Wuk Indians
Cabazon Band of Cahullia Mission Indians of the Cabazon Reservation	Cahuilla Band of Mission Indians of the Cahuilla Reservation
Cahto Indian Tribe of the Laytonville Rancheria	California Valley Miwok Tribe (formerly the Sheep Ranch Rancheria of Me-Wuk Indians)
Campo Band of Diegueno Mission Indians of the Campo Indian Reservation	Capitan Grande Band of Mission Indians of the Barona Reservation
Capitan Grande Band of Mission Indians of the Viejas Reservation	Cedarville Reservation of Northern Paiute Indians
Chemehuevi Indian Tribe of the Chemehuevi Reservation	Cher-Ae Heights Indian Community of the Trinidad Rancheria
Chicken Ranch Rancheria of Me-Wuk Indians	Chico Rancheria
Cloverdale Rancheria of Pomo Indians	Coast Indian Community of Yurok Indians of the Resighini Rancheria(See Resighini Rancheria)
Cold Springs Rancheria of Mono Indians	Colorado River Indian Tribes of the Colorado River Indian Reservation
Colusa Rancheria	Cortina Indian Rancheria
Coyote Valley Band of Pomo Indians	Cuyapaipe Community of Diegueno Mission Indians of the Cuyapaipe Reservation
Death Valley Timbi-Sha Shoshone Band	Dry Creek Rancheria of Pomo Indians
Elem Indian Colony of Pomo Indians of the Sulphur Bank Rancheria	Elk Valley Rancheria

Table A-2: Tribes with Potential Geothermal Resources in California	
Enterprise Rancheria of Maidu Indians	Fort Bidwell Indian Community of Paiute Indians
Fort Independence Indian Community of Paiute Indians	Fort Mojave Indian Tribe
Fort Yuma Indian Reservation	Greenville Rancheria of Maidu Indians
Grindstone Creek Rancheria of Wintun-Wailaki Indians	Guidiville Rancheria
Hoopa Valley Tribe	Hopland Band of Pomo Indians of the Hopland Rancheria
Inaja Cosmit Band of Diegueno Mission Indians of the Inaja and Cosmit Reservation	Jackson Rancheria of Me-Wuk Indians
Jamul Band of Mission Indians, Jamul Indian Village	Karuk Tribe
Kashia Band of Pomo Indians of the Stewarts Point Rancheria	La Jolla Band of Luiseno Mission Indians of the La Jolla Reservation
La Posta Band of Diegueno Mission Indians of the La Posta Indian Reservation	Lone Pine Paiute Shoshone Reservation
Los Coyotes Band of Cahuilla Mission Indians of the Los Coyotes Reservation	Lytton Band of Pomo Indians at the Lytton Rancheria
Manchester Band of Pomo Indians of the Manchester-Point Arena Rancheria	Manzanita Band of Diegueno Mission Indians of the Manzanita Reservation
Mechoopda Indian Tribe of Chico Rancheria	Mesa Grande Band of Diegueno Mission Indians of the Mesa Grande Reservation
Middletown Rancheria of Pomo Indians	Mooretown Rancheria of Maidu Indians
Morongo Band of Cahuilla Mission Indians of the Morongo Reservation	North Fork Rancheria of Mono Indians
Paiute-Shoshone Indians of the Bishop Community of the Bishop Reservation	Pala Band of Luiseno Mission Indians of the Pala Reservation
Paskenta Band of Nomlaki Indians (see Grindstone Creek Rancheria)	Pauma Band of Luiseno Mission Indians of the Pauma and Yuima Reservation
Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation	Picayune Rancheria of Chukchansi Indians
Pine Community of the Lone Pine Reservation	Pinoleville Band of Pomo Indians
Pit River Tribe:	Big Bend, Montgomery Creek, and Roaring Creek Rancherias
XL Ranch and Likely and Lookout Rancherias	
Quartz Valley Indian Community of the Quartz Valley Reservation	
Ramona Band or Village of Cahuilla Mission Indians	Potter Valley Rancheria of Pomo Indians
Redwood Valley Rancheria of Pomo Indians	Quechan Tribe of the Fort Yuma Indian Reservation
Rincon Band of Luiseno Mission Indians of the Rincon Reservation	Redding Rancheria
Rohnerville Rancheria	Resighini Rancheria (formerly known as the Coast Indian Community of Yurok Indians of the Resighini Rancheria)
Rumsey Indian Rancheria of Wintun Indians	Robinson Rancheria of Pomo Indians
San Pasqual Band of Diegueno Mission Indians	Round Valley Indian Tribes of the Round Valley Reservation (formerly known as the Covelo Indian Community)
Santa Rosa Band of Cahuilla Mission Indians of the Santa Rosa Reservation	San Manuel Band of Serrano Mission Indians of the San Manuel Reservation
Santa Ysabel Band of Diegueno Mission Indians of the Santa Ysabel Reservation	Santa Rosa Indian Community of the Santa Rosa Rancheria
Sherwood Valley Rancheria of Pomo Indians	Santa Ynez Band of Chumash Mission Indians of the Santa Ynez Reservation
Smith River Rancheria	Sheep Ranch Rancheria of Me-Wuk Indians (See California Valley Miwok Tribe)
Stewarts Point Rancheria	Shingle Springs Band of Miwok Indians, Shingle Springs Rancheria (Verona Tract)
Sycuan Band of Diegueno Mission Indians	Soboba Band of Luiseno Mission Indians of the Soboba Reservation
Wiyot Tribe Table Bluff Reservation	Susanville Indian Rancheria of Paiute, Maidu, Pit River & Washoe

Table A-2: Tribes with Potential Geothermal Resources in California

	Indians
Torres-Martinez Band of Desert Cahuilla Mission Indians	Trinidad Rancheria
Tuolumne Band of Me-Wuk Indians of the Tuolumne Rancheria	Table Mountain Rancheria
United Auburn Indian Community of the Auburn Rancheria	Tule River Indian Tribe of the Tule River Reservation
Utu Utu Gwaitu Paiute Tribe of the Benton Paiute Reservation	Twenty-Nine Palms Band of Mission Indians (Chemehuevi)
Washoe Tribe of Nevada and California of the Woodfords Community	Upper Lake Rancheria
Viejas Reservation	Yurok Tribe of the Yurok Reservation

Laws, Regulations and Incentives

California classifies geothermal resources as Mineral, and claims ownership of these resources where they occur on state-owned land, otherwise the resource is the property of the owner of the mineral estate.

Permits for siting of power plants greater than or equal to 50 MW on all lands, including federal lands, are issued by the California Energy Commission. The Division of Oil, Gas, and Geothermal Resources is the lead agency for the environmental review of exploratory wells (excluding Imperial County) and permits the drilling, operation, plugging and abandonment of all production and injection wells. The local authority is the lead agency for the environmental review of developmental wells, pipelines and power plants generating less that 50 MW (Battocletti 2005). California has established a Geothermal State Working Group with leadership from the California Energy Commission. The California group brings together state and regional energy professionals for workshops and other outreach activities. A geothermal industry summit was held in Sacramento in 2004, during which geothermal stakeholders examined opportunities for further development in relation to California's RPS legislation, as well as grid interconnection and industry partnership topics (USDOE 2007a).

The state's RPS requires ten percent renewable energy by 2010, with a minimum of one percent over the previous year for 2004-2010. The RPS mandates geothermal electric growth of one percent by year, at least 20 percent by 2010 and a long-term goal of 33 percent by 2020 (Richter 2007). The state offers supplemental energy payments applicable to geothermal power plants through its RPS as well as energy efficiency rebates (USDOE 2007a). In 2006 California passed a GHG law setting reduction targets of 1990 levels by 2020 and 80 percent below 1990 levels by 2050. The state requires a performance standard for electricity generation and sales of 1,100 lbs. of CO_2 per MWh (Camp 2007).

(CDC 2002, ftp://ftp.consrv.ca.gov/pub/oil/maps/Geothermal/MapS-11.pdf)

COLORADO

Resource Geography

Expert opinion suggests Colorado has a large geothermal resource base, although development in the state has been limited to direct-use applications (USDOE 2007a). When last inventoried in 1993, Colorado had 59 sites with water temperatures above 95° F (35° C) and 34 geothermal wells (CGS 2007). High-temperature resources exist at greater depth beneath most of the mountainous regions of the state (CGS 2007, CSWG 2007, USDOE 2007a). From preliminary heat flow and geothermal gradient maps, several areas can be identified that have potential for geothermal power generation. These locations include the Mt. Princeton area near Buena Vista, the Waunita Hot Springs area in southeast Gunnison County, the San Luis Basin especially along its margins, the San Juan Mountains near Ouray and Rico, Pagosa Springs, the Raton Basin west of Trinidad, and possibly an area near Somerset. Also, past geothermal and geochemistry studies at hot springs in the Steamboat Springs area indicate geothermal resources at depth may have temperatures above 250° F (121° C). Oil and gas development has also indicated geothermal resource potential in both the Denver and San Juan Basins (CSWG 2007).

Utilization

Geothermal electric power has not historically been considered competitive given low energy prices in the state. Thus further exploration and analysis is needed to characterize known geothermal prospects and determine what would be needed for development. As suggested above, some resources may require deep drilling, while small power units similar to the plant at Chena Hot Springs in Alaska may be applicable in some locations (Fleischmann 2007). Current plans for development continue to focus on direct-use, particularly for recreation, therapeutic properties and aquaculture. Several unique aquaculture-related projects are currently in operation, i.e. alligator farms (Clutter 2001).

Technical Capabilities

Colorado universities, state agencies, and private firms contribute technical capabilities to the local and national geothermal communities. The Colorado Geological Survey has conducted and published various assessments of the state's geothermal resource base, while the National Renewable Energy Laboratory in Golden, Colorado is the nation's leading institution for the research and development of renewable energy technologies, including geothermal energy (USDOE 2007a). Currently the Colorado Geological Survey is compiling a Colorado-specific geothermal database, which will be used to create an updated and more detailed state-wide heat flow map and geothermal gradient map (CSWG 2007).

Electrical Power Generation and Capacity

No geothermal power plants are currently proposed for the state, but literature cites short-term geothermal potential as 20 MW, with long-term as 50 MW.

The literature reports a range of potential capacity for geothermal electricity generation from 0-780 MW (Richter 2007). The Colorado Geological Survey reports that the state displays a number of criteria for geothermal power potential, including quarternary volcanoes and fault lines, and one of the highest high flows in the US. Studies indicate that Colorado may have some of the best high-temperature resources in the country for extraction via "enhanced geothermal system" or "hot dry-rock" technology (CGS 2007). (A hot dry-rock resource is deep, hot crystalline rock that can be used to generate geothermal energy by pumping water down to the rock and thus heating it before it returns to the surface) (Battocletti 2005).

Tribal Lands

Maps and data for geothermal resources on tribal lands in Colorado are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_colorado.html (USDOE 2007d). Tribes for which information is available are listed in table A-3 below.

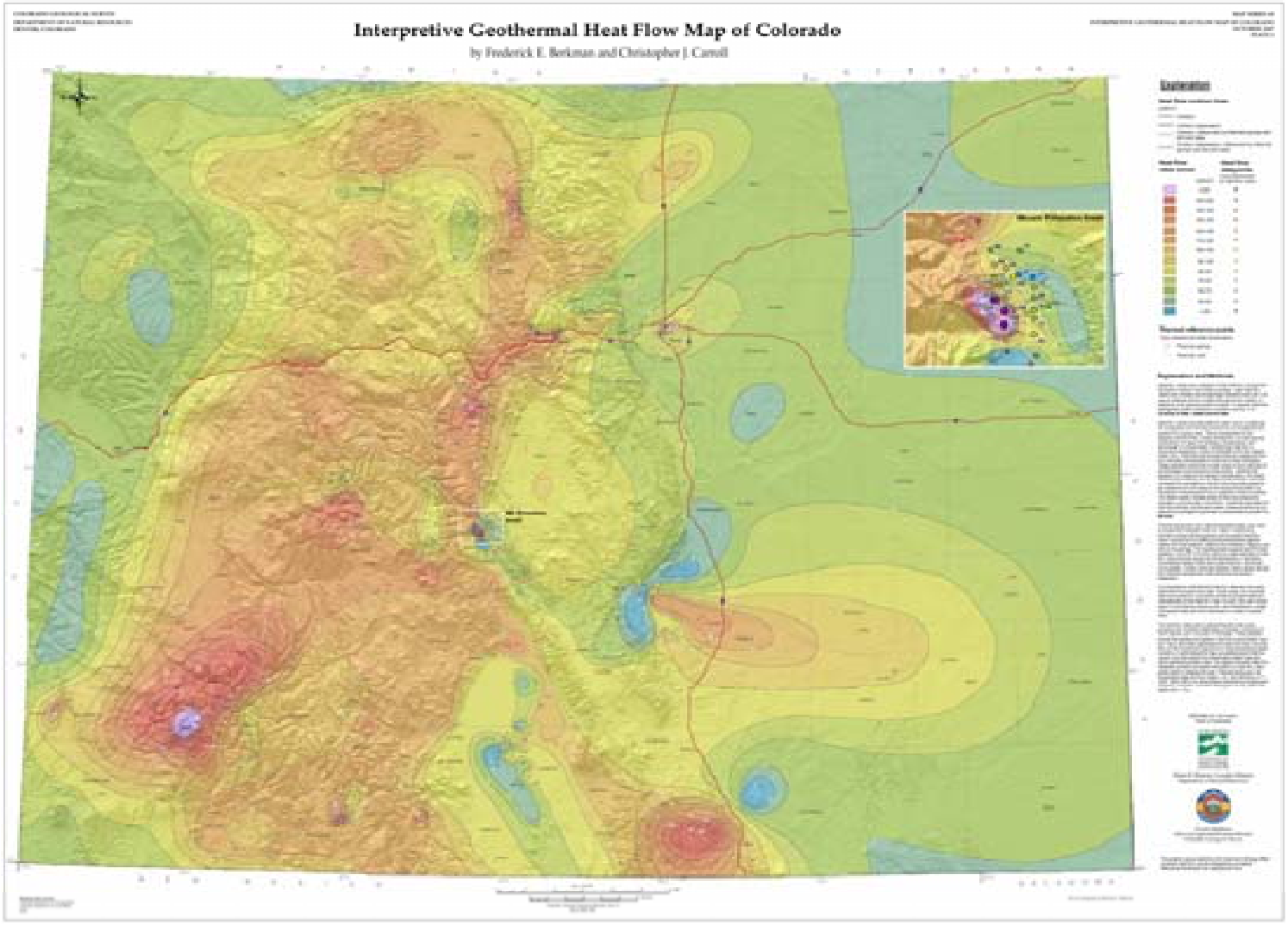
Table A-3: Tribes with Potential Geothermal Resources in Colorado
Southern Ute Indian Tribe of the Southern Ute Reservation: Main tribal lands Western-most tribal lands
Ute Mountain Tribe of the Ute Mountain Reservation

Laws, Regulations and Incentives

The State of Colorado classifies geothermal resources as Water and stipulates that geothermal resources are publicly-owned. A property right to a hot dry-rock resource is an incidence of the overlaying surface, unless several resources are transferred with the subsurface estate expressly (Battocletti 2005).

The Colorado Division of Water Resources is the lead state agency administering geothermal resource rules and regulations, as well as overseeing the permitting of injection wells. The US Environmental Protection Agency (EPA), Region 8, has primacy however, and oversees the administration of underground fluid injection wells. The state Department of Public Health and Environment's Water Quality Control Division is responsible for administering surface disposal of wastewater, including geothermal fluids (Battocletti 2005). Colorado has established a Geothermal State Working Group with leadership from Delta-Montrose Electric Association. The Colorado group is in the process of bringing together state and regional energy professionals to work together to promote the increased utilization of the state's geothermal resources (USDOE 2007a). Colorado has a RPS of 20 percent by 2020 for investor-owned utilities (IOUs) and ten percent for rural co-ops and municipality utilities (four percent solar for 2007-2010 for IOUs only) (Richter 2007). Outside of the RPS the state offers no incentives for geothermal

development and no funding is available at the state level for development (USDOE 2007a). Presently Colorado has no GHG laws or legislation pending, but does participate in the National Climate Registry (Camp 2007).



(CGS 2007b, http://geosurvey.state.co.us/Default.aspx?tabid=484 .)

IDAHO

Resource Geography

Idaho has both low-temperature geothermal sources for potential direct-use and high-temperature sites (concentrated in the southern part of the state) that may provide opportunities for electricity production (Crimp 2006).

Utilization

Current development focuses on community heating though construction of the state's first geothermal power generation facility, a 10-megawatt plant at Raft River (approximately 200 miles southeast of Boise), was completed in January 2008. (USDOE 2007a, USGI 2008).

Past exploration and development efforts have been limited as low energy costs and the small size of the state's population did not necessitate new sources of electric power. Thus further exploration and characterization of Idaho's geothermal resources is needed to better define the state's resource potential (Fleischmann 2007). In addition to Raft River, three other sites are currently being investigated for potential electricity generation: the China Cap site in Caribou County (with a literature-estimated capacity of 100 MW), an area near Willow Springs (which has a literature estimated-capacity of 100 MW) (USDOE 2007a) and a site at Crane Creek, in western Idaho (with a literature-estimated value of 100-179 MW) (Neely 2007).

Technical Capabilities

The Idaho National Laboratory houses national expertise in the research and development of geothermal energy resources. The laboratory maintains databases of geological characteristics to aid in the characterization and development of geothermal reservoirs nationwide. Additionally, the Energy Division of the Idaho Department of Water Resources provides technical support for geothermal projects in the state and conducts educational outreach activities to promote further geothermal development (USDOE 2007a).

Electric Power Generation and Capacity

Four projects are in development, with a total literature-estimated MW potential of 39-239. Literature-cited potential energy production from geothermal resources places estimates at 855 MW short-term and 1,670 long-term (Richter 2007) with an overall electricity generation potential between 366-5 million MW, depending on development scenarios (USDOE 2007a).

Tribal Lands

Tribal lands in Idaho make up roughly 1.1% of the state's land. The largest reservation is the Fort Hall Reservation north of Pocatello where potential for geothermal resource development has been suggested by research in the area (Fleischmann 2007). Maps and data for geothermal resources on tribal lands in Idaho are available through the DOE tribal energy program at:

http://www1.eere.energy.gov/tribalenergy/guide/geo_idaho.html (USDOE 2007e). Tribes for which information is available are listed in table A-4 below.

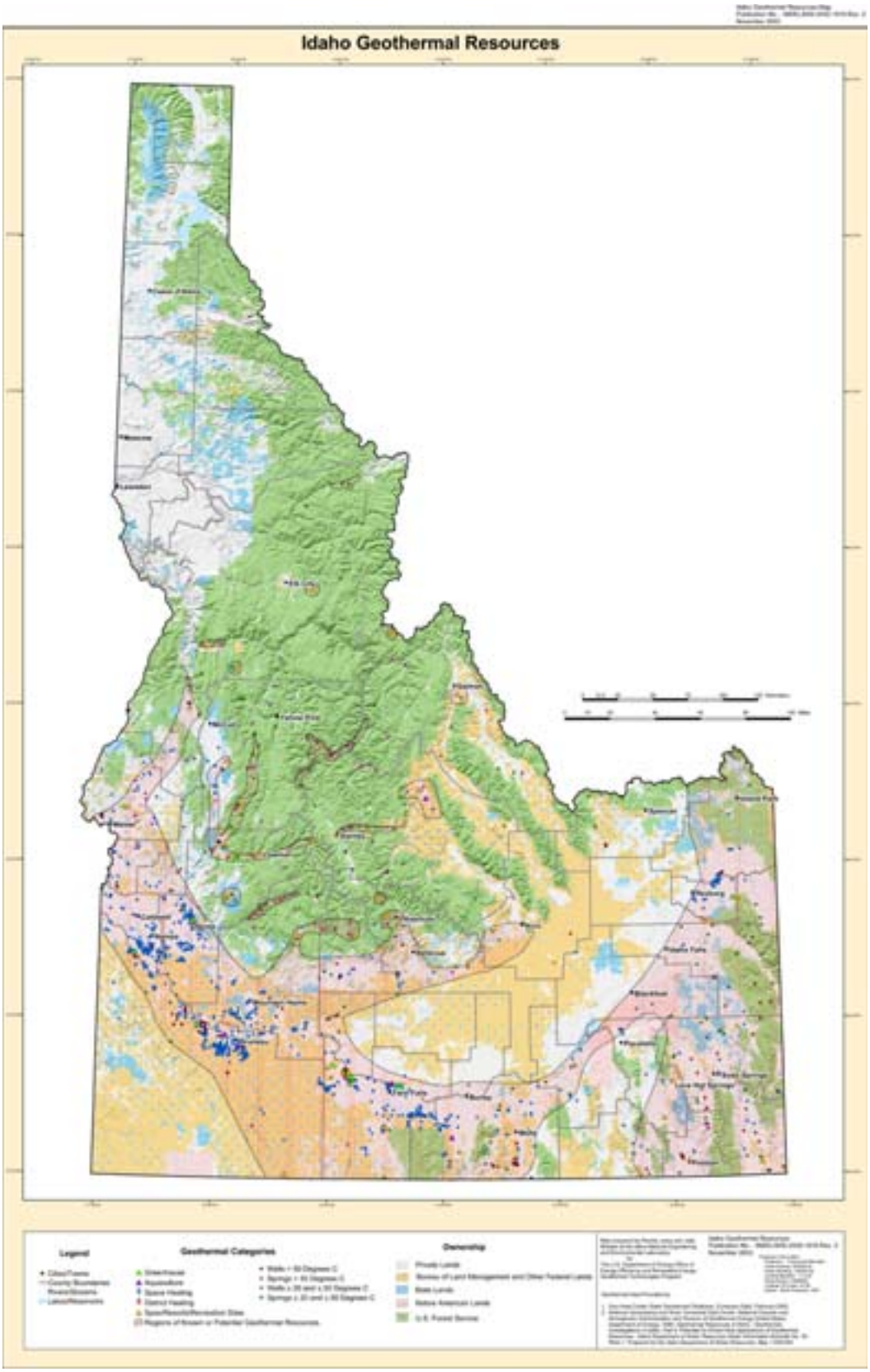
Table A-4: Tribes with Potential Geothermal Resources in Idaho
Coeur D'Alene Tribe of the Coeur D'Alene Reservation
Duck Valley Reservation
Fort Hall Reservation
Kootenai Tribe
Nez Perce Tribe
Shoshone-Bannock Tribes of the Fort Hall Reservation
Shoshone-Paiute Tribes of the Duck Valley Reservation

Laws, Regulations and Incentives

Idaho classifies geothermal resources as *sui generis* and Water. Groundwater with a temperature greater than or equal to 212°F at the well bottom fall under the category of *sui generis* and is further classified as a "geothermal resource". Groundwater between 85-212°F at the well bottom is classified as a "low temperature geothermal resource". The state claims ownership of all geothermal resources underlying state and school lands and holds the right to regulate development and use of all of the state's geothermal resources (Battocletti 2005).

The Idaho Department of Water Resources issues water rights, well-drilling permits, and injection well permits. The state's DEQ Water Quality Division is responsible for administering surface disposal of wastewater, including geothermal fluids. The Idaho Department of Lands has a process that includes permitting, bonding and royalties. The state does not have comprehensive environmental review statutes and does not coordinate permitting at the state level. Developers must obtain permits from state and local boards and agencies. The use of "geothermal resources" (as classified by the state) does not require a permit to appropriate water unless it will decrease groundwater in any aquifer or other groundwater resource, or measurably decrease groundwater available from prior water rights. The use of "low-temperature geothermal resources" requires a permit to appropriate water (Battocletti 2005). Idaho has established a Geothermal State Working Group with leadership from the Idaho Energy Division. The group organizes workshops to promote the increased utilization of the state's geothermal resources (USDOE 2007a).

Idaho currently has no RES or RPS (Richter 2007) but does offer incentives for geothermal development, including low-interest loans, and sales tax exemption for equipment used in construction of geothermal plants. Minimal state funding is allocated for geothermal development (most previous research has been federally funded) (USDOE 2007a). The state presently has no GHG laws or pending legislation. As of May 2007, the Director of Idaho Department of Environmental Quality is, by executive order, to develop GHG reduction strategies (Camp 2007).



(Laney 2003c, http://geothermal.id.doe.gov/maps/id.pdf)

MONTANA

Resource Geography

The state of Montana has more than 50 geothermal areas and at least 15 high-temperature sites. There are seven locations with surface temperatures above 149° F (65° C), plus 20 locations with temperatures above 110° F (43° C). Low- and moderate-temperature wells and springs can be found in nearly all areas of Montana (MDEQ 2008).

The US DOE and Montana state government have joined together to organize a database of locations where geothermal resources have been identified. Records show at least 15 high-temperature sites, several with estimated deep reservoir temperatures exceeding 176.7°C. Some of these sites are located in the vicinity of Helena, Bozeman, Ennis, Butte, Boulder and White Sulphur Springs (Fleischmann 2007, MDEQ 2008).

Utilization

While there are many areas in Montana with the potential to support geothermal electrical generation, development has thus far been limited to direct-use applications due to the proximity of previously proposed plans to Yellowstone National Park, an issue that created controversy and concern. Geothermal electrical development has also been overlooked in the past due to the state's low fossil fuel prices, small population, and lack of transmission access to remote locations (Fleischmann 2007).

Current development focuses on direct-use (mostly recreational and therapeutic). One private company is currently exploring the possibility of installing a small binary plant near an existing spa (Battocletti 2005).

Technical Capacities

No technical capacities are present in the state at this time.

Electrical Power Generation and Capacity

There is presently no installed geothermal electric capacity in the state. Electricity generation potential estimates are not available at this time. A recent study regarding deep oil wells at Poplar Dome Oil Field (located on the Fort Peck Indian Reservation in northeast Montana) indicated potential for generating one MW from producing oil wells or three MW by deepening and hydrofracturing unused wells (via the injection of high-pressure water into bedrock in order to increase existing bedrock fractures). This area currently produces 20,000 barrels per day of water at 130°C and there is interest in the possibility of the area supporting small geothermal power plants (USDOE 2007a).

Tribal Lands

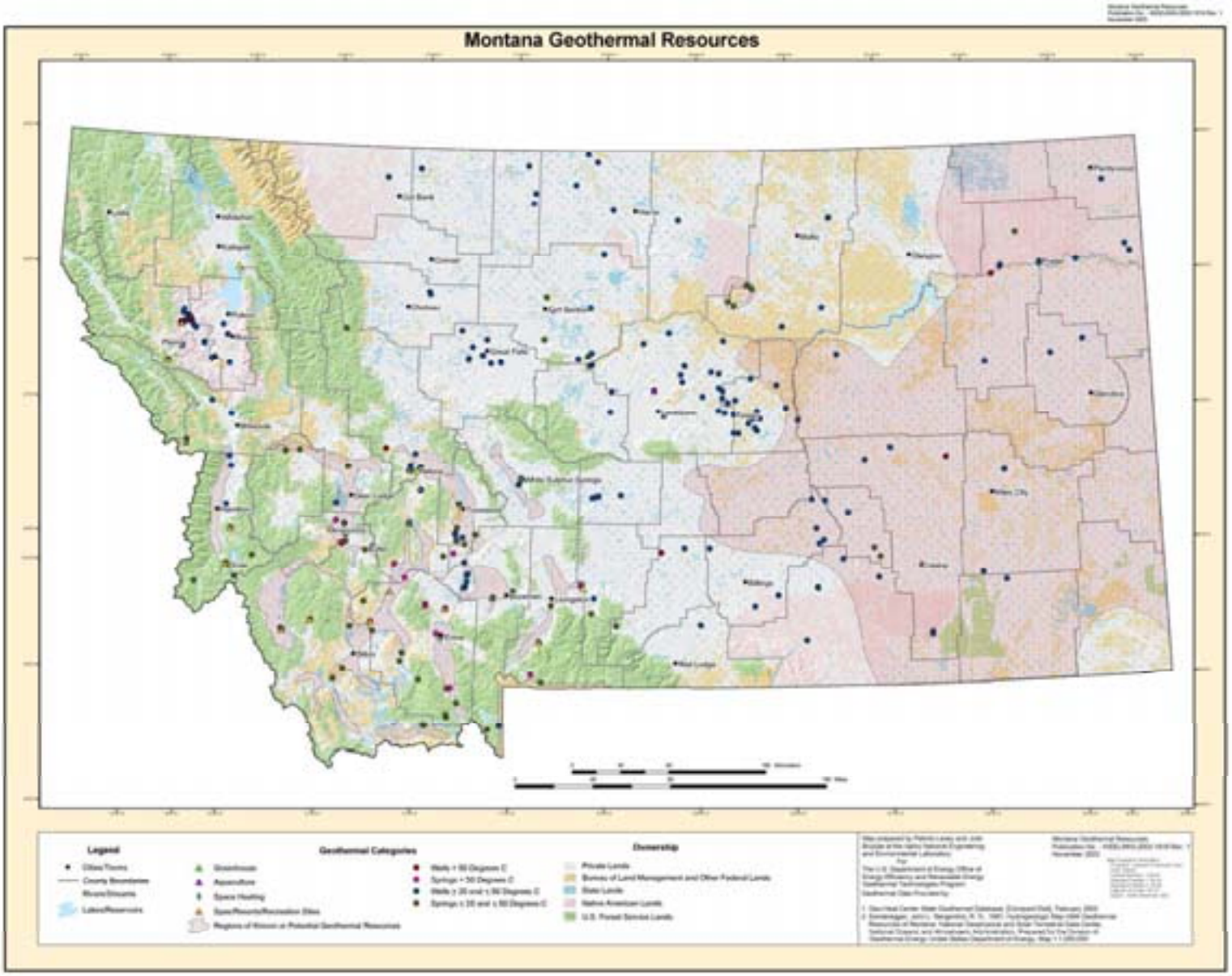
Maps and data for geothermal resources on tribal lands in Montanta are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_montatna.html (USDOE 2007f). Tribes for which information is available are listed in table A-5 below.

Table A-5: Tribes with Potential Geothermal Resources in Montana
Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation: Eastern lands Western lands
Blackfeet Tribe of the Blackfeet Indian Reservation
Chippewa-Cree Indians of the Rocky Boy's Reservation
Confederated Salish & Kootenai Tribes of the Flathead Reservation
Crow Tribe: Main tribal lands Eastern-most lands
Flathead Reservation
Fort Belknap Reservation
Fort Peck Indian Reservation: Eastern lands Western lands
Gros Ventre & Assiniboine Tribes of the Fort Belknap Reservation
Northern Cheyenne Tribe of the Northern Cheyenne Indian Reservation
Rocky Boy's Reservation

Laws, Regulations and Incentives

The state of Montana classifies geothermal resources as *sui generis* and claims ownership to geothermal resources on state lands. State water laws apply to all geothermal development involving production and diversion of geothermal fluids. Groundwater is defined by the state as a public reserve that must be appropriated (Battocletti 2005).

The Montana Department of Natural Resources and Conservation is responsible for issuing water rights and well construction permits. The US EPA, Region Eight, oversees the administration of underground fluid injection. The Montana Department of Environmental Quality (DEQ) is responsible for administering surface disposal of wastewater, including geothermal fluids (Battocletti 2005). A state Geothermal Working Group is planned for Montana (USDOE 2007). The state currently has a RPS that requires IOUs to obtain five percent of their energy from renewable sources for years 2008-2009, ten percent for 2010-2014, and 15 percent for 2015 and each year after (Richter 2007). Geothermal power plants are eligible for RPS incentives as well as tax credits, grants and loans, however no state funding is currently available specifically for geothermal development (USDOE 2007a). In May 2007, Montana passed GHG legislation prohibiting the approval of new coal generating units unless 50 percent of CO_2 emitted is captured and sequestered (Camp 2007).



(Laney 2003d, http://geothermal.id.doe.gov/maps/mt.pdf)

NEVADA

Resource Geography

High temperature (>150°C) resources suitable for electric power production are located primarily in the northwest portion of the state, while direct-use occurs state-wide, particularly in regard to food processing plants. There are several geothermal research facilities in the state and field investigations are on-going to further characterize geothermal resources (NCMR 2008, USDOE 2007a).

Utilization

Nevada is second to California in levels of geothermal electricity production. Direct use in the state consists of primarily agriculture drying and industrial applications such as mining (Lund 2003).

Technical Capabilities

Nevada universities, state agencies, and private firms contribute technical capabilities to the local and national geothermal communities. The Great Basin Center for Geothermal Energy, part of the University of Nevada at Reno (UNR), conducts geologic research and has produced a database of Nevada's geothermal resources to accelerate projects in the Great Basin region. Additionally, the UNR Redfield branch campus will feature a Renewable Energy Center for research and education in renewable energy systems (USDOE 2007a).

Electrical Power Generation and Capacity

Nevada has a current installed capacity of 297.4 MW. Literature estimates of geothermal electricity production put short-term potential at 1,488 MW and long-term potential at 2,895 MW. There are currently 15 geothermal plants (totaling 40 units) in operation in the state (NCMR 2008). A 20 MW capacity plant was commissioned at Steamboat in November 2005, the first in response to the state's RPS. Types of plants in the state include binary, single flash; double flash and combination double flash & binary (Richter 2007).

Plans include power generation in the Pumpernickel Valley, Stillwater and Salt Wells areas and within Washoe, Churchill, Humboldt and Elko counties. Power purchase contracts have already been established with local utilities for proposed power plant construction at some locations (USDOE 2007a). The manner in which Nevada has combined federal and state efforts to develop geothermal resources has been very effective and could serve as a model for other states (Battocletti 2005).

Tribal Lands

Tribal lands in Nevada make up roughly 1.7% of the state's land. There are three tribal reservations of particular interest for geothermal development opportunities. One is the Pyramid Lake Paiute Reservation located 50 miles

north of Reno where extensive exploration has been performed and development is likely within the next few years. The others are in the Walker River Paiute Reservation and the Fallon Reservation and Colony of the Paiute-Shoshone tribe. Developers have expressed interest in geothermal projects in both reservations, although no projects have yet been proposed. However, the Fallon Reservation and Colony abuts existing geothermal power facilities at Stillwater, and tribal leaders are involved in the process of the new facility currently being developed there (Fleischmann 2007). Maps and data for geothermal resources on tribal lands in Nevada are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_nevada.html (USDOE 2007g). Tribes for which information is available are listed in table A-6 below.

Table A-6: Tribes with Potential Geothermal Resources in Nevada
Confederated Tribes of the Goshute Reservation
Duck Valley Reservation
Duckwater Shoshone Tribe of the Duckwater Reservation
Ely Shoshone Tribe
Fallon Reservation and Colony
Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation
Fort Mojave Indian Tribe
Goshute Reservation
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
Lovelock Paiute Tribe of the Lovelock Indian Colony- no map available
Moapa Band of Paiute Indians of the Moapa River Indian Reservation
Paiute-Shoshone Tribe of the Fallon Reservation and Colony
Pyramid Lake Paiute Tribe of the Pyramid Lake Reservation
Reno-Sparks Indian Colony
Shoshone-Paiute Tribes of the Duck Valley Reservation
Summit Lake Paiute Tribe
Te-Moak Tribes of Western Shoshone Indians: Battle Mountain Band South Fork Band Elko Band Wells Band
Walker River Paiute Tribe of the Walker River Reservation
Winnemucca Indian Colony
Yerington Paiute Tribe of the Yerington Colony and Campbell Ranch
Yomba Shoshone Tribe of the Yomba Reservation
Washoe Tribe of Nevada and California: Carson Colony Dresslerville Community Stewart Community

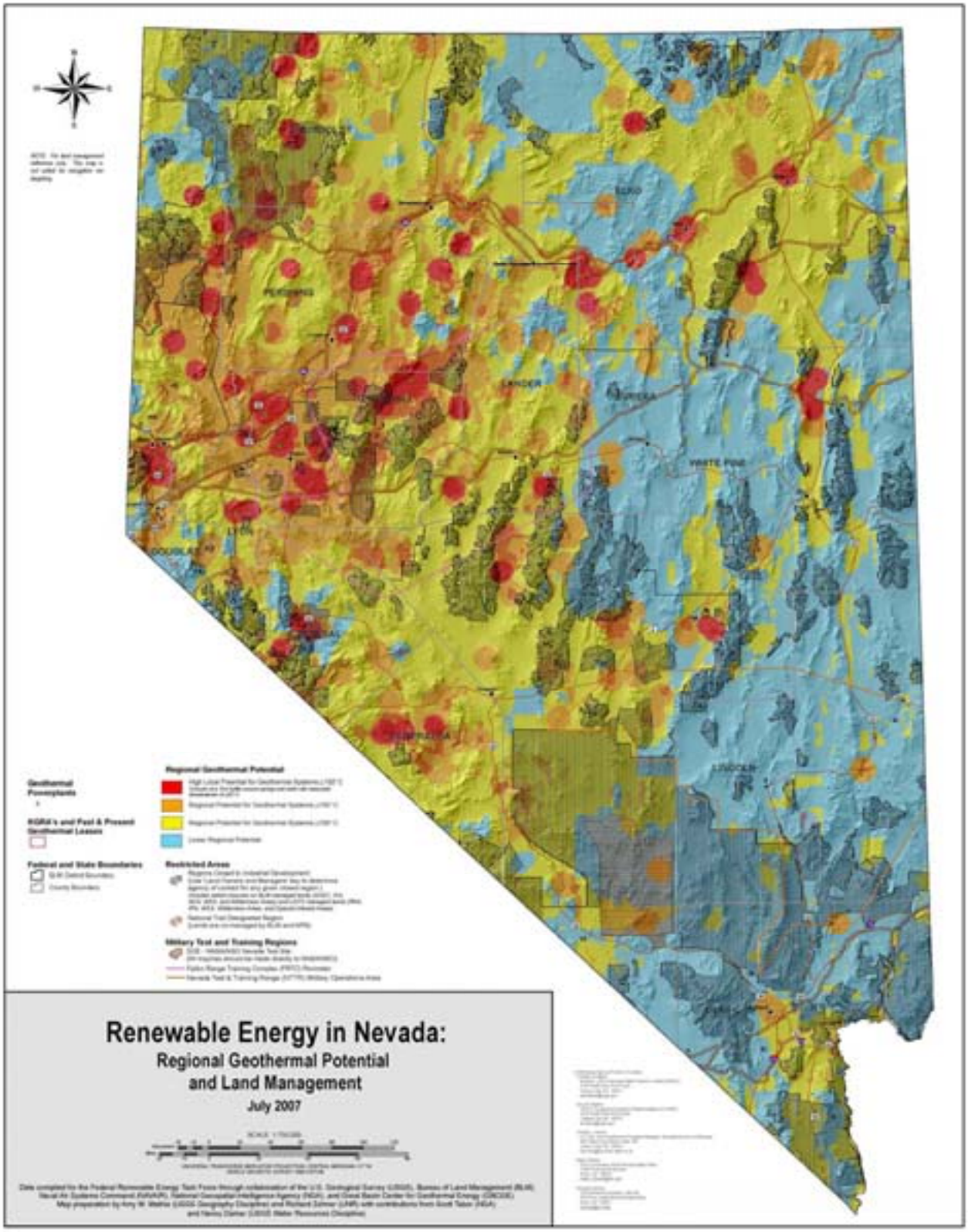
Laws, Regulations and Incentives

Nevada classifies geothermal resources as both Mineral and Water. Resources in the state belong to the owner of the surface estate unless they have been reserved by or conveyed to another individual (NCMR 2006, Battocletti 2005).

The state's lead geothermal regulatory agency is the Division of Minerals Commission on Mineral Resources, which issues permits to drill or operate geothermal wells. The length of the permitting process varies depending on well type, location and the agencies involved. Permitting for a commercial or industrial well could take 45 days whether on private or federal lands. Permitting for wells on federal land by a federal agency takes a minimum of three months; however periods of a year or more are typical. Unlike California, Idaho and the Pacific Northwest, where a number of the best geothermal prospects are located on USFS land, most of Nevada's promising resources are on federal land managed by the BLM (Battocletti 2005).

The Nevada Department of Conservation and Natural Resources Division of Water Resources are responsible for issuing water rights. The state Department of Conservation and Natural Resources Bureau of Water Pollution Control oversees the administration of underground fluid injection wells as well as the administration of surface disposal of wastewater, including geothermal fluids. The Nevada Department of Environmental Protection administers the Clean Water and Clean Air Acts (Battocletti 2005). Nevada has established a Geothermal State Working Group with leadership from the Nevada Division of Minerals-Oil, Gas and Geothermal Program. The Nevada group brings together state and regional energy professionals to promote the increased utilization of the state's geothermal resources (USDOE 2007a).

The state's RPS stipulates a requirement of 20 percent renewable energy by 2015 (solar being five percent of annual and one percent of total generation). The RPS for geothermal electric and hot water district heating systems recommends an increase of up to 20 percent by 2015 (Richter, 2007). Nevada's geothermal development is primarily federally-funded however the state offers the incentive of property-tax exemption for geothermal power plants (USDOE 2007a). Currently the state has no GHG reduction targets but is considering GHG legislation (SB422) that would require power plant emissions to be below 2006 levels for 2011-2014, below 2005 levels in 2015, one percent below each of the previous years for 2016-2019 and one an a half percent below 2019 levels for 2020 (Camp 2007).



(UNR 2007, http://www.unr.edu/Geothermal/pdffiles/NV_GEOTHERM.pdf)

NEW MEXICO

Resource Geography

New Mexico contains abundant geothermal resources throughout a large temperature gradient. (USDOE 2007a). In a recent update of the geothermal database for New Mexico, 359 discrete thermal wells and springs were identified (NMEMNRD 2007). Resources suitable for most development are concentrated in the west and north-central regions of the state, with high temperature gradients ranging from 1.6° F to 2.5° F per 100 feet in depth (NMEM 2006). There are no geothermal power plants currently operating, however, direct-use applications are on-going. The northwest region contains volcanic activity from the Valles Caldera in the Jemez Mountain Range (west of Los Alamos), where the only known high-temperature geothermal system in the state occurs (base temperatures in this system exceed 500° F, 260° C) (USDOE 2007a). During the 1970s and 1980s a large geothermal power project was under development in the Valles Caldera, however regulatory and resource issues led to the cancellation of the project (demonstration projects revealed inconsistent reservoir permeability and low productivity, though drilling and testing indicated a viable potential of 20 MW) (Fleischmann 2007).

While other potential geothermal resource areas exist, limited research has been done and most areas are without apparent surface manifestations. These areas are high-risk and developers in the state may need government funding to aid with early exploration and to reduce the high investment risk associated with their development. Sites in eight counties (Doña Ana, Grant, Hidalgo, McKinley, Rio Arriba, San Miguel, Sandoval, and Valencia), have been identified as potential geothermal resources (NMEMNRD 2007). The Rio Grande Rift area, specifically near Las Cruces, also needs to be explored in greater detail (Fleischmann 2007).

Utilization

There are no geothermal power plants currently operating, however, current development has included electric power production. An attempt to introduce geothermal electricity production occurred in the southwest at the Burgett Geothermal Greenhouses (near Cotton City), but was suspended due to design problems (NMEM 2006, USDOE 2007a). Drilling has occurred at two locations where small power units will be installed to provide electricity for an aquaculture facility and greenhouse. Other direct-use applications are on-going (USDOE 2007a).

Technical Capabilities

New Mexico universities, state agencies, and private firms contribute technical capabilities to the local and national geothermal communities. New Mexico State University (NMSU) at Las Cruces conducted geothermal research that resulted in the development of a geothermal space-heating system that at one point heated up to 30 campus buildings, such as dorms and athletic facilities.

Sandia National Laboratory in Albuquerque is one of the three main national laboratories working on geothermal R&D (USDOE 2007a).

Electrical Power Generation and Capacity

In the near-term development is likely for small-scale power. The state has two projects in development, with a total estimated potential of 21 MW. Literature estimates put geothermal electricity generation potential for short-term at 80 MW and 170 MW long-term (Richter 2007).

Tribal Lands

Tribal lands in New Mexico make up roughly 8.4% of its total acreage and several locations on tribal reservations have been identified as having potential for geothermal development. This includes tribal lands in the San Juan Basin of northwest New Mexico where considerable oil and gas drilling has occurred and intermediate-temperature fluid has been encountered. Another potential area is in the Jemez Mountains (in the vicinity of Valles Caldera). From 2002-2004, the Pueblo of Jemez worked with USDOE who cost-shared a feasibility study to install a geothermal direct use heating facility. The study concluded that there were business opportunities related to geothermal resources, but further drilling is needed before these applications can be developed on the site (Fleischmann 2007). Maps and data for geothermal resources on tribal lands in New Mexico are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_newmexico.html (USDOE 2007h). Tribes for which information is available are listed in table A-7 below.

Table A-7: Tribes with Potential Geothermal Resources in New Mexico
Jicarilla Apache Tribe of the Jicarilla Apache Indian Reservation
Mescalero Apache
Navajo Nation: Northwestern lands in New Mexico Northeastern lands in New Mexico Southwestern lands in New Mexico Southeastern lands in New Mexico Alamo Navajo Chapter Canoncito (Tohajiileeh) ChapterRamah Navajo Chapter
Pueblo of Acoma
Pueblo of Cochiti
Pueblo of Isleta
Pueblo of Jemez
Pueblo of Laguna
Pueblo of Nambe
Pueblo of Picuris
Pueblo of Pojoaque
Pueblo of San Felipe
Pueblo of San Ildefonso
Pueblo of San Juan
Pueblo of Sandia
Pueblo of Santa Ana

Table A-7: Tribes with Potential Geothermal Resources in New Mexico
Pueblo of Santa Clara
Pueblo of Santo Domingo
Pueblo of Taos
Pueblo of Tesuque
Pueblo of Zia
Pueblo of Zuni
Ute Mountain Tribe of the Ute Mountain Reservation

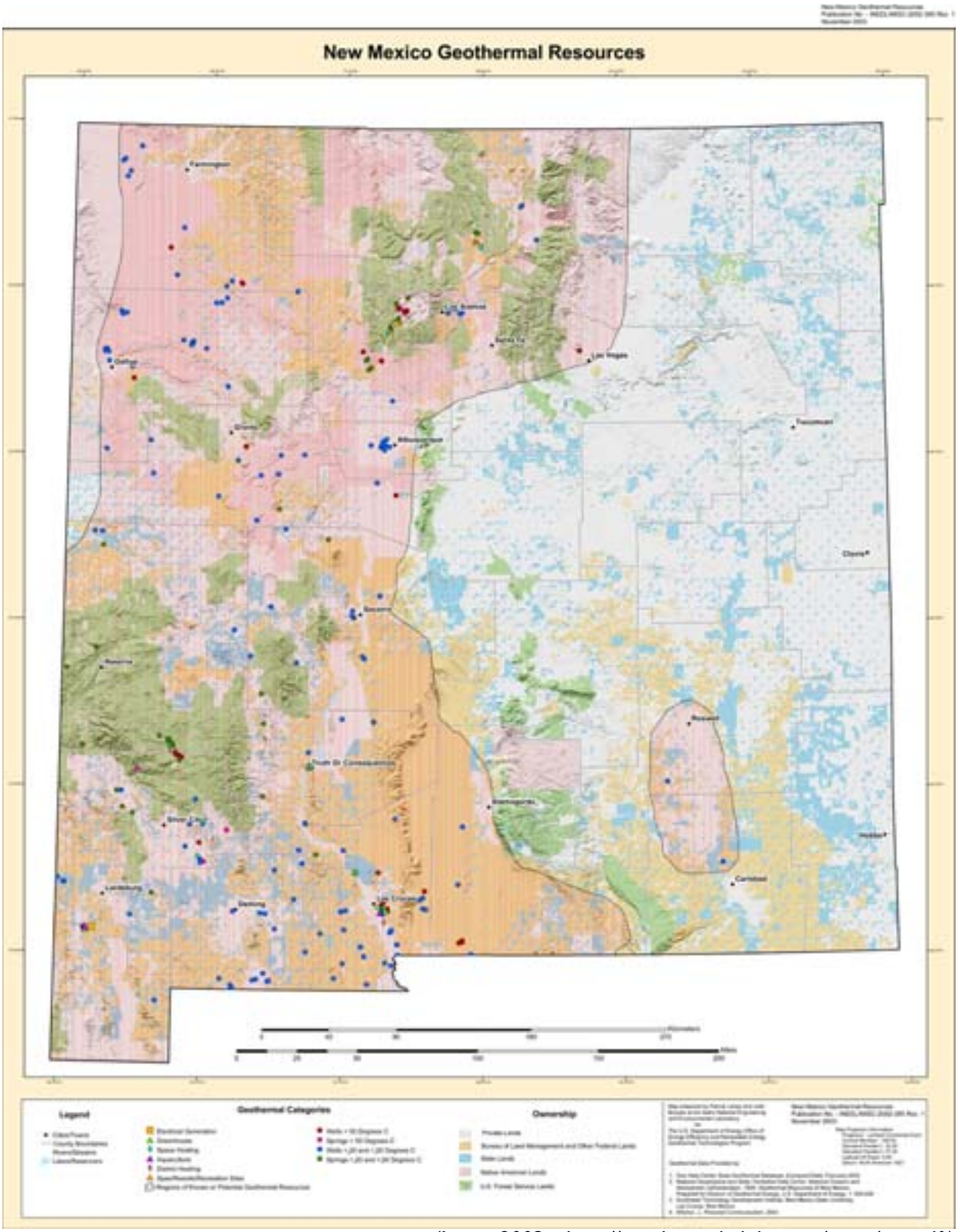
Laws, Regulations and Incentives

New Mexico classifies geothermal resources as Mineral if the fluid produced has a temperature greater than 250°F, and as Water if the fluid produced has a temperature less than or equal to 250°F. The state claims ownership of geothermal resources when and where it holds the mineral rights. If the fluid produced is "mineral", the resource is under the primary jurisdiction of the Oil Conservation Division of the New Mexico Energy, Minerals and Natural Resources Department for drilling. This agency coordinates with the US EPA, Region Eight, which has authority over wastewater discharge to surface waters in the state. Both of these latter agencies, in addition to the state Environmental Department, have regulatory authority over geothermal discharge permits. The New Mexico State Land Office leases the lands of the state mineral estate (Battocletti 2005).

Geothermal fluid under 250°F is considered "water" and the resource is under the primary responsibility of the New Mexico Office of the State Engineer in regards to drilling and permitting. New Mexico does not have comprehensive environmental review statutes.

The state's RPS requires 20 percent renewable energy by 2020 for IOUs, ten percent for rural co-ops and municipality utilities, with one Kilowatt (KW) of geothermal energy counting as two KW (Richter 2007). In addition to the state's RPS, geothermal resource development qualifies for the U.S. Department of the Interior Energy Efficiency and Renewable Energy's bond program (U.S. Department of Energy, 2007). New Mexico has established a Geothermal State Working Group with leadership from the New Mexico Energy, Minerals and Natural Resources Department (USDOE 2007a).

Presently New Mexico does not have GHG laws or pending legislation, however the state has a GHG reduction target that outlines 2000 levels by 2012, ten percent below 2000 levels by 2020, and 75 percent below 2000 levels by 2050 (Camp 2007). There is currently no state funding for geothermal development. Most funding has come from the federal level from the US DOE (USDOE 2007a).



(Laney 2003e, http://geothermal.id.doe.gov/maps/nm.pdf)

OREGON

Resource Geography

Oregon's geothermal resources are located primarily in the central and eastern regions of the state, with some activity occurring in the Cascade Range, and in the southeast basin and range areas (USDOE 2007a). The state's geothermal resource base has been well documented and numerous direct-use projects have been constructed (primarily street and building heating, and recreational and therapeutic use) (Fleischmann 2007).

Utilization

While a small-scale geothermal power plant ran in south-central Oregon in the mid-1980's, the state currently has no plants in operation (Fleischmann 2007, ODE 2008). Indirect use is being pursued and several promising resource sites have been identified. Resources that may have significant potential for power-plant development on a small scale include: Klamath Falls, Lakeview, Summer Lake, Malheur River and Vale (ODGMI 2003, USDOE 2007a). Researchers in Oregon are currently experimenting with geothermal heat and power technologies for alternative fuel production and expansions are planned for several direct-use facilities (Fleischmann 2007).

Development has and will continue to focus on direct use and further exploration of potential sites for geothermal electricity generation. While several large-scale geothermal power plants are currently under development, their success is contingent upon coordinated federal and state efforts to conduct EISs (Fleischmann 2007).

Technical Capabilities

The Oregon Institute of Technology's Klamath Falls campus houses the Geo-Heat Center, a national resource for the research and development of geothermal energy. The Geo-Heat Center aids in the transfer of technical information and provides project development support for geothermal direct-use applications (USDOE 2007a).

Electrical Power Generation and Capacity

There are currently four geothermal power plant projects in development in the state, with a total literature-estimated MW potential of 128.2-213.2. Projected potential for the state is 380 MW short-term and 1,250 MW long-term (Richter 2007), with a total literature-estimated geothermal electricity production potential of 17 million MWh/year (Nielsen 2002).

Geothermal leases for the Crump Geyser site (in Warner Valley, south-central Oregon) have been secured by a private developer. Data for this site indicates temperatures in excess of 180°C and the potential for electricity generation has been estimated at 85 MW. Research shows Newberry Crater (near Bend in central Oregon) holds resources sufficient for a 30 MW plant that is currently in

the initial planning stages (ODGMI 2003, USDOE 2007a). In July 2006 Davenport Power executed a 20-year power sales agreement with Pacific Gas & Electric (PG&E) involving the sale of 60-120 MW of geothermal-produced electricity from the proposed Newberry Site. The first 30 MW phase of this projected is scheduled to begin operation in 2009, the second 30 MW phase in 2010, and the remaining 60 MW in 2011 (USDOE 2007a).

The main difficulties pertaining to development of geothermal power plants in this state have been a lack of transmission access and regulatory hurdles similar to those experienced in California in association with development on federal lands (Fleischmann 2007).

Tribal Lands

Maps and data for geothermal resources on tribal lands in Oregon are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_Oregon.html (USDOE 2007i). Tribes for which information is available are listed in table A-8 below.

Table A-8: Tribes with Potential Geothermal Resources in Oregon
Burns Paiute Tribe of the Burns Paiute Indian Colony
Celilo Indian Village
Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians
Confederated Tribes of the Grand Ronde Community
Confederated Tribes of the Siletz Reservation
Confederated Tribes of the Umatilla Indian Reservation (Cayuse, Umatilla, & Walla Walla Tribes)
Confederated Tribes of the Warm Springs Reservation
Coquille Tribe
Cow Creek Band of Umpqua Indians
Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation
Grand Ronde Community
Klamath Indian Tribe- no map available
Siletz Reservation
Umatilla Indian Reservation (Cayuse, Umatilla, & Walla Walla Tribes)
Warm Springs Reservation
Warm Springs Tribe of the Celilo Indian Village

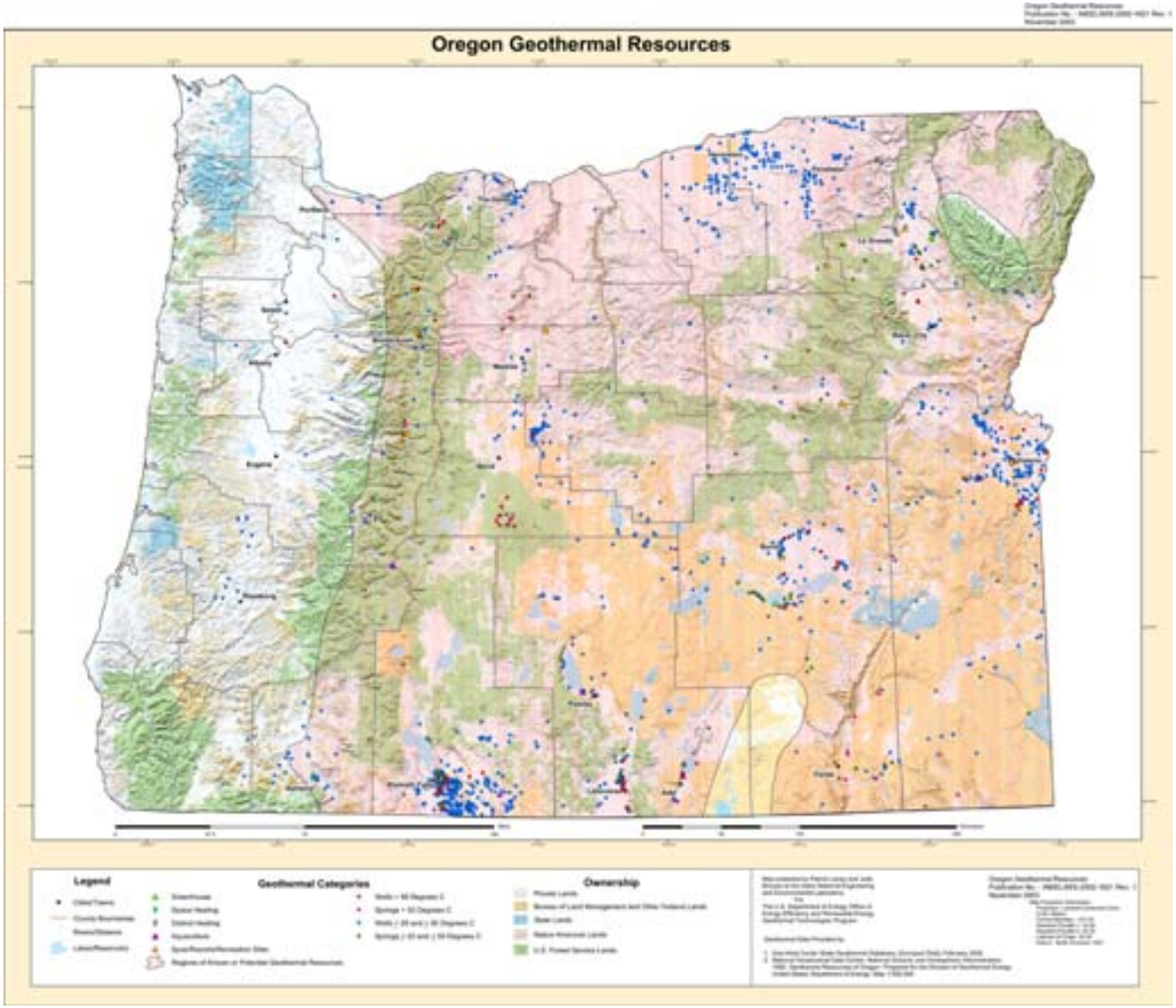
Laws, Regulations and Incentives

Oregon classifies geothermal resources as Mineral if the temperature of the bottom hole is greater that 250° F (121° C), and as Water if the temperature of the bottom hole is less that 250° F (121° C). The state claims ownership of all geothermal resources located on state and private land (Battocletti 2005). The Oregon DEQ is the primary agency for the disposal of water in either surface or injection well applications. Geothermal resources classified as "water" are regulated by the state Water Resources Department, while resources classified as "mineral" are regulated by the Oregon Department of Geology and Mineral Industries. The Department of State Lands issues exploration permits and drilling leases for resources on state-owned land. Oregon does not have

comprehensive environmental review statutes. A developer must obtain permits directly from local land use boards (Battocletti 2005).

The state Energy Facility Siting Council (EFSC) has jurisdiction over geothermal energy facilities of 38.95 MW or greater (Battocletti 2005). The state has a RPS requiring large utilities to generate 25 percent of their power from renewable energy sources by 2025, with lesser requirements for small utilities (Richter 2007). Oregon has established a Geothermal State Working Group with leadership from the Oregon Department of Energy, which is shared by the state of Washington (USDOE 2007a).

Incentives for geothermal development include low interest loans, business energy tax credits, and cash incentives through the Energy Trust of Oregon resources (USDOE 2007a). The state passed GHG legislation in 2007 that requiring GHG levels be ten percent below 1990 levels by 2020 and 75 percent below 1990 levels by 2050. Oregon has a GHG emission generation performance standard for electric generation and sales of 675 lbs. CO_2 per MWh (Camp 2007).



(Laney 2003f, http://geothermal.id.doe.gov/maps/or.pdf.)

UTAH

Resource Geography

The majority of the state's renewable energy comes from geothermal sources (Nielsen 2002), which are abundant in the western and central parts of the state (UGS 2008). Geothermal resources range from low to high temperature (above 150°C). The majority of the systems suitable for power production are located within the Sevier thermal area, a region of southwest Utah covering a portion of the eastern Basin and Range Physiographic Province, and part of the Basin and Range-Colorado Plateau transition zone (Harja 2007, UGS 2008).

Research indicates that geothermal resources underlie much of the Wasatch Front, where a large portion of the state's population resides (Fleischmann 2007). Known high-temperature systems include the Roosevelt KGRA and the Cove Fort-Sulphuredale KGRA (USGS 2008). Literature from state offices suggests several known resource areas for potential development, including Abraham (Crater Springs) Hot Springs area, the Meadow-Hatton area, Joseph Hot Springs, and the Newcastle, Monroe-Red Hill, and Thermo Hot Springs areas. Other areas with development potential that have been previously investigated but lacked identified resources include: the Drum Mountains-Whirlwind Valley area (near the Millard-Juab County line), and the Beryl area in western Iron County. The same office suggests the need for further exploration of the west side of Black Rock Desert in Millard County, where bottom hole temperatures of 380° F (193° C) were measured during exploratory oil and gas well drilling in 1980 (Harja 2007) as well as the Escalante Desert (UGS 2008).

Utilization

Currently the potential extent of Utah's geothermal resources is not well understood, and the geology of the resources is complicated in some areas. Lack of transmission capacity may hinder development for indirect-use in some areas, however direct use is diverse and ongoing throughout the state (Fleischmann 2007).

Technical Capabilities

Utah universities, state agencies, and private firms contribute technical capabilities to the local and national geothermal communities. The Utah Geological Survey maintains a database of geothermal resource information to support development projects.

Electrical Power Generation and Capacity

Utah (along with California and Nevada) is one of the few states in the region to have developed geothermal power plants. Currently the state has three geothermal power plants (one running, two decommissioned). Types of plant include binary, single flush, and dry steam. Current geothermal electrical output is 26 MW, with a literature-projected potential of 48-183 MW (including MW

projections for two projects in development). Short-term potential is cited as 230 MW, with 620 MW long-term (Richter, 2007). Literature estimates place overall geothermal electricity potential for Utah at nine million MWh/year (Nielsen 2002).

The state's first geothermal power plant (the Blundell geothermal plant) came online at Roosevelt Hot Springs (in Beaver County) in 1984 and has remained online since. While it currently produces 26 MW gross, expansion has been planned and additional binary units are expected to go online in November 2007, adding an additional 11 MW. Two other facilities were built at Cove Fort-Sulphurdale KGRA (in Beaver County) during the same time period, with a total capacity of 12 MW (UGWG 2005, USDOE 2007a**).** While these were decommissioned in 2003, new owners (ENEL North America) have been successful in obtaining additional federal geothermal leases within the KGRA (Harja 2007).

Tribal Lands

Tribal land covers roughly 4.4% of Utah's land. The largest section of this land is located in the southeast, as part of the Navajo nation. Significant geothermal potential has not been indicated in this area, however, there are several Paiute reservations near Cove Fort and Roosevelt Hot Springs, as well as tribal land in southwestern Utah that may be promising for geothermal development. The site of the Renaissance project is near tribal land, and the developer is working with the Northwestern Shoshoni Tribe on the project (Fleischmann 2007). Maps and data for geothermal resources on tribal lands in Utah are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_Utah.html (USDOE 2007j). Tribes for which information is available are listed in table A-9 below.

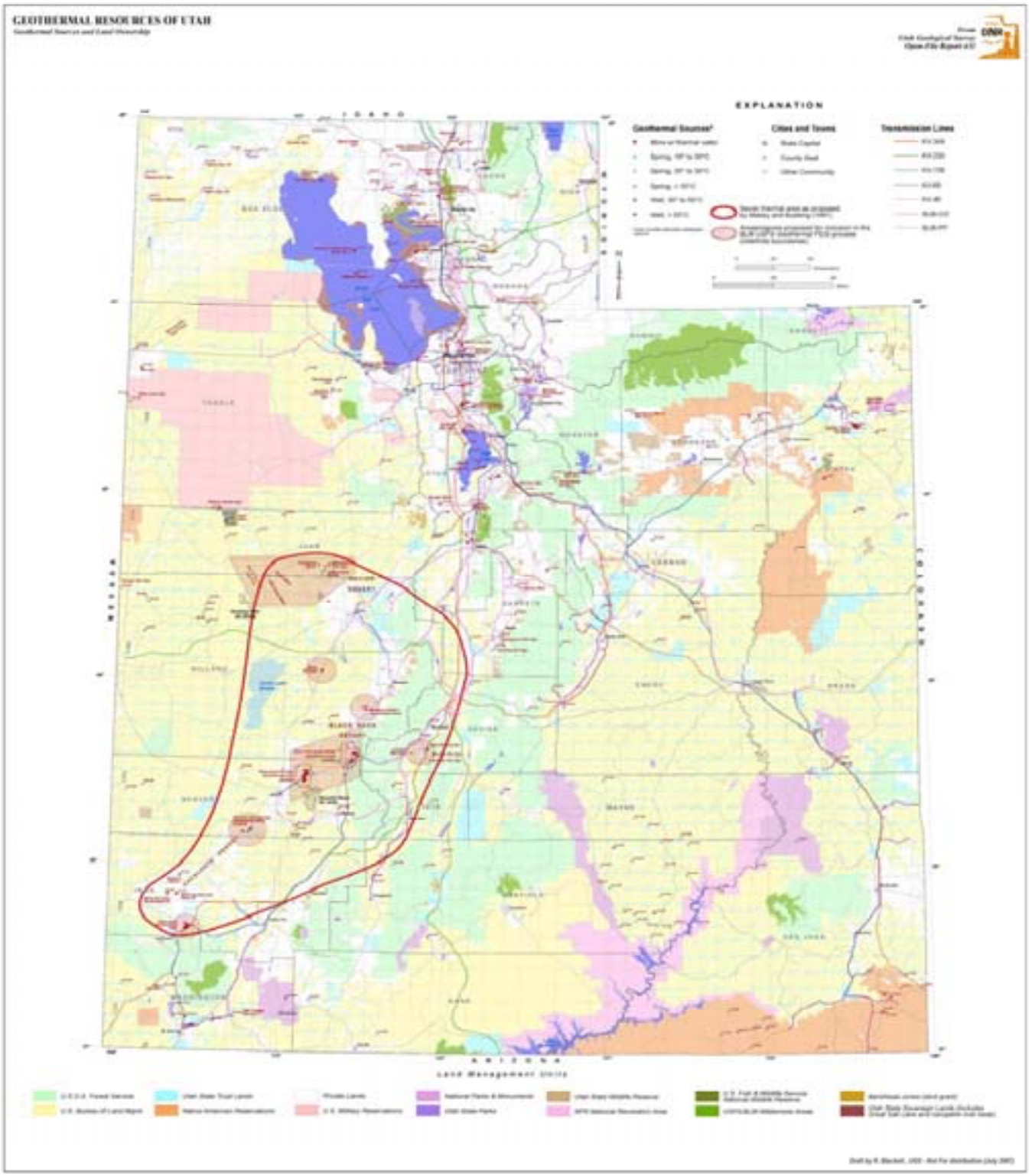
Table A-9: Tribes with Potential Geothermal Resources in Utah
Confederated Tribes of the Goshute Reservation
Goshute Reservation
Navajo Nation: Four Corners region lands North central Arizona and central Utah lands
Northern Ute Indian Tribe of the Uintah and Ouray Reservation: Eastern lands Western lands
Northwestern Band of Shosoni Nation
Paiute Indian Tribe of Utah: Lands in central Utah Main reservation in southwest Utah
Skull Valley Band of Goshute Indians
Ute Mountain Tribe of the Ute Mountain Reservation

Laws, Regulations and Incentives

Utah classifies geothermal resources as Water. Ownership is derived from an interest in the land and not from an appropriated right to geothermal fluids.

The right to a geothermal resource is based on ownership of the mineral rights or surface rights, which are usually obtained by direct ownership or leasing (Battocletti 2005).

The state Department of Natural Resources Division of Water Rights has jurisdiction and authority over all geothermal resources and issues water rights and well construction permits. The Utah Division of Water Quality oversees fluid disposal plans and permits. State regulations do not apply on tribal land, which makes up 4.4 percent of the state (Battocletti 2005). Utah does not have a comprehensive environmental review statute, nor a RPS or RPS (Richter 2007). Utah has established a Geothermal State Working Group with leadership from the Utah Geological Survey. The state does not presently have state funding for geothermal research or projects, however the US DOE funds specific research. Utah offers sales-tax exemption for the purchase of leasing of equipment used to generate energy for geothermal plants resources (USDOE 2007). In August 2007 Utah developed state goals to reduce GHG emissions 15 percent by 2020 as part of its union with the Western Climate Initiative (Camp 2007).


GEOTHERMAL RESOURCES OF UTAH
EXPLANATION
Geothermal Sources
Cities and Towns
Transmission Lines
Land Management Units

(Harja 2007)

WASHINGTON

Resource Geography

While the state has high volcanic activity, only the Cascade Range holds high potential for moderate to high temperature geothermal resources, particularly in Northern Cascade Mountains (Nielsen 2002). The most recent assessment of the state's geothermal potential was completed in 1994 and identified 34 thermal springs (primarily in the Cascade Mountains) and 941 thermal wells, primarily located in the Columbia Basin (USDOE 2007a).

Utilization

Geothermal resources in Washington have been virtually undeveloped. There are no district heating systems or large buildings using the resource. There are no commercial developments such as aquaculture, greenhouses and no power plants. Resource use is currently limited to recreational and therapeutic applications (Geo-Heat 2007). Low energy prices and lack of knowledge about the state's resource base have contributed to this current status (Fleischmann 2007).

Several exploration leases are currently pending but are associated with important scenic areas where environmental considerations could prohibit development. There are no near-term plans to develop geothermal resources in the Columbia Basin (USDOE 2007a). Near-term developments of any kind are likely to focus, at least initially, on the expansion of direct-use applications, though literature cites one geothermal power plant project in development, with a potential MW capacity of 50-100 (Richter 2007).

Technical Capabilities

The geothermal experts at the Washington State University Extension Energy Program have world-class expertise in high- and low-temperature geothermal energy. The group has prepared a series of guides on developing geothermal energy, and a series of case studies on geothermal heat pumps (USDOE 2007a, WSUEEP 2004).

Electrical Power Generation and Capacity

Potential projected geothermal electrical output is currently undefined, but literature estimates site a short-term projection of 50 MW, with long-term projections of 600 MW for sites at Mount Baker, and Wind River in the Cascade Range (Richter 2007). The USGS estimates geothermal resource potential for electricity generation to be 127 MW (Nielsen 2002).

Tribal Lands

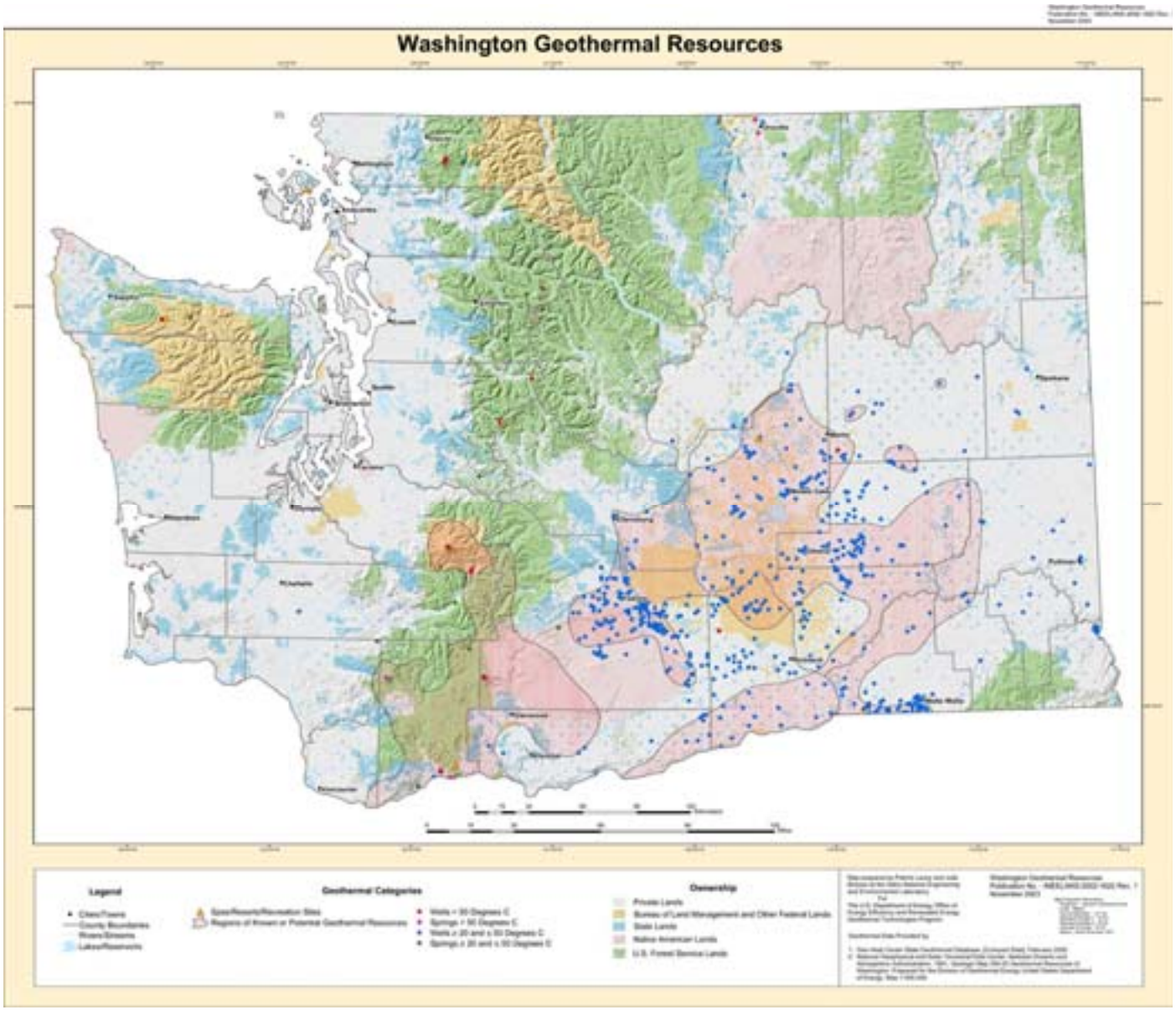
Map and data for geothermal resources on tribal lands in Washington are available through the DOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_Washington.html (USDOE 2007k). Tribes for which information is available are listed in table A-10 below.

Table A-10: Tribes with Potential Geothermal Resources in Washington	
Colville Reservation	Chehalis Reservation
Confederated Tribes of the Colville Reservation	Confederated Tribes of the Chehalis Reservation
Hoh Indian Tribe of the Hoh Indian Reservation	Confederated Tribes and Bands of the Yakama Indian Nation
Kalispel Indian Community	Jamestown S'Klallam Tribe
Lummi Tribe of the Lummi Reservation	Lower Elwha Klallam Tribal Community
Muckleshoot Indian Tribe	Makah Indian Tribe of the Makah Indian Reservation
Nooksack Indian Tribe	Nisqually Indian Tribe of the Nisqually Reservation
Port Gamble S'Klallam Tribe	Payallup Tribe of the Puyallup Reservation
Quileute Tribe of the Quileute Reservation	Port Madison Reservation
Samish Indian Tribe	Quinault Tribe of the Quinault Reservation
Shoalwater Bay Tribe of the Shoalwater Bay Indian Reservation	Sauk-Suiattle Indian Tribe
Snoqualmie Tribe	Skokomish Indian Tribe of the Skokomish Reservation
Squaxin Island Tribe of the Squaxin Island Reservation	Spokane Tribe of the Spokane Reservation
Suquamish Indian Tribe of the Port Madison Reservation	Stillaguamish Tribe
Tulalip Tribes of the Tulalip Reservation	Swinomish Indians of the Swinomish Reservation
Yakama Indian Nation	Upper Skagit Indian Tribe

Laws, Regulations and Incentives

Washington classifies geothermal resources capable of generating electricity (no specific temperature is defined) as *sui generis*. All direct-use geothermal resources are considered to be groundwater and regulated as such. The state Department of Ecology is responsible for issuing water rights, well construction permits and fluid disposal plans, including underground injections. Developers must also secure ownership or lease rights from the Washington Department of Natural Resources Division of Lands. Environmental review is required under Washington's State Environmental Policy Act. The Washington Energy Facility Site Evaluation Council (EFSEC) determinations operate in lieu of state environmental reports and has the authority to issue permits under the Federal Clean Air Act and Clean Water Act (Battocletti 2005, http://www.energy.wsu.edu/documents/renewables/washington.pdf), however it's jurisdiction covers only plants 250 MW and greater. Washington has an RPS that requires three percent renewable energy by 2012 and 15 percent by 2020, with less that five MW capacity counting as double (Richter 2007). Geothermal development incentives for the state include eligibility under the RES, and utility-run incentives. Washington has a combined Geothermal Working Group with the state of Oregon (USDOE 2007a).

In April 2007 the state passed GHG legislation (SSB6001), which mandates that GHG levels be at 1990 levels by 2020, 25 percent below 1990 levels by 2035 and less than 50 percent of 1990 level (or 70 percent below current projected annual emissions for 2050) by 2050. Washington also has a GHG emission generation performance standard for electric generation and sales of 1,100 lbs. of CO_2 per MWh (Camp 2007).



(Laney 2003g, **http://geothermal.id.doe.gov/maps/wa.pdf**)

WYOMING

Resource Geography

The majority of Wyoming's geothermal resources are concentrated in the state's northwest corner, in and around Yellowstone National Park. Elsewhere, groundwater at elevated temperatures occurs beneath large areas and research indicates that the state has a substantial geothermal resource base. High-temperature geothermal hotspots outside of environmentally sensitive areas (such as Yellowstone and the protected area of Hot Springs State Park in Thermopolis) could be suitable for electricity generation (USDOE 2007a).

One KGRA near Jackson Hole has been identified, and may be capable of yielding high-temperature water (aside from Yellowstone). The possibility of volcanic and magmatic activity exists along the northern end of Jackson Hole, which may indicate geothermal reservoirs. Outside of this area it is likely geothermal development will require very deep drilling analogous to oil and gas exploration (Lyons 2003, USDOE 2007a).

Utilization

Geothermal development in the state has so far been limited to direct-use applications, specifically for recreational and therapeutic purposes. Concern and controversy surrounding the development of geothermal resources near Yellowstone National Park has precluded development of resources near Yellowstone (USDOE 2007a). Wyoming's sparse population is also a causal factor associated with limited geothermal development. Finally, most renewable energy efforts in the state have focused primarily on harnessing wind power (Fleischmann 2007).

Technical Capabilities

Wyoming's coal resources are among the richest in the world, and the state possesses a wide variety of other energy sources. Renewable energy efforts are currently concentrated on harnessing wind energy, and little work has been done to harness Wyoming's geothermal potential. In the 1980s studies were done for the Western Area Power Administration to evaluate the geothermal potential of resources near Thermopolis for electricity generation (USDOE 2007a).

Electrical Power Generation and Capacity

With one project in development and no existing geothermal power plants, Wyoming has a literature-estimated geothermal electricity potential of 0.2 MW (Richter 2007). Estimates for short and long-term potential are not available. The USGS has estimated that the state has no potential for electricity generation from geothermal sources without inclusion of Yellowstone Park (Nielsen 2002). There is interest in the potential for developing small geothermal electricity units in conjunction with oil and gas wells present in Wyoming. A demonstration project at the Teapot Dome oil field (operated by

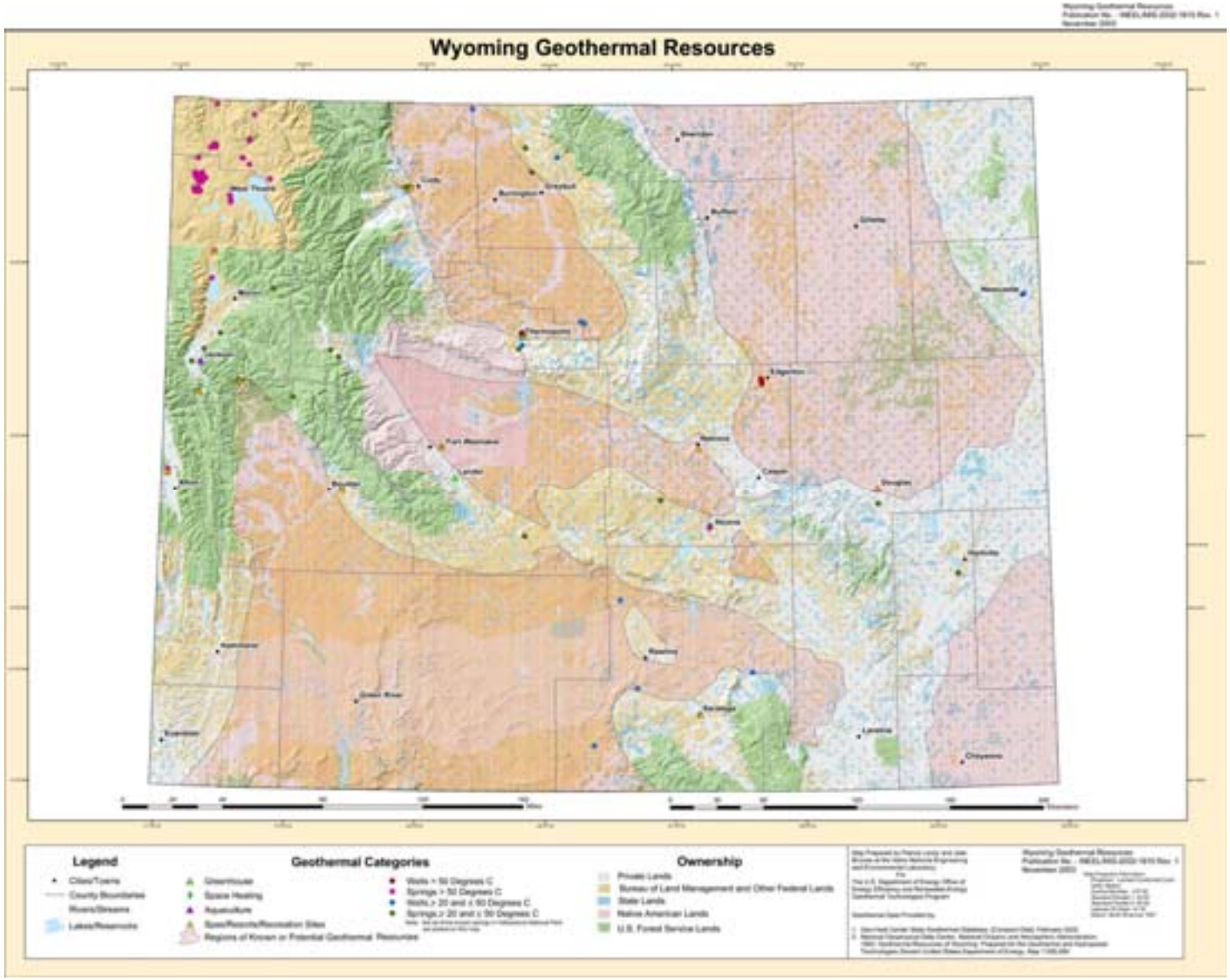
the US DOE) is currently under development and would install a binary unit for electrical generation and use on-site. This demonstration project, if successful, could lead to greater investment in Wyoming's geothermal resources (USDOE 2007a).

Tribal Lands

A Map and data for geothermal resources the Northern Arapaho tribe and Shoshone Tribe of the Wind river reservation in Wyoming is available through the USDOE tribal energy program at: http://www1.eere.energy.gov/tribalenergy/guide/geo_Wyoming.html (USDOE 2007l).

Laws, Regulations and Incentives

Wyoming classifies geothermal resources as Water, and regulates them as a groundwater resource. Geothermal rights are a public resource and only available through appropriation. The State Engineer's Office is responsible for issuing water rights, well construction permits, and is the lead agency in overseeing geothermal production wells. The state DEQ is responsible for administering surface and ground water disposal of wastewater, including geothermal fluids (Battocletti 2005, Heasler 1985). Wyoming does not have comprehensive environmental review statutes, nor does it have a RPS or RPS (Richter 2007). The state presently has no GHG laws or pending legislation. Wyoming has established a state Geothermal Working Group. The only incentive for geothermal development is sales-tax exemption for equipment used to generate renewable energy resources (USDOE 2007a).



(Laney 2003h, http://geothermal.id.doe.gov/maps/wy.pdf.)

STATE OF TRIBAL LANDS

Status of Exploration and Development

Beyond those included in the aforementioned state profiles, no other geothermal projects have been developed recently on tribal lands, but there is significant potential for such development. For example, the Jemez Pueblo, the Acoma Pueblo lands west of Albuquerque, the Navajo Indian Reservation, the lands of the Jicarilla Apache tribe, and the Zia Pueblo lands have lower temperature geothermal potential. The analysis of geothermal potential relative to tribal lands deserves more attention to determine the extent to which developing these resources might involve or affect tribes. An informal analysis suggests that 57 reservations may have some potential for geothermal electricity production, representing approximately 10 percent of the American Indian population on reservations and Tribal Jurisdictional Statistical Areas (TJSAs, in Oklahoma). Another 72 reservations and TJSAs may have potential for geothermal direct-use applications (Dunley 2007)

Statutes, Policies and Analyses

The following discussion covers the statutes and policies which may be relevant to geothermal development on tribal lands. These include National Environmental Policy Act, the National Historic Preservation Act, the American Indian Religious Freedom Act, Executive Order 13007 on Indian Sacred Sites, the DOE policy on American Indians, and Environmental Impact Assessment analysis (Dunley 2007).

National Environmental Policy Act. The National Environmental Policy Act is an umbrella law that requires environmental reviews of federal actions including Environmental Impact Statements (EISs) and Environmental Assessments (EAs). This review process includes analysis of social impacts of the proposed actions when appropriate and may be utilized to review the social and environmental impacts of federal projects on tribal lands

National Historic Preservation Act. The National Historic Preservation Act of 1966, amended in 1992, establishes a federal policy of encouraging preservation of cultural resources for present and future generations. The federal lead agency for a proposed action is responsible for initiating the "Section 106" review process and for consulting with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. For example, in the case of several proposed Medicine Lake geothermal projects, the U.S. Forest Service, as the Surface Managing Agency, initiated the Section 106 review process. The review included such issues as protection of Native American graves, archeological sites and resources, spiritual and vision quest sites, and paleontological resources (Dunley 2007).

American Indian Religious Freedom Act. The American Indian Religious Freedom Act of 1978 holds that federal agencies shall protect and preserve the

religious freedom of American Indians. Although this issue was addressed during the Medicine Lake approval processes, the issue of spiritual values, in the public context, has still not been completely defined. More work will need to be done (Dunley 2007).

Executive Order 13007 on Indian Sacred Sites. Executive Order 13007 of 1996 (61 Federal Register 26771) provides that federal agencies are required to accommodate access to and ceremonial use of sacred sites by Indian religious practitioners, and to avoid adverse effects to sacred sites and to maintain their confidentiality. The act requires that, for any proposed action, agencies ascertain the impacts of the proposed activity on places of religious significance, sacred sites, plant species for food and healing, air quality, visual quality, noise quality, wildlife and game habitat, spiritual significance, battlegrounds, vision quest, power places, and other tribal activities, such as hunting, camping, and gathering (Dunley 2007).

The Indian Development Act. The Geothermal Steam Act does not allow for BLM leasing on Indian reservations. The Indian Development Act provides that the BLM can be a technical consultant to a Native American tribe interested in negotiating with industry for development of geothermal resources at tribal lands. The BLM, if invited by the tribe, could facilitate the negotiation between the tribe and the developer (Dunley 2007).

Minerals Management Service Office of Indian Compliance and Asset Management. This office is a special organization within the Minerals Revenue Management dedicated to serving mineral producing tribes and individual Indian mineral owners. Based in Denver, the office is a focal point for Indian mineral issues and contact with the Indian community (Dunley 2007).

American Indian and Alaska Native Tribal Government Policy, U.S. Department of Energy. DOE first developed a policy governing its work with American Indians in 1992. The policy states that the department will identify and seek to remove impediments to working directly and effectively with tribal governments on DOE programs. Further, the policy committed DOE to consider Indian cultural issues in all its programs. Secretary Abraham has reaffirmed DOE's government-to-government policy (Dunley 2007).

Tribal Energy Self-Sufficiency Act (Draft). This bill is planned to be introduced in the Senate. Its provisions make energy projects eligible for revolving loans, loan guarantees, interest subsidies, and other incentives under the Indian Financing Act of 1974 (Dunley 2007).

Guidelines for Permitting on Tribal Lands

As sovereign nations, tribes have inherent authority over their land. Their approval must be obtained to use or lease tribal resources (e.g. land, water and

minerals). Tribes are not subject to state regulation and can negotiate with state and local governmental agencies.

Permitting on tribal land can take different paths, depending on the tribal authority provided by treaty or prescribed by constitutions developed under the Indian Reorganization Act of 1934, Powers specified by Congress and the inherent tribal authority the tribe asserts as a Sovereign Nation (Battocletti 2005).

The Following are General tenets of law in Indian Country:

- Federal agencies, such as the EPA, work directly with tribes on a "government to government" basis, Indian Country lands cannot be leased under the Geothermal Steam Act. They can be leased under agreements with the tribe itself or with the Indian Enterprise Corporations formed by the tribe, both with limitations on the rights granted. Often the tribes do not have commercial codes in place and cannot be sued without their permission (Battocletti 2005).
- Lands are generally (but not always) held in trust by the US and administered by the Bureau of Indian Affairs, which is generally the SMA in Indian Country when there is a third party lease or mineral management agreement (Battocletti 2005).
- Tribes can undertake exploration on their own, without BIA oversight. Even if there is no lease, there will be times in a tribally-initiated project that will require working with BIA (Battocletti 2005).
- Tribes can write their own regulations or adopt the regulations of other federal, state or local agencies. They may voluntarily relinquish sovereignty for a limited time and defined purpose to take advantage of another state, federal or local agency's rules and oversight (Battocletti 2005).
- Tribes with appropriate regulations in place can apply for primacy over the Clean Air, Safe Drinking Water, and Clean Water Acts (Battocletti 2005).
- Projects with impacts outside of Indian Country may be subject to local and state permitting regulation (Battocletti 2005).
- Where no tribal ordinances applicable to a proposed action exist, an express federal statute allocating governmental authority over specific activities may control. Inherent tribal authority may also be preempted by a comprehensive federal regulatory scheme (Battocletti 2005).

- Tribes are not subject to NEPA unless they use funds from federal agencies such as the DOE. In some cases, the BIA is the lead agency for NEPA on trust lands (Battocletti 2005).
- Where lands within Indian Country have been "allotted" to individual tribal members and then sold to non-Native Americans, another layer of jurisdiction uncertainty is created (Battocletti 2005).
- Tribes generally lack a history of natural resource development. Because of recent growing appreciation and expanded assertions of inherent sovereign powers by tribes, they may have difficulty accepting that there are jurisdictional authorities imposed by federal regulatory schemes for natural resource development on their land (Battocletti 2005).
- To determine the permitting path for a particular project, tribal sovereignty, tribal ordinances and codes, and tribal preferences must be weighed, along with other federal authorities. Tribes, consultants advising tribes, and members of industry forming contractual development agreements with tribes, are urged to ensure that standard requirements for safety, health, environment, and conservation of the resource are applied to the project as would be done by responsible geothermal exploration and development projects on federal, state and private lands where permitting and regulatory requirements are more clearly outlined (Battocletti 2005).

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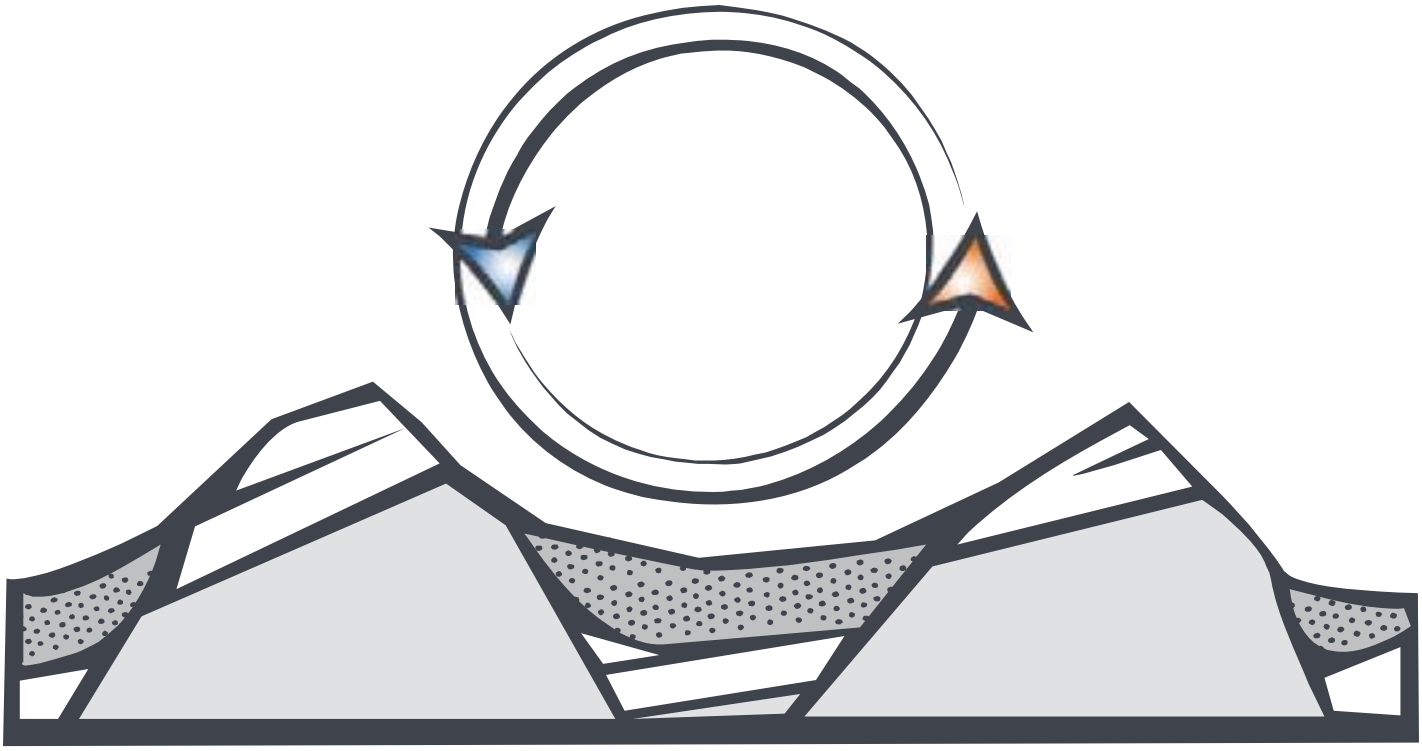

APPENDIX B

MEMORANDUM OF UNDERSTANDING: IMPLEMENTATION OF SECTION 225 OF THE ENERGY POLICY ACT OF 2005 REGARDING GEOTHERMAL LEASING AND PERMITTING

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MEMORANDUM OF UNDERSTANDING
BETWEEN
UNITED STATES DEPARTIMENT OF THE INTERIOR
AND
UNITED STATES DEPARTMENT OF AGRICULTURE

IMPLEMENTATION OF SECTION 225 OF THE ENERGY POLICY ACT OF 2005 REGARDING GEOTHERMAL LEASING AND PERMITTING

Forest Service Agreement No. 06-SU-11132428-051

I. PARTIES AND PARTICIPATING AGENCIES

A. The parties to this Memorandum of Understanding (MOU) are the United States Department of the Interior (DOI) and the United States Department of Agriculture (USDA).

B. Participating agencies include:

1. Within DOI, the Bureau of Land Management (BLM); and

2. Within USDA, the Forest Service (FS).

II. PURPOSE

The purpose of this MOU is to facilitate interagency coordination and establish policies and procedures to implement Section 225 of the Energy Policy Act of 2005, Public Law 109-58 (hereinafter the "Act"). Section 225 requires the coordination of geothermal leasing and permitting on public lands and National Forest System (NFS) lands between the Secretary of the Interior and Secretary of Agriculture.

A. The Act requires that this MOU establish:

1. An administrative procedure for processing geothermal lease applications on lands managed by the FS, including specifying lines of authority, steps in application processing and time limits for the application process;

2. A 5-year program for geothermal leasing of lands in the National Forest System with a process for updating that program every 5 years;

3. A program to reduce the backlog of all geothermal lease applications pending on January 1, 2005, by 90 percent within the 5-year period beginning on the enactment of the Act, August 8, 2005; and

4. A data retrieval system for tracking lease and permit applications.

III. AUTHORITIES

A. The primary authority for this MOU is Section 225(a) of the Energy Policy Act of 2005 (Public Law 109-58).

B. Other authorities for entering into this MOU and the roles and responsibilities that each agency will undertake are under the provisions of the Geothermal Steam Act of 1970 (84 Stat. 1566; 30 U.S.C. 1001-1025), as amended and supplemented (P.L. 109-58, Title II, Subtitle B, §225, 119 Stat. 665 (Aug. 8, 2005), the Energy Security Act, 94 Stat. 611, 42 U.S.C. § 8001 note 8854-8855), the Mineral Leasing Act of 1920, as amended (30 U.S.C. § 226-3), the National Environmental Policy Act of 1969 (83 Stat. 852; 42 U.S.C. 4321-4347), the National Forest Management Act of 1974 (90 Stat. 2949), and the Federal Land Policy and Management Act of 1976 (90 Stat. 2743, 43 U.S.C. 1701-1782.)

IV. PRINCIPLES AND GOALS

A. Principles for implementing this MOU include:

1. Participating agencies will seek improved information sharing and use, as well as an improved understanding of respective agency roles and responsibilities;
2. Development of geothermal energy is a priority for both agencies;
3. Geothermal exploration and production on Federal lands will support the Nation's increased need for energy resources; and
4. The financial resources made available through Section 234 of the Act should be used to enhance the capability to process geothermal lease applications and permit authorizations.

B. Goals for implementing this MOU include:

1. Identifying new or improved ways to increase the efficiency and minimize duplication of the geothermal leasing process;
2. Establishing interagency coordination mechanisms that can adapt to changing demands or circumstances;
3. Developing a more consistent approach among the agencies, and greater certainty in processing time requirements, to improve customer service;
4. Establishing interagency coordination mechanisms to allow for adequate flexibility to adapt to changing demands and technologies related to geothermal development;
5. Promoting responsible stewardship of Federal subsurface and surface resources through permitting actions; and

6. Developing a joint interagency data retrieval system to track application progress.

V. ROLES, RESPONSIBILITIES AND DELEGATION OF AUTHORITY

A. BLM.

1. General regulatory and management responsibilities. The BLM administers more than 261 million surface acres of public lands and 700 million acres of subsurface mineral estate (Federal land beneath surface lands owned or managed by other parties, such as the FS, National Park Service, Department of Defense and U.S. Fish and Wildlife Service).

2. Geothermal leasing. The BLM receives nominations from applicants, which may include proposed tract configurations for parcels. The BLM then forwards the proposal to the FS, which decides whether or not to consent to leasing and if so, what lease stipulations are necessary to minimize impacts to other resources and comply with regulations, policy and forest plan direction. With FS consent and once lease parcels are configured, the BLM is responsible for conducting geothermal lease sales and issuing competitive and noncompetitive leases. Although the BLM cannot issue a lease without the consent of the FS, the BLM can add any additional terms, conditions or stipulations that it deems necessary and appropriate, and must make an independent decision whether to issue the lease after review of the decision and documentation presented by the FS, and any other relevant factors.

3. Geothermal operations. If an operator proposes to conduct exploration operations on unleased FS lands, the application is submitted directly to the FS, which has the lead to conduct any necessary National Environmental Policy Act (NEPA) review and decide if the permit application should be approved and, if approved, what conditions of approval will be attached. If an operator proposes to conduct exploration operations on leased FS lands where the operator also is the lessee, the permit application is submitted to the BLM, which is the lead agency for permit review. In this case, the BLM will coordinate the NEPA review with FS, which will propose permit conditions of approval involving surface issues. The BLM will determine if the permit application should be approved and, if approved, what conditions of approval will be attached to the permit.
   Subsequent to leasing, if an operator proposes to drill wells intended for production or injection or to utilize the geothermal resource (which are lease exclusive operations) on Federal lands, the BLM is responsible for review and final approval of these types of operational permit applications, after consultation with the FS. Under most circumstances, a single NEPA document will be prepared with the BLM as lead and the FS as a cooperating agency. There are situations where specific interagency agreements apply and the FS will take the lead in preparing the NEPA document.

B. FS.

1. General regulatory and management responsibilities. The FS is responsible for the surface management of 192 million acres of National Forest System (NFS) lands. The Geothermal Steam Act as amended defines the role of the FS in the management of geothermal resources.

2. The FS is responsible for consenting (or not consenting) to the leasing of NFS lands, for conducting NEPA analysis for leasing, for developing appropriate terms and conditions under which the lease may be developed, and to ensure that doing so is consistent with the Land and Resource Management Plan developed under the National Forest Management Act.

3. Subsequent to leasing, the FS cooperates with the BLM to ensure that management goals and objectives for geothermal exploration and development activities are achieved, that operations are conducted to minimize effects on surface resources, and that the lands affected by operations are reclaimed. The BLM issues and administers geothermal leases on NFS lands only after the FS has consented to leasing under appropriate terms and conditions and has taken the actions necessary for the BLM to offer available lands for lease.

4. Administrative procedure for processing lease applications. The FS authorization to implement the leasing decision is to be forwarded to the BLM within 60 days of the initial receipt by FS of the leasing proposal if it conforms to a Forest Land Management Plan and is covered by an existing leasing NEPA document. If this timeframe cannot be met, FS is to provide the BLM with an expected date of completion, along with an explanation for the delay by entering information into the joint tracking system.

VI. FIVE-YEAR PROGRAM PLAN

The FS will:

A. Coordinate with the BLM, USGS, states and other interested parties to update potential geothermal areas through existing and new resource assessments;

B. Develop a process to delineate the boundaries of geothermal potential areas (including nominated lands) that will then be prioritized for leasing decisions and the associated NEPA process;

C. Coordinate with the BLM to establish the initial 5-year NEPA schedule needed for timely leasing decisions;

D. Review the schedule as new nominations are submitted or data from interested parties changes;

E. Address the existing backlog and newly nominated lands in the first 5-year plan; and

F. Coordinate with the BLM to find supplemental funding for the program such as that provided by Section 234 of the Act to ensure timely completion.

VII. PRE-LEASE ENVIRONMENTAL DOCUMENTATION

The FS, generally, will take the lead for completing the pre-lease NEPA documents and is responsible for providing the official FS consent or non-consent to leasing on FS lands. By this MOU, FS and the BLM agree to jointly prepare NEPA documents that will meet the requirements of both agencies in reaching their independent leasing decisions. The FS and the BLM will also identify, through the analysis, reasonable and justifiable stipulations needed to protect or minimize impacts to specific resources or land uses. The BLM will also provide a "reasonably foreseeable development (RFD) scenario" if requested by the FS, to facilitate the disclosure of potential environmental impacts. The FS will transmit the consent or non-consent decision on geothermal leasing to the BLM. Appropriate offices will be involved at appropriate levels of decision making. The following will apply, however, to the extent agreed upon by both agencies under sections VII. A. and B. below:

A. Subject to the terms of future, individualized MOUs regarding geothermal resources that may be developed between particular BLM and FS offices or for a particular NEPA process, as a general matter, the BLM will:

1. Appoint a specialist to participate as a member of the FS Interdisciplinary Team in the joint preparation, and completion of the NEPA document as necessary;

2. Provide informal training on geothermal operations, their potential impacts on the environment, the effect of mitigation on operations, mitigation development, and stipulation policy, upon request and in cooperation with the FS;

3. Assist the FS in jointly scoping the issues and determining the level of NEPA document to be prepared;

4. Assist the FS in the formulation of mitigation measures and lease stipulations;

5. Ensure that the NEPA document is consistent with the BLM leasing policies and NEPA document preparation standards, so that the document can be used by both agencies to reach independent decisions, if needed;

6. Cooperate with the FS to ensure that the draft NEPA document is completed on schedule (set in Section VI. C. above);

7. Complete review and comment on the draft NEPA document within 30 working days of receipt;

8. Assist and coordinate with the FS in the review of public and agency comments, discuss and work towards agreement on proposed lease stipulations and mitigations, make necessary revisions to the draft NEPA documents and assist in preparing the draft Decision Notice (DN)/Record of Decision (ROD);

9. After an independent review, adopt the final EA/EIS and sign the DN/ROD or prepare and sign a separate BLM decision document and return the original signed documents to the FS; and

10. Issue leases with recommended special environmental stipulations or reject lease applications in accordance with the DN/ROD.

B. Subject to the terms of future, individualized MOUs regarding geothermal resources that may be developed between particular BLM and FS offices or for a particular NEPA process, as a general matter, the FS will:

1. Jointly scope the issues to be addressed in the NEPA document with the BLM, including determining the level of NEPA document to be prepared and developing a schedule for completion of the document. The goal is to complete each NEPA document within 1 to 2 years;

2. Work with the BLM to provide a RFD scenario, if needed, to be used as a basis for impact analysis in the NEPA document;

3. Request training from the BLM on post-lease geothermal operations, their potential impacts on the environment, the effect of mitigation on operations, mitigation development, and stipulation policy when determined to be necessary;

4. Prepare the NEPA document in cooperation with and with the assistance of the BLM, and

    a. Include a specialist from the BLM staff on the FS Interdisciplinary (ID) Team as necessary;

    b. Coordinate with the BLM to ensure that the NEPA document is consistent with BLM leasing and analysis policies;

5. Discuss and work toward agreement on potential mitigation measures and lease stipulations as part of alternative development with the BLM;

6. Forward a copy of the preliminary NEPA document to the BLM for review and comment within 1 week of completion;

7. Jointly review with the BLM all comments on the draft NEPA document and incorporate comments and changes as agreed;

8. Prepare the final NEPA document for public comment and review, address all public comments, prepare a DN/ROD in cooperation with the BLM and forward the final copy to the deciding officer for the FS; and

9. Transmit the leasing consent or non-consent decision, the NEPA document, and the signed FS version of the DN/ROD to the BLM within 15 calendar days after any appeals are resolved.

VIII. COMPETITIVE LEASING

The BLM is responsible for conducting geothermal lease sales and issuing competitive leases (see attached Table).

A. BLM will:

1. Coordinate and schedule an annual BLM/FS meeting to develop a proposed competitive leasing schedule, considering each agency's budgets and other work priorities;

2. Send a written request to the FS for appropriate stipulations and special terms for lease issuance at least 180 days prior to the scheduled sale date; and

3. Coordinate with the FS (lead agency) to complete the pre-lease NEPA document according to the procedures outlined in this MOU.

B. FS will:

1. Coordinate with the BLM in scheduling and holding the proposed competitive sale meeting;

2. Utilize information in mineral resource assessment in future planning documents and decisions;

3. Provide appropriate stipulations for the NFS lands involved in a proposed lease sale and special terms for lease issuance at least 90 days prior to the scheduled sale date; and

4. Coordinate with the BLM to complete the pre-lease NEPA document according to the procedures in Section VII of this MOU.

IX. NONCOMPETITIVE LEASING

The BLM is responsible for conducting geothermal lease sales and issuing noncompetitive leases (see attached Table).

A. BLM will:

1. Transmit any noncompetitive lease application package involving NFS lands to the FS within 30 days of receipt; and

2. Upon receipt of the FS consent and stipulations, make an independent decision whether to issue each lease within 30 days of conveying terms and conditions to the applicant.

B. FS will:

1. Forward land parcel lease requests from the FS to the appropriate Forest Supervisor for environmental clearance within 15 days of receipt; and

2. Complete a review of the existing NEPA document and coordinate with the BLM during the environmental review process, as outlined in Part VII. A. above, and transmit a letter of consent or no consent to the BLM within 60 days from receipt of land parcel lease requests.

C. Direct Use

Outside of the circumstances outlined in the Geothermal Steam Act of 1970, 30 U.S.C. 1003(c) as amended, by section 222 of the Act, the only lands available to be leased without a competitive sale are those in areas designated by the Secretary of the Interior for exclusive direct-use utilization of geothermal resources only pursuant to 30 U.S.C. 1003(f). Subject to forthcoming implementing regulations, such exclusive direct-use areas may have been identified and designated via attached stipulation in advance of the nomination to lease, or the designation may occur in response to the nomination to lease after appropriate reviews at the conclusion of the 90-day competitive interest notice period (30 U.S.C. 1003(f)).

X. JOINT DATA RETRIEVAL SYSTEM FOR BLM AND FS TO TRACK STATUS OF LEASE AND PERMIT APPLICATIONS

The joint data retrieval system will be completed in time to implement the forthcoming geothermal regulations being prepared to implement the geothermal provisions of the Act.

A. BLM will:

1. Provide designated FS staff with the appropriate level of access to BLM's Automated Fluid Minerals Support System (AFMSS), Legacy Rehost 2000 (LR 2000), and National Integrated Land System (NILS) transaction and reporting systems, as well as data systems used for the management of geothermal resources. Access to users will be provided within 2 weeks after submission of a request using Form 1260. Systems will be available for use 90 percent of the time within standard business operating hours using established industry metrics. The details and specifics of how the FS will access and use BLM systems will be documented in a Service Level Agreement consistent with BLM/DOI policies. FS will be able to view the status of and enter updates to transactions related to proposals on National Forest System lands, while those on the BLM lands will appear as read-only to FS users;

2. Determine infrastructure, protocols, and procedures necessary to provide secure access to joint data retrieval systems and joint geographic information system. Provide security requirements to Forest Service;

3. Assure adequate system performance and security to maintain data integrity for FS users which access the BLM's data systems used for the management of geothermal resources; and

4. Be responsible for the Information Technology management, including Project Change Management, of the BLM's data systems used for the management of geothermal resources.

B. FS will:

1. Establish infrastructure, protocols, and procedures to meet the security requirements as determined by BLM for access to joint data retrieval systems and geographic information systems by designated Forest Service staff;

2. Provide the BLM with a completed BLM Form-1260 for all FS users who need to access the BLM's data systems used for the management of geothermal resources; and

3. Use the BLM's Project Change Management Boards for requesting changes to the BLM's data systems used for the management of geothermal resources.

XI. MEASURES OF SUCCESS OR CHANGE FOR GEOTHERMAL LEASING AND PERMITTING PROGRAMS

A. Success Measures. Measures of success for the Geothermal Leasing and Permitting Programs include:

1. Streamlining and increasing interagency efficiency in processing geothermal leases, permits and associated agency approvals;

2. Increasing ability to more timely process and issue geothermal leases and approve permits that will withstand administrative and judicial challenge; and

3. Decreasing the lease application backlog by 90 percent in 5 years.

B. Data for Measuring Success. For Geothermal Leasing and Permitting, the following, at a minimum, will be tracked and measured:

1. The total number of nominations and permit applications received, processed, and issued;

2. The elapsed time from receipt to issuance or approval, including the time required for major steps or components; and

3. The number of applications backlogged.

C. The information identified in the preceding paragraph will be collected for 5 fiscal years after enactment of the Act and will be compared to the same parameters in each of the 3 fiscal years preceding passage of the Act.

XII. MUTUAL UNDERSTANDING AND AGREEMENT

A. Freedom of Information Act (FOIA). Any information furnished to the BLM and FS under this instrument is subject to the Freedom of Information Act (5 U.S.C. 552).

B. Participation in similar activities. This instrument in no way restricts the BLM or FS from participating in similar activities with other public or private agencies, organizations, and individuals.

C. Responsibilities of Parties. The BLM and FS and their respective offices will handle their own activities and utilize their own resources, including expenditures of their own funds, in pursuing these objectives, except as previously outlined. Each party will carry out its separate activities in a coordinated and mutually beneficial manner.

D. Principal Contacts

1. BLM.

Assistant Director, Minerals, Realty and Resource Protection
1849 C Street, N.W.
Washington, DC 20240
(202) 208-4201

2. FS.

Director, Minerals and Geology Management
1400 Independence Ave., SW
Washington, DC 20250
(703) 605-4791

XIII. FUNDING

A. Section 234 of the Energy Policy Act of 2005 authorizes rentals, royalties and other payments required under leases under the Geothermal Steam Act of 1970, excluding funds required to be paid to state and county governments, to be deposited in a special fund available to "…the Secretary of the Interior for expenditure, without further appropriation and without fiscal year limitation, to implement the Geothermal Steam Act of 1970 and this Act…."

B. Section 234(c) of the Energy Policy Act of 2005 authorizes the Secretary of the Interior to expend or transfer funds as necessary to the FS for purposes of coordination and processing of geothermal leases and geothermal use authorizations on Federal land.

C. The details of the levels of support to be furnished to FS by the BLM, with respect to funding and personnel, will be developed in specific future agreements on an annual or case-by-case basis, contingent on the availability of identified staffing needs and types of funding.

XIV. COMMENCEMENT/EXPIRATION/TERMINATION AND MODIFICATION

As described in Section XIII. A. B. C., the Act mandates the establishment of a fund for geothermal leasing through fiscal year 2010. The MOU will continue beyond that date for the purposes of coordinating geothermal leasing. The BLM and FS will review this MOU every 5 years for currency and applicability. This MOU may be revised and modified as necessary; terms herein are contingent upon regulations yet to be promulgated. All parties potentially affected by a modification must sign the modification for it to be effective.

XV. MEETINGS

The agencies will meet on an annual basis. Additional coordination meetings or conference calls may be held as needed.

XVI. DISPUTE RESOLUTION

If a dispute arises under this MOU that is not resolved informally between or among the parties, then any party may pursue the following dispute resolution procedure:

A. The party that seeks resolution will provide a written statement of its dispute, along with any rationale or supporting documents, to the other interested party. The parties will engage in discussions in an attempt to arrive at a consensus and resolve the dispute.

B. If no resolution is reached within thirty (30) calendar days of receipt of the statement of dispute, then the dispute may be elevated to the parties' respective headquarters-level officials. If consensus is not achieved by the headquarters-level officials within thirty (30) calendar days of their receipt of the statement of dispute, the parties will promptly elevate the matter to the respective Secretaries' Offices, who will resolve the matter.

C. The time limits in the preceding paragraph may be extended on the agreement of the parties to the dispute.

XVII. SUPPLEMENTAL AGREEMENTS

Subsequent to the signing of this MOU, additional Federal or state interagency agreements may be required for the purposes of outlining more specific interagency relationships.

XVIII. NO PRIVATE RIGHT OF ACTION AND LIMITED APPLICABILITY

This MOU is not intended to, and does not create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity, by a person against the United States, its agencies, its officers, or any person. This MOU does not direct or apply to any person outside of the signatory Parties.

ACCORDINGLY, the parties have signed this MOU on the dates set forth below, to be effective for all purposes as of the date last signed. The signatures may be executed using counterpart original documents.

DIRECTOR, BUREAU OF LAND MANAGEMENT — DATE 4/5/06

CHIEF, FOREST SERVICE — DATE 4/14/06

Geothermal Leasing on NFS Lands

The BLM and the Forest Service will coordinate geothermal resource leasing activities on NFS lands as follows:

J = joint responsibility S = sole responsibility

Action	Responsible Agency		Remarks
	BLM	FS	
Pre-Lease Environmental Documentation			
Serve as lead agency for geothermal leasing availability analyses and decisions and conduct analysis.		S	
Participate as co-lead agency or cooperating agency for geothermal leasing availability analyses and decisions for NFS lands.	S		
Analyze split estate lands (private surface/Federal minerals) within boundaries of NFS units.	J	J	Analysis and decision-making on all lands under Federal authority (both the BLM and the FS) within a defined leasing area will ensure consistency in geothermal resource management.
Provide expertise in the areas of geothermal engineering and geothermal geology on interdisciplinary teams performing environmental analyses for leasing on NFS lands.	S		The BLM must provide expertise in delegated program areas in geothermal operations, including ground water protection.
Provide Reasonably Foreseeable Development Scenario (RFD) for geothermal leasing on NFS lands.	S		Analysis must include information on geothermal reservoirs, resource distribution, and production characteristics, and must address downhole operations. The RFD will follow the Interagency Reference Guide "Reasonably Foreseeable Development Scenarios and Cumulative Effects Analysis". FS may need to provide information on surface use (roads, etc.) for inclusion or consideration in the RFD. RFD may be developed by other parties. If so, the BLM should provide final review.
Ensure consistency in lease stipulations across jurisdictional boundaries.	J	J	
Develop lease stipulations for NFS lands that are only as restrictive as necessary to protect the resources for which they are applied.		S	The FS should develop stipulations with the BLM input for consistency. (See above.)
Issue leasing decision.		S	The FS and the BLM should coordinate the signing and release of decision documents on leasing of NFS lands. NOTE: The BLM has sole decision authority for split estate lands (Federal minerals/private or State surface) within boundaries of Forest Service administrative units.)
Adopt FS leasing analysis.	S		

Action	Responsible Agency		Remarks
	BLM	**FS**	
Competitive Leasing			
Coordinate and schedule the BLM/FS meeting to develop a proposed competitive leasing schedule.	J	J	
Send written request to the FS for appropriate stipulation and special terms for lease issuance at least 180 days prior to sale.	S		
Utilize information in mineral resource assessment in future planning documents and decisions.	S		
Provide appropriate stipulations for NFS land involved in proposed lease sale and special terms for lease issuance at least 90 days prior to scheduled sale date.		S	.
Noncompetitive Leasing			
Transmit any noncompetitive lease application package involving NFS land to the FS within 30 days of receipt.	S		
Forward land parcel lease requests from the FS to appropriate Forest Supervisor for environmental clearance within 15 days of receipt.		S	
Complete a review of the existing NEPA document and transmit letter of consent or no consent to the BLM within 60 days from receipt of land parcel lease requests.		S	Coordinate with the BLM during the environmental review process, as outlined in Part VII. A.
Upon receipt of the FS consent and stipulation, make an independent decision as to whether to issue each lease within 30 days of conveying terms and conditions to applicant.	S		

J = joint responsibility S = sole responsibility

Action	Responsible Agency		Remarks
	BLM	FS	
Joint Data Retrieval System for the BLM and the FS to Track Status of Lease and Permit Applications			
Determine infrastructure, protocols, and procedures necessary to provide secure access to joint data retrieval systems and joint geographic information system. Provide security requirements to Forest Service.	S		The BLM program and IT staff will work with corresponding staff in Forest Service to determine standards.
Establish infrastructure, protocols, and procedures to meet the security requirements as determined by BLM for access to joint data retrieval systems and geographic information systems by designated Forest Service staff.		S	Implement security requirements to meet BLM standards for those Forest Service staff requiring access to the joint data retrieval systems.
Provide designated FS staff with the appropriate level of access to the joint data retrieval system.	S		At the initiation of this MOU the joint data retrieval systems include AFMSS, LR 2000, and NILS. The details and specifics of how the FS will access and use BLM systems will be documented in a Service Level Agreement consistent with BLM/DOI policies.
Provide the BLM with a completed BLM Form- 1260 for all FS users who need to access the joint data retrieval system.		S	.
Assure adequate system performance and security to maintain data integrity for FS users who access the joint data retrieval system.	S		
Utilize the BLM's Project Change Management Boards for requesting changes to the joint data retrieval system.		S	
Be responsible for the Information Technology management, including Project Change Management, of the joint data retrieval system.	S		

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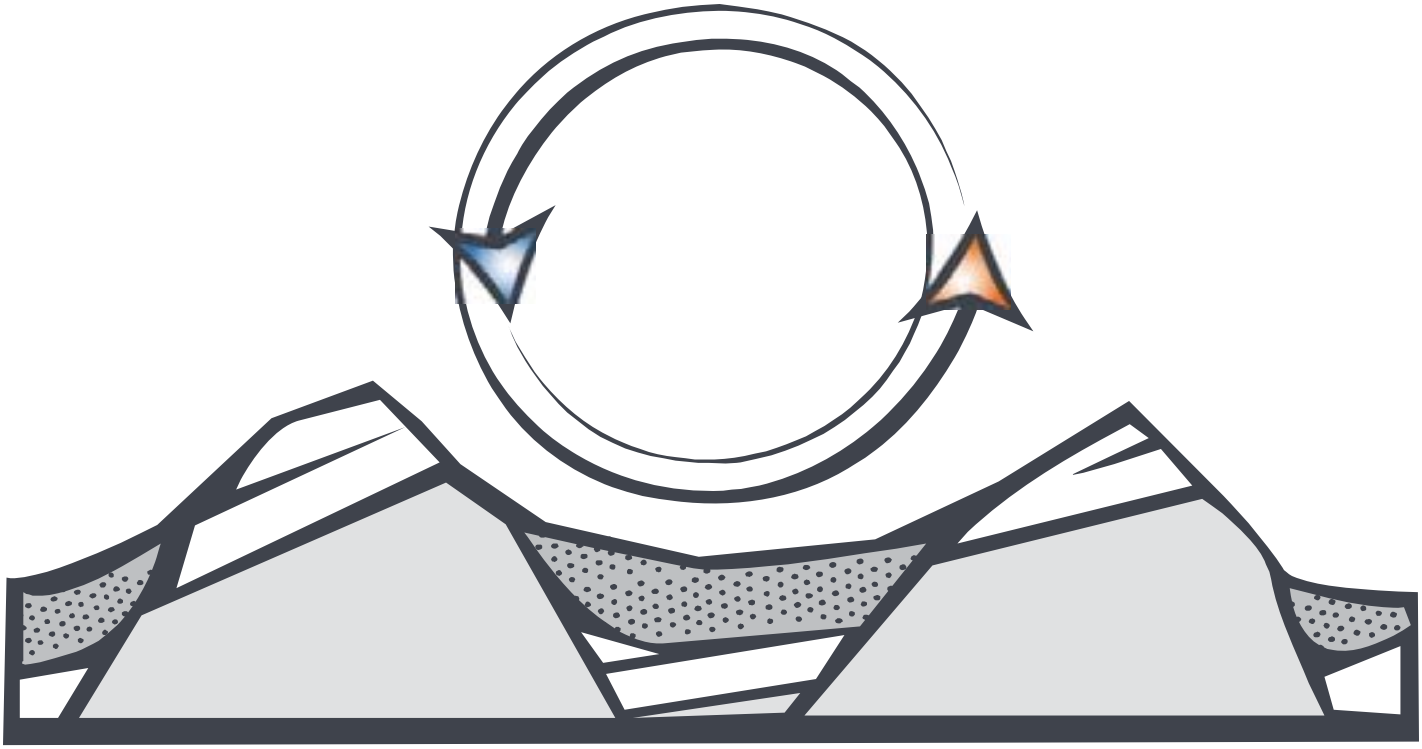

Appendix C

Preliminary List of Areas of ACEC Status for Fluid Mineral Leasing

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List of Acronyms : NSO = No Surface Occupancy, TL = Timing Limitations, CSU = Controled Ssurface Use, CSM = Control Surface Management, CNL =Closed to New Leasing, NNR = No New ROW

State	District and/or Field Office	ACEC Name	Acres	Closed to Leasing	Open to Geothermal Leasing	Applicable Stipulations*
AK	Central Yukon	Dulbi-Kaiyuh Mountains	7,039		OPEN	
AK	Central Yukon	Dulbi-Kaiyuh Mountains	6,435		OPEN	
AK	Central Yukon	Dulbi-Kaiyuh Mountains	10,036		OPEN	
AK	Central Yukon	Dulbi-Kaiyuh Mountains	4,439		OPEN	
AK	Steese NCA	Big Windy Hot Spring	152	CLOSED		
AK	Utility Corridor	Kanuti Hot Springs ACEC	43	CLOSED		
AK	Central Yukon	Ishtalitna Creek Hot Springs RNA	1,025	CLOSED		
AK	Central Yukon	McQuesten Creek RNA	3,930	CLOSED		
AK	Central Yukon	Spooky Valley RNA	10,072	CLOSED		
AK	Central Yukon	Tozitna Subunit South	62,645		OPEN	
AK	Central Yukon	Hogatza	30,509		OPEN	
AK	Central Yukon	Indian River Watershed	161,198		OPEN	
AK	Central Yukon	Tozitna River Watershed	947,111		OPEN	
AK	Central Yukon	Galena Mountain Watershed ACEC - East Unit	6,054		OPEN	
AK	Central Yukon	Tozitna Subunit North	128,799		OPEN	
NM	Roswell	North Pecos			OPEN	None
NM	Roswell	Overflow Wetlands			OPEN	None
NM	Roswell	Ft. Stanton		CLOSED		None
NM	Roswell	Mescalero Sands		CLOSED		None
NM	Roswell	Roswell Cave Complex		CLOSED		None
NM	Rio Puerco	Torrejon Fossil Fauna			OPEN	CSU
NM	Rio Puerco	Jones Canyon			OPEN	NSO
NM	Rio Puerco	San Luis Mesa Raptor Area			OPEN	TL, CSU
NM	Rio Puerco	Cabezon Peak		CLOSED		None
NM	Rio Puerco	Canon Tapia			OPEN	NSO
NM	Rio Puerco	Elk Springs			OPEN	TL, CSU
NM	Rio Puerco	Tent Rocks			OPEN	TL, CSU
NM	Rio Puerco	Ojito			OPEN	CSU
NM	Rio Puerco	Ball Ranch		CLOSED		None
NM	Rio Puerco	Pronoun Cave Complex			OPEN	CSU
NM	Rio Puerco	Bluewater Canyon			OPEN	NSO
NM	Farmington	Cedar Hill			OPEN	CSM
NM	Farmington	*Chacra Mesa Complex			OPEN	CSM, NSO
NM	Farmington	East Side Rincon			OPEN	CSM, NSO
NM	Farmington	Farmer's Arroyo			OPEN	NSO
NM	Farmington	La Jara			OPEN	CSM
NM	Farmington	*Andrews Ranch			OPEN	NSO, CNL
NM	Farmington	*Bee Burrow			OPEN	NSO, CNL
NM	Farmington	*Bis Sa'ani			OPEN	NSO, CNL
NM	Farmington	Casa Del Rio		CLOSED		None
NM	Farmington	*Casamero Community			OPEN	NSO, CNL, NNR
NM	Farmington	Church Rock Outlier			OPEN	NSO, CNL

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State	District and/or Field Office	ACEC Name	Acres	Closed to Leasing	Open to Geothermal Leasing	Applicable Stipulations*
NM	Farmington	*Greenlee Ruin			OPEN	None
NM	Farmington	*Halfway House			OPEN	NSO, CNL, NNR
NM	Farmington	*Holmer Group			OPEN	NSO, CNL, NNR
NM	Farmington	*Indian Creek			OPEN	CNL, NNR
NM	Farmington	Jacques Chacoan Community			OPEN	NSO, NNR
NM	Farmington	*Kin Nizhoni			OPEN	NSO
NM	Farmington	Lake Valley			OPEN	NSO, CNL
NM	Farmington	*Morris 41			OPEN	NSO, CNL, NNR
NM	Farmington	*Pierre's Site			OPEN	NSO, CNL,NNR
NM	Farmington	*Toh-La-Kai			OPEN	NNR
NM	Farmington	*Twin Angels			OPEN	NSO, NNR
NM	Farmington	*Upper Kin Klizhin			OPEN	CNL, NNR
NM	Farmington	Ah-Shi-Sle-Pah Road			OPEN	CSM, NSO
NM	Farmington	*Crowpoint Steps and Herradura			OPEN	CSM, NNR
NM	Farmington	*North Road			OPEN	NSO, CNL
NM	Farmington	Adams Canyon			OPEN	NSO, NNR
NM	Farmington	Blanco Mesa			OPEN	NSO, NNR
NM	Farmington	Cagle's Site			OPEN	NSO
NM	Farmington	Canyon View Ruin			OPEN	NSO,NNR
NM	Farmington	Christmas Tree Ruin			OPEN	NSO, NNR
NM	Farmington	Cottonwood Divide			OPEN	NSO, NNR
NM	Farmington	Crow Canyon			OPEN	NSO, NNR
NM	Farmington	Deer House			OPEN	NSO, CSM, NNR
NM	Farmington	Devil's Spring Mesa			OPEN	NSO, CSM, NNR
NM	Farmington	Encinada Mesa-Carrizo Canyon			OPEN	NSO, NNR, CSM
NM	Farmington	Frances Mesa			OPEN	NSO, CSM
NM	Farmington	Gould Pass Camp			OPEN	NSO
NM	Farmington	Humming Bird			OPEN	NSO, NNR
NM	Farmington	Kachina Mask			OPEN	NSO
NM	Farmington	Kin Yazhi			OPEN	NSO, NNR
NM	Farmington	Kiva			OPEN	NSO
NM	Farmington	Munoz Canyon			OPEN	CSM
NM	Farmington	Pointed Butte			OPEN	NSO, NNR
NM	Farmington	Pork Chop Pass			OPEN	NSO
NM	Farmington	Pretty Woman			OPEN	NSO, NNR
NM	Farmington	Prieta Mesa			OPEN	NSO, NNR
NM	Farmington	Rincon Largo District			OPEN	NSO, NNR

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NM	Farmington	Rincon Rockshelter			OPEN	NSO
NM	Farmington	San Rafael Canyon			OPEN	CSM
NM	Farmington	Simon Ruin			OPEN	NSO, NNR
NM	Farmington	Star Rock			OPEN	NSO, NNR
NM	Farmington	String House			OPEN	NSO, NNR
NM	Farmington	Superior Mesa			OPEN	NSO, NNR
NM	Farmington	Tapacito and Split Rock			OPEN	NSO, NNR
NM	Farmington	Truby's Tower			OPEN	NSO
NM	Farmington	Albert Mesa			OPEN	NSO, NNR
NM	Farmington	Dogie Canyon School			OPEN	NSO
NM	Farmington	Gonzales Canyon-Senon S. Vigil Homestead			OPEN	NSO, NNR
NM	Farmington	Haynes Trading Post			OPEN	NSO
NM	Farmington	Margarita Martinez Homestead			OPEN	NSO, NNR
NM	Farmington	Martin Apodaca Homestead			OPEN	NSO
NM	Farmington	Moss Trail			OPEN	NSO, NNR
NM	Farmington	Rock House-Nestor Martin Homestead			OPEN	NSO
NM	Farmington	Santos Peak			OPEN	NSO
NM	Farmington	Ashiih Naa'a			OPEN	NSO, NNR
NM	Farmington	Cho'li'I			OPEN	NSO
NM	Farmington	Dzil'na'oodlii			OPEN	NSO, NNR
NM	Farmington	Bi Yaazh			OPEN	NSO
NM	Farmington	Blanco Star Panel			OPEN	NSO, NNR
NM	Farmington	Delgadita/Pueblo Canyons			OPEN	NSO, NNR
NM	Farmington	Encierro Canyon			OPEN	NSO
NM	Farmington	Four Ye'i			OPEN	NSO
NM	Farmington	Hummingbird Canyon			OPEN	NSO, NNR
NM	Farmington	Largo Canyon Star Ceiling			OPEN	NSO
NM	Farmington	Martinez Canyon			OPEN	NSO
NM	Farmington	Pregnant Basketmaker			OPEN	NSO
NM	Farmington	Shield Bearer			OPEN	NSO
NM	Farmington	Star Spring-Jesus Canyon			OPEN	NSO
NM	Farmington	Angel Peak			OPEN	NSO
NM	Farmington	*Simon Canyon			OPEN	NSO, CNL
NM	Farmington	Bald Eagle			OPEN	CSM
NM	Farmington	*The Hogback			OPEN	CSM, CNL
NM	Farmington	Mexican Spotted Owl			OPEN	CSM, NSO
NM	Farmington	River Tracts			OPEN	NSO
NM	Farmington	Ah-shi-sle-pah			OPEN	CNL
NM	Carslbad	Pecos River Canyons Complex			OPEN	NSO, NNR
NM	Carslbad	Lonesome Ridge			OPEN	NSO, NNR
NM	Carslbad	Dark Canyon			OPEN	NSO, NNR
NM	Carslbad	Chosa Draw			OPEN	NSO, NNR

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State	District and/or Field Office	ACEC Name	Acres	Closed to Leasing	Open to Geothermal Leasing	Applicable Stipulations*
NM	Carslbad	Blue Spring			OPEN	NSO, NNR
NM	Los Cruces	Three Rivers			OPEN	
NM	Los Cruces	Sacramento Escarpment			OPEN	
NM	Los Cruces	Cornudas Mts.			OPEN	
NM	Los Cruces	Alamo			OPEN	
NM	Los Cruces	Wind Mt.			OPEN	
NM	Los Cruces	Alkali Lakes			OPEN	
NM	Los Cruces	Alamo Hueco Mtns.			OPEN	
NM	Los Cruces	Apache Box			OPEN	
NM	Los Cruces	Big Hatchet Mtns			OPEN	
NM	Los Cruces	Bear Creek			OPEN	
NM	Los Cruces	Central Peloncillo Mtns.			OPEN	
NM	Los Cruces	Cooke's Range			OPEN	
NM	Los Cruces	Cowboy Spring			OPEN	
NM	Los Cruces	Florida Mtns			OPEN	
NM	Los Cruces	Gila Lower Box			OPEN	
NM	Los Cruces				OPEN	
NM	Los Cruces	Gila Middle Box			OPEN	
NM	Los Cruces	Granite Gap			OPEN	
NM	Los Cruces	Guadalupe Canyon			OPEN	
NM	Los Cruces	Los Tules		CLOSED		NSO
NM	Los Cruces	Northern Peloncillo Mtns.			OPEN	
NM	Los Cruces	Old Town			OPEN	
NM	Los Cruces	Organ/Franklin Mtns			OPEN	
NM	Los Cruces	Rincon		CLOSED		NSO
NM	Los Cruces	Robledo Mtns			OPEN	
NM	Los Cruces	San Diego Mtn.			OPEN	
NM	Los Cruces	Uvas Valley			OPEN	
NM	Los Cruces	Aden Lava Flow RNA			OPEN	
NM	Los Cruces	Antelope Pass RNA			OPEN	
NM	Los Cruces	Kilbourne Hole NNL			OPEN	
NM	Los Cruces	Lordsburg Playa RNA			OPEN	
NM	Los Cruces	Paleozoic Trackways RNA			OPEN	
NM	Socorro	Ladron Mt/Devil's Backbone Complex			OPEN	NSO
NM	Socorro	Cerro Pomo			OPEN	
NM	Socorro	Horse Mountain			OPEN	NSO
NM	Socorro	Tinajas	40	CLOSED		
NM	Socorro	Sawtooth			OPEN	NSO
NM	Socorro	San Pedro			OPEN	NSO
NM	Socorro	Zuni Salt Lake	46,746	CLOSED		
NM	Socorro	Pelona Mountain			OPEN	CSU
NM	Taos	San Antonio Gorge	547		OPEN	NSO
NM	Taos	San Antonio WSA	7,000	CLOSED		None

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State	District and/or Field Office	ACEC Name	Acres	Closed to Leasing	Open to Geothermal Leasing	Applicable Stipulations*
NM	Taos	San Antonio	75,500		OPEN	CSU
NM	Taos	Winter Range	6,688		OPEN	TL
NM	Taos	Rio Grande and Red Wild and Scenic	17,286	CLOSED		None
NM	Taos	Wild Rivers Recreation Area			OPEN	NSO
NM	Taos	Orilla Verde Recreation Area	8,406	CLOSED		None
NM	Taos	Copper Hill			OPEN	NSO
NM	Taos	Lower Gorge	16,351	CLOSED		None
NM	Taos	Black Mesa			OPEN	CSU
NM	Taos	Ojo Caliente	13,000		OPEN	CSU
NM	Taos	Sombrillo	9,000		OPEN	CSU
NM	Taos	Ku Pueblo	65		OPEN	NSO
NM	Taos	Ojo de Zorro Pueblo	24		OPEN	NSO
NM	Taos	Pueblo Quemado	159		OPEN	NSO
NM	Taos	Pueblo Sarco	10		OPEN	NSO
NM	Taos	San Lazaro Pueblo	77		OPEN	NSO
NM	Taos	La Cienega	3,556		OPEN	NSO
NM	Taos	Rio Chama	19,956	CLOSED		None
NM	Taos	Santa Cruz Lake Recreation Area	640		OPEN	NSO
NM	Taos	Sabinoso WSA	15,760	CLOSED		None
NM	Taos	Riparian Aquatic			OPEN	None
NV	Elko	Salt Lake	6,037			
NV	Winnemucca	Osgood Mountains Milkvetch	60		OPEN	NSO
NV	Winnemucca	Soldier Meadows	2,077			
NV	Winnemucca	Pine Forest	42,398	CLOSED		
NV	Winnemucca	Stillwater	55,322	CLOSED		
NV	Winnemucca	Raised Bog	40	CLOSED		
NV	Carson City	Carson Wandering Skipper	243	CLOSED		
NV	Carson City	Incandescent Rocks	1,072		OPEN	
NV	Carson City	Pah Rah High Basin Petroglyph District	3,881	CLOSED		
NV	Carson City	Steamboat	40	CLOSED		
NV	Carson City	Stewart Valley	16,000		OPEN	None
NV	Carson City	Virginia Range Williams Combleaf Habitat	473	CLOSED		
NV	Ely	Beaver Dam Slope	36,900			
NV	Ely	Kane Springs	65,900			
NV	Ely	Morman Mesa	109,700		OPEN	NSO
NV	Las Vegas	Arden Historic Sites	1,480		OPEN	NSO
NV	Las Vegas	Armagosa Mesquite	6,891		OPEN	TL, CSU
NV	Las Vegas	Arrow Canyon	2,084		OPEN	NSO
NV	Las Vegas	Ash Meadows	37,152	CLOSED		
NV	Las Vegas	Big Dune	1,920		OPEN	NSO
NV	Las Vegas	Bird Spring	161		OPEN	NSO

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NV	Las Vegas	Coyote Springs	75,500		OPEN	NSO
NV	Las Vegas	Crescent Townsite	437		OPEN	NSO
NV	Las Vegas	Devil's Throat	640		OPEN	NSO, NNR
NV	Las Vegas	Gold Butte Part A	185,569		OPEN	NSO
NV	Las Vegas	Gold Butte Part B	118,937		OPEN	TL, CSU
NV	Las Vegas	Gold Butte Part C (Virgin Mtns)	38,431	CLOSED		
NV	Las Vegas	Gold Butte Townsites	160		OPEN	NSO, NNR
NV	Las Vegas	Hidden Valley	3,360		OPEN	NSO
NV	Las Vegas	Keyhole Canyon	361		OPEN	NSO
NV	Las Vegas	Morman Mesa	151,360		OPEN	NSO
NV	Las Vegas	Piute/Eldorado	329,440		OPEN	NSO
NV	Las Vegas	Rainbow Gardens	37,620		OPEN	NSO
NV	Las Vegas	Red Rock Springs	640		OPEN	NSO, NNR
NV	Las Vegas	River Mountains	5,617		OPEN	NSO
NV	Las Vegas	Sloan Rock Art District	0		OPEN	NSO
NV	Las Vegas	Stump Spring	641		OPEN	NSO
NV	Las Vegas	Timber Mountain Caldera	110,720			
NV	Las Vegas	Virgin River	6,411		OPEN	NSO
NV	Las Vegas	Whitney Pocket	160		OPEN	NSO, NNR
NV	Battle Mt	Lunar Crater	39,680		OPEN	
NV	Battle Mt	Amargosa-Oasis	490		OPEN	
NV	Battle Mt	Cane Man Hill	680		OPEN	
NV	Battle Mt	Lone Mountain	14,400		OPEN	
NV	Battle Mt	Railroad Valley	15,470		OPEN	
NV	Battle Mt	Rhyolite	425		OPEN	
NV	Battle Mt	Tybo-McIntyre Charcoal Kilns	80		OPEN	
ID	Four Rivers	Snake River Birds of Prey NCA	26,300	CLOSED		
ID	Four Rivers	Guffey Butte/Black Butte Archaeological District			OPEN	
ID	Four Rivers	Boise Front	12,000		OPEN	None
ID	Four Rivers	Columbian Sharp-tailed Gouse Habitat	4,200		OPEN	TL
ID	Four Rivers	Long-billed Curlew Habitat	61,000		OPEN	TL
ID	Owyhee	Owyhee River Bighorn Sheep Habitat Area	112,276		OPEN	NSO
ID	Owyhee	Boulder Creek ONA	6,978		OPEN	NSO
ID	Owyhee	Coal Mine Basin RNA	1,604		OPEN	NSO
ID	Owyhee	Guffey Butte/Black Butte Archaeological District	7,750	CLOSED		
ID	Owyhee	McBride Creek RNA	261	CLOSED		
ID	Owyhee	Jump Creek Canyon	612	CLOSED		
ID	Owyhee	Cinnabar	277	CLOSED		
ID	Owyhee	Pleasant Valley Table RNA	1,467	CLOSED		
ID	Owyhee	Sommercamp Butte RNA	440	CLOSED		

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ID	Owyhee	Squaw Creek RNA	150	CLOSED		
ID	Owyhee	The Badlands RNA	1,833	CLOSED		
ID	Owyhee	The Tules RNA	114	CLOSED		
ID	Owyhee	North Fork Juniper Woodland ONA	4,204	CLOSED		
ID	Bruneau	Mud Flat Oolite RNA	5		OPEN	NSO
ID	Bruneau	Owyhee River Bighorn Sheep Habitat Area	56,123		OPEN	NSO
ID	Bruneau	Triplet Butte	304		OPEN	NSO
ID	Bruneau	Cottonwood Creek	325		OPEN	NSO
ID	Jarbidge	Sand Point	810		OPEN	NSO
ID	Jarbidge	Salmon Falls Creek	2,697		OPEN	NSO
ID	Jarbidge	Bruneau-Jarbidge River	85,224		OPEN	NSO
ID	Salmon	Trial Creek			OPEN	NSO
ID	Salmon	Sevenmile			OPEN	NSO
ID	Upper Snake	North Menan Butte	1,120		OPEN	NSO
ID	Upper Snake	Nine Mile Knoll	40,090		OPEN	NSO
ID	Upper Snake	Snake River	11,120		OPEN	NSO
ID	Upper Snake	Henry's Lake	1,681		OPEN	NSO
ID	Upper Snake	North Menan Butte RNA			OPEN	NSO
ID	Upper Snake	St. Anthony Sand Dunes RNA			OPEN	NSO
ID	Upper Snake	Game Creek RNA			OPEN	NSO
ID	Upper Snake	Reid Canal Island RNA			OPEN	NSO
ID	Upper Snake	Pine Creek RNA			OPEN	NSO
ID	Upper Snake	Squaw Creek RNA			OPEN	NSO
ID	Upper Snake	China Cup Butte		CLOSED		
ID	Challis	Antelope Flat RNA			OPEN	
ID	Challis	Birch Creek			OPEN	
ID	Challis	Cronk's Canyon RNA			OPEN	
ID	Challis	Donkey Hills			OPEN	
ID	Challis	Dry Gulch RNA			OPEN	
ID	Challis	East Fork Salmon River Bench RNA			OPEN	
ID	Challis	Herd Creek Watershead RNA			OPEN	
ID	Challis	Lone Bird			OPEN	
ID	Challis	Malm Gulch/Germer Basin RNA			OPEN	
ID	Challis	Peck's Canyon RNA			OPEN	
ID	Challis	Penal Gulch			OPEN	
ID	Challis	Sand Hollow			OPEN	
ID	Challis	Summit Creek RNA			OPEN	
ID	Challis	Thousand Springs RNA			OPEN	
ID	Pocatello	Downey Watershead			OPEN	NSO
ID	Pocatello	Bown Canyon Blad Eagle Sanctury			OPEN	NSO

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ID	Pocatello	Old Juniper Townsite			OPEN	NSO
ID	Pocatello	Indian Rocks			OPEN	NSO
ID	Pocatello	Travertine Park			OPEN	NSO
ID	Pocatello	Stump Creek			OPEN	NSO
ID	Pocatello	Van Komn Homestead			OPEN	NSO
ID	Pocatello	Dairy Hollow RNA			OPEN	NSO
ID	Pocatello	Formation Cave RNA			OPEN	NSO
ID	Pocatello	Oneida Narrows RNA			OPEN	NSO
ID	Pocatello	Pine Gap RNA			OPEN	NSO
ID	Pocatello	Robber's Roost RNA			OPEN	NSO
ID	Pocatello	Cheatbeck Canyon RNA			OPEN	NSO
ID	Burley	Granite Pass-Goose Creek Trail			OPEN	TL
ID	Burley	Goose Creek Mesa		CLOSED		
ID	Burley	Jim Sage Canyon			OPEN	TL
ID	Burley	Oregon California Trail Junction			OPEN	
ID	Burley	Salmon Falls Creek			OPEN	NSO
ID	Burley/Shoshone	Sub-Station Tract			OPEN	NSO
ID	Burley/Shoshone	Playas			OPEN	NSO
ID	Burley/Shoshone	Box Canyon			OPEN	
ID	Burley/Shoshone	Vineland Lake			OPEN	
ID	Shoshone	King Hill			OPEN	
ID	Shoshone	McKinney Butte			OPEN	
ID	Shoshone	Tee-Maze			OPEN	
ID	Shoshone	Big Beaver			OPEN	
ID	Shoshone	Sun Peak			OPEN	
ID	Shoshone	Elk Mountain			OPEN	
OR	Lakeview	Devils Garden ACEC	28,241	CLOSED		
OR	Lakeview	Lake Abert ACEC	50,165	CLOSED		NSO
OR	Lakeview	Lost Forest/Sand Dunes/Fossil Lake ACEC Complex	8,500	OPEN		None
OR	Lakeview	Lost Forest RNA	8,883	CLOSED		
OR	Lakeview	Sand Dunes	9,125	CLOSED		
OR	Lakeview	Fossil Lake	8,988		OPEN	NSO
OR	Lakeview	Warner Wetlands ACEC	52,033		OPEN	NSO
OR	Lakeview	Abert Rim ACEC	18,049	CLOSED		
OR	Lakeview	Black Hills ACEC/RNA	3,048		OPEN	NSO
OR	Lakeview	Connley Hills ACEC/RNA	3,599		OPEN	NSO
OR	Lakeview	Fish Creek Rim ACEC/RNA	8,725		OPEN, portion closed	
OR	Lakeview	Foley Lake ACEC/RNA	2,230		OPEN	
OR	Lakeview	Guano Creek/Sink Lakes ACEC/RNA	11,199	CLOSED		
OR	Lakeview	Hawksie-Walksie ACEC/RNA	17,339	CLOSED		
OR	Lakeview	High Lakes ACEC	38,985		OPEN	

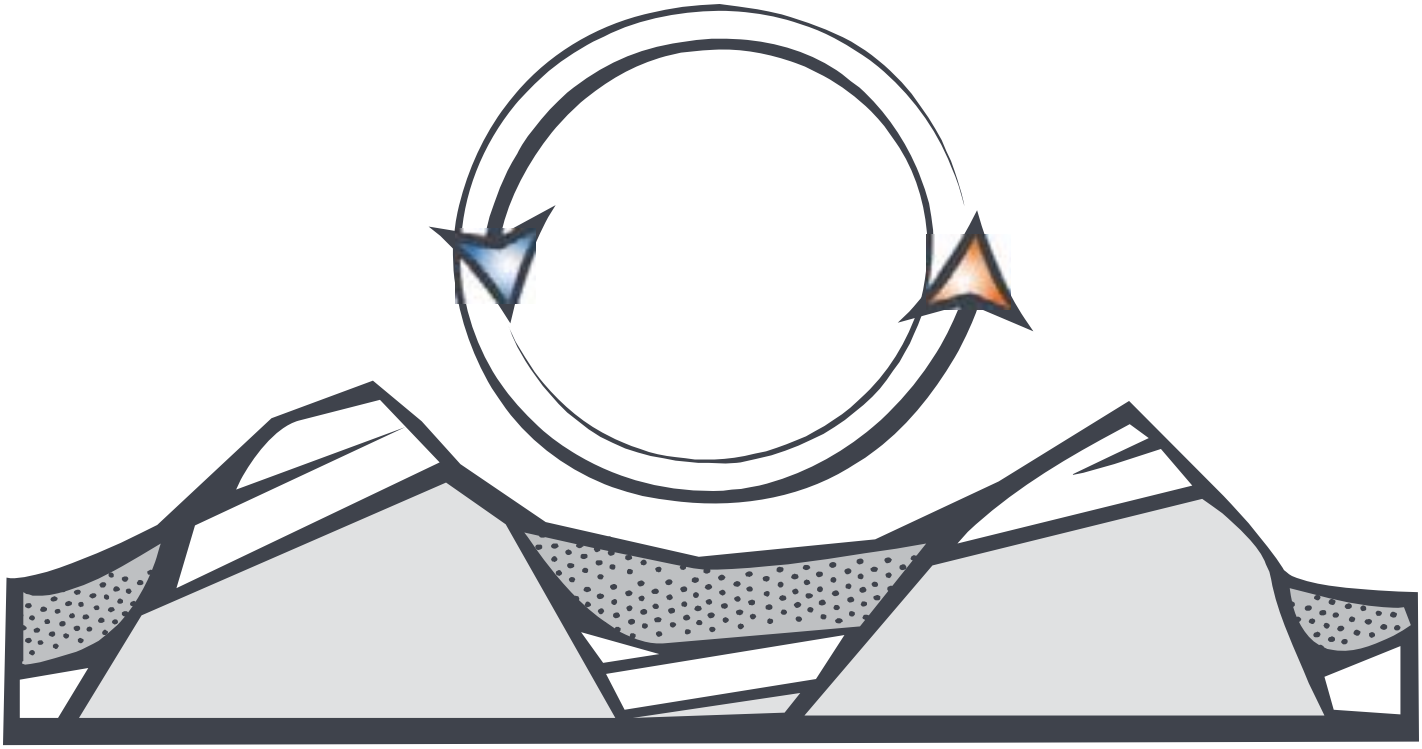
List of Acronyms : NSO = No Surface Occupancy, TL = Timing Limitations, CSU = Controled Ssurface Use, CSM = Control Surface Management, CNL =Closed to New Leasing, NNR = No New ROW

State	District and/or Field Office	ACEC Name	Acres	Closed to Leasing	Open to Geothermal Leasing	Applicable Stipulations*
OR	Lakeview	Juniper Mountain ACEC/RNA	6,335		OPEN	NSO
OR	Lakeview	Rahilly-Gravelly ACEC/RNA	19,648		OPEN	NSO
OR	Lakeview	Red Knoll ACEC	11,127		OPEN	
OR	Lakeview	Spanish Lake ACEC/RNA	4,699		OPEN	
OR	Lakeview	Table Rock ACEC	5,139		OPEN	NSO
OR	Klamath Falls	Upper Klamath River ACEC	5,092		OPEN	NSO
OR	Klamath Falls	Miller Creek ACEC	2,000		OPEN	NSO
OR	Klamath Falls	Yainax Butte ACEC	720		OPEN	NSO
OR	Klamath Falls	Spencer Creek OHV Vehicle Closure (Riparian)	320		OPEN	NSO
OR	Klamath Falls	Clover Creek Forest Educational Area	30		OPEN	NSO
OR	Klamath Falls	Surveyor Forest Special Management Area	150		OPEN	NSO
OR	Klamath Falls	Bumpheads Special Management Area	50		OPEN	NSO
OR	Klamath Falls	Old Baldy Research Natural Area	620		OPEN	NSO
OR	Klamath Falls	Alkali Lake Special Management Area	240		OPEN	NSO
OR	Klamath Falls	Tunnel Creek Special Management Area	280		OPEN	NSO
OR	Klamath Falls	Wood River Wetland	3,220		OPEN	NSO
OR	Klamath Falls	Four Mile Wetland	1,173		OPEN	NSO
WY	Casper	Jackson Canyon			OPEN	NSO
WY	Casper	Salt Creek			OPEN	None
WY	Casper	Alcova Fossil Area			OPEN	None
WY	Casper	Bates Hole			OPEN	CSU
WY	Cody	Carter Mountain	7,819		OPEN	None
WY	Cody	Chapman Bench	160		OPEN	None
WY	Cody	Five Springs Falls	160		OPEN	NSO
WY	Cody	Little Mountain	22,270		OPEN	None
WY	Cody	Sheep Mtn Anticline	12,285		OPEN	NSO
WY	Kemmer	Raymond Mountain			OPEN	
WY	Lander	Green Mountain			OPEN	
WY	Newcastle	Whoopup Canyon			OPEN	
WY	Pinedale	Rock Creek			OPEN	
WY	Pinedale	Beaver Creek			OPEN	
WY	Rawlings	Como Bluff			OPEN	
WY	Rawlings	Sand Hills			OPEN	
WY	Rawlings	Jep Canyon			OPEN	
WY	Rawlings	Shamrock Hills			OPEN	
WY	Rock Springs	Greater Red Creek	131,890	CLOSED		
WY	Rock Springs	Greater Sand Dunes	38,650		OPEN	TL
WY	Rock Springs	Natural Corrals	1,276		OPEN	NSO

List of Acronyms : NSO = No Surface Occupancy, TL = Timing Limitations, CSU = Controled Ssurface Use, CSM = Control Surface Management, CNL =Closed to New Leasing, NNR = No New ROW

State	District and/or Field Office	ACEC Name	Acres	Closed to Leasing	Open to Geothermal Leasing	Applicable Stipulations*
WY	Rock Springs	Oregon Buttes	3,450	CLOSED		
WY	Rock Springs	Pine Springs	6,030		OPEN	
WY	Rock Springs	Steamboat Mtn	43,270		OPEN	
WY	Rock Springs	South Pass Historic Landscape	53,780		OPEN	
WY	Rock Springs	White Mtn Petroglyphs	20		OPEN	TL, NSO
WY	Worland	Upper Owl Creek			OPEN	
WY	Worland	Spanish Point Karst		CLOSED		

* Stipulations and limitions are based on information provided. The lack of such constraints does not mean that they do not exist for the



Appendix D

Best Management Practices

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APPENDIX D
BEST MANAGEMENT PRACTICES – MITIGATION MEASURES

Best Management Practices (BMP) are state-of-the-art mitigation measures applied on a site-specific basis to reduce, prevent, or avoid adverse environmental or social impacts. They are applied to management actions to aid in achieving desired outcomes for safe, environmentally responsible resource development, by preventing, minimizing, or mitigating adverse impacts and reducing conflicts.

This appendix provides a list of sample Best Management Practices have been collected from various BLM and FS documents addressing geothermal and fluid mineral leasing and development, including resource management plans (RMPs), forest plans, and environmental reports for geothermal leasing and development. The purpose of this appendix is to provide a list of recommended BMPs that could be applied to the use authorizations on a site-specific basis as conditions of approval or could be proactively incorporated into the permit application by the lessee. When implementing new BMPs, offices are encouraged to work with an affected lessee early in the process, to explain how BMPs may fit into their development proposals and how BMPs can be implemented with the least economic impact to the lessee. Offices should discuss potential resource impacts with the lessee and seek the operator's recommended solutions. The office should also encourage the lessee to incorporate necessary and effective BMPs into their project proposal. Best Management Practices not incorporated into the permit application by the lessee may be considered and evaluated through the environmental review process and incorporated into the permit as conditions of approval or rights-of-way stipulations.

All offices shall incorporate appropriate environmental BMPs into proposed use authorizations after appropriate environmental review. Environmental BMPs to be considered in nearly all circumstances include the following:

Interim reclamation of well locations and access roads soon after the well is put into production;

- Painting of all new facilities a color that best allows the facility to blend with the background, typically a vegetated background;
- Design and construction of all new roads to a safe and appropriate standard, "no higher than necessary" to accommodate their intended use; and
- Final reclamation recontouring of all disturbed areas, including access roads, to the original contour or a contour that blends with the surrounding topography.

Other environmental BMPs are more suitable for consideration by an administrative unit on a case-by-case basis, (1) depending on their effectiveness, (2) the balancing of increased operating costs vs. the benefit to the public and resource values, (3) the availability of less restrictive mitigation alternatives that accomplish the same objective, and (4) other site specific factors. Examples of typical, case-by-case BMPs are identified below.

Guidelines for applying and selecting project-specific requirements include determining whether the measure would (1) ensure compliance with relevant statutory or administrative requirements, (2) minimize local impacts associated with siting and design decisions, (3) promote post construction stabilization of impacts, (4) maximize restoration of previous habitat conditions, (5) minimize cumulative impacts, or (6) promote economically feasible development of geothermal energy on BLM-administered or FS-administered land.

The following typical BMPs provide the BLM, FS, industry, and stakeholders a set of improved practices for developing geothermal energy and minimize impacts to the biophysical and cultural landscape. The list is comprehensive but is not meant to be all inclusive given the constant development of improved practices, diversity of the western states, and potential for unique site-specific conditions. Local land use plans may contain other BMPs that better address such unique situations. Where the BMPs presented here are inconsistent with or incompatible with those developed under a specific land use plan, the staff will conduct an environmental review to determine the appropriate practices.

The list is presented according to development phase and is subgrouped by resources. Since a number of these BMPs can be applied to a variety of situations and during multiple phases of development, operations, and maintenance, there may be duplication of or similarity between them. Furthermore, although these BMPs may be identified for specific situations or

actions (e.g. drilling or road construction), they are not exclusive to those actions unless otherwise specified. A menu of typical BMPs can also be found on the BLM Washington Office Fluid Minerals web site at: www.blm.gov/bmp

PHASE 1: EXPLORATION

General

- The area disturbed by monitoring and testing (i.e., footprint) shall be kept to a minimum.
- Existing roads shall be used to the maximum extent feasible. If new roads are necessary, they shall be designed and constructed to the appropriate standard.
- Available information describing the environmental and sociocultural conditions in the vicinity of the proposed project shall be collected and reviewed as needed to predict potential impacts of the project.
- The project shall be planned to utilize existing roads and utility corridors to the maximum extent practicable, and to minimize the number and length/size of new roads, lay-down areas, and borrow areas.
- A monitoring program shall be developed to ensure that environmental conditions are monitored during the well drilling, testing, and construction phases. The monitoring program requirements, including adaptive management strategies, shall be established at the project level to ensure that potential adverse impacts of geothermal development are mitigated. The monitoring program shall identify the monitoring requirements for each environmental resource present at the site, establish metrics against which monitoring observations can be measured, identify potential mitigation measures, and establish protocols for incorporating monitoring observations and additional mitigation measures into standard operating procedures and BMPs.
- "Good housekeeping" procedures shall be developed to ensure that during operation the site will be kept clean of debris, garbage, fugitive trash or waste, and graffiti; to prohibit scrap heaps and dumps; and to minimize storage yards.
- All control and mitigation measures established for the project in the operation plan and the resource-specific management plans that are part of the operation plan shall be maintained and implemented throughout construction and operation of the project, as appropriate.
- Existing sites shall be used in preference to new sites.

- Site monitoring protocols defined in the operation plan shall be implemented. These will incorporate monitoring program observations and additional mitigation measures into standard operating procedures and BMPs to minimize future environmental impacts.
- Results of monitoring program efforts shall be provided to the BLM authorized officer.
- Operators shall identify unstable slopes and local factors that can induce slope instability (such as groundwater conditions, precipitation, earthquake activities, slope angles, and the dip angles of geologic strata). Operators also shall avoid creating excessive slopes during excavation and blasting operations. Special construction techniques shall be used where applicable in areas of steep slopes, erodible soil, and stream channel crossings.

Land Use, Recreation, and Special Designations

- The BLM and operators shall contact appropriate agencies, property owners, and other stakeholders early in the planning process to identify potentially sensitive land uses and issues, rules that govern geothermal energy development locally, and land use concerns specific to the region.
- The Secretary of Agriculture's rules and regulations must be complied with for all use and occupancy of the NFS lands prior to approval of an exploration plan by the Secretary of Interior and for uses of all existing improvements, such as forest development roads, within and outside the area permitted by the Secretary of Interior; and use and occupancy of the NFS lands not authorized by an exploration plan approved by the Secretary of Interior.
- To plan for efficient use of the land, necessary infrastructure requirements shall be consolidated wherever possible, and current transmission and market access shall be evaluated carefully.
- An access road siting and management plan shall be prepared incorporating existing BLM standards regarding road design, construction, and maintenance such as those described in the BLM 9113 Manual and the *Surface Operating Standards for Oil and Gas Exploration and Development* (i.e., the Gold Book).
- A traffic management plan shall be prepared for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan shall incorporate measures such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any necessary changes in temporary lane configuration.

- Existing roads shall be used, but only if in safe and environmentally sound locations. If new roads are necessary, they shall be designed and constructed to the appropriate standard and be no higher than necessary to accommodate their intended functions (e.g., traffic volume and weight of vehicles).
- Excessive grades on roads, road embankments, ditches, and drainages shall be avoided, especially in areas with erodible soils. Special construction techniques shall be used, where applicable. Abandoned roads and roads that are no longer needed shall be recontoured and revegetated.
- Access roads and on-site roads shall be surfaced with aggregate materials, wherever appropriate.
- Access roads shall be located to follow natural contours and minimize side hill cuts.
- Roads shall be designed so that changes to surface water runoff are avoided and erosion is not initiated.
- Road use shall be restricted during the wet season if road surfacing is not adequate to prevent soil displacement, rutting, etc., and resultant stream sedimentation.
- Road use shall be restricted during the wet season if road surfacing is not adequate to prevent soil displacement, rutting, etc., and resultant stream sedimentation.
- Potential soil erosion shall be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts shall be cleaned and maintained regularly.
- Project personnel and contractors shall be instructed and required to adhere to speed limits commensurate with road types, traffic volumes, vehicle types, and site-specific conditions, to ensure safe and efficient traffic flow and to reduce wildlife collisions and disturbance and airborne dust.
- Traffic shall be restricted to the roads developed for the project. Use of other unimproved roads shall be restricted to emergency situations.
- Signs shall be placed along construction roads to identify speed limits, travel restrictions, and other standard traffic control information. To minimize impacts on local commuters, consideration shall be given to limiting construction vehicles traveling on public roadways during the morning and late afternoon commute time.

- Signs directing vehicles to alternative park access and parking would be posted in the event construction temporarily obstructs recreational parking areas near trailheads.
- Whenever active work is being performed, the area would be posted with "construction ahead" signs on any adjacent access roads or trails that might be affected.
- Whenever possible, construction activities would be avoided during high recreational use periods.
- Operators shall consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) shall be identified and addressed in the traffic management plan;
- Access roads shall be located to minimize stream crossings. All structures crossing streams shall be located and constructed so that they do not decrease channel stability or increase water velocity. Operators shall obtain all applicable federal and state permits.
- Stream crossings on newly constructed roads should be designed to handle a 100 year flood event, and also provide for fish passage
- Existing drainage systems shall not be altered, especially in sensitive areas such as erodible soils or steep slopes.
- Roads shall be located away from drainage bottoms and avoid wetlands, if practicable.

Geologic Resources and Seismic Setting

- Prior to geothermal exploration and development, a complete subsurface geotechnical investigation would be conducted to analyze the soil and geologic conditions. The investigation would evaluate and identify potential geologic hazards and would provide remedial grading recommendations, foundation and slab design criteria, and soil parameters for the design of geothermal power infrastructure.
- A detailed geotechnical analysis would be performed prior to the construction of any structures; so they could be sited to avoid any hazards from subsidence or liquefaction (i.e., the changing of a saturated soil from a relatively stable solid state to a liquid during earthquakes or nearby blasting).

Paleontological Resources

- Operators shall determine whether paleontological resources exist in a project area on the basis of the sedimentary context of the area, a records search for past paleontological finds in the area,

and/or, depending on the extent of existing information, a paleontological survey.

- If paleontological resources are present at the site, or if areas with a high potential to contain paleontological material have been identified, a paleontological resources management plan shall be developed. This plan shall include a mitigation plan for collection of the fossils; mitigation could include avoidance, removal of fossils, or monitoring. If an area exhibits a high potential but no fossils were observed during survey, monitoring by a qualified paleontologist could be required during all excavation and earthmoving in the sensitive area. A report shall be prepared documenting these activities. The paleontological resources management plan also shall (1) establish a monitoring program, (2) identify measures to prevent potential looting/vandalism or erosion impacts, and (3) address the education of workers and the public to make them aware of the consequences of unauthorized collection of fossils on public land.
- Unexpected discovery of cultural or paleontological resources during construction shall be brought to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.

Soil Resources

- Foundations and trenches shall be backfilled with originally excavated material as much as possible. Excess excavation materials shall be disposed of only in approved areas or, if suitable, stockpiled for use in reclamation activities.
- Borrow material shall be obtained only from authorized and permitted sites.

Water Resources

- Operators shall develop a storm water management plan for the site to ensure compliance with applicable regulations and prevent off-site migration of contaminated storm water or increased soil erosion.
- Operators shall gain a clear understanding of the local hydrogeology. Areas of groundwater discharge and recharge and their potential relationships with surface water bodies shall be identified.
- Operators shall avoid creating hydrologic conduits between two aquifers during foundation excavation and other activities.

Air Quality and Climate

The following BMPs would be incorporated into lease terms to minimize air quality impacts from fugitive dust:

- The number and size/length of roads, temporary fences, lay-down areas, and borrow areas shall be minimized.
- Topsoil from all excavations and construction activities shall be salvaged and reapplied during reclamation.
- All areas of disturbed soil shall be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities shall be undertaken as early as possible on disturbed areas.
- Erosion controls that comply with county, state, and federal standards shall be applied. Practices such as jute netting, silt fences, and check dams shall be applied near disturbed areas.
- Dust abatement techniques shall be used on unpaved, unvegetated surfaces to minimize airborne dust.
- Speed limits (e.g., 25 mph [40 kph]) shall be posted and enforced to reduce airborne fugitive dust.
- Construction materials and stockpiled soils shall be covered if they are a source of fugitive dust.
- Dust abatement techniques shall be used before and during surface clearing, excavation, or blasting activities.

For managing diesel exhaust, each individual project proponent should be required to prepare and submit to the BLM an Equipment Emissions Mitigation Plan. Requirements for emissions controls should be incorporated into the lease terms for individual geothermal leases. An Equipment Emissions Mitigation Plan will identify actions to reduce diesel particulate, carbon monoxide, hydrocarbons, and nitrogen oxides associated with construction and drilling activities. The Equipment Emissions Mitigation Plan should apply to all lands authorized for lease and should require that all drilling/construction-related engines are maintained and operated as follows:

- Are tuned to the engine manufacturer's specification in accordance with an appropriate time frame.
- Do not idle for more than five minutes (unless, in the case of certain drilling engines, it is necessary for the operating scope).
- Are not tampered with in order to increase engine horsepower.
- Include particulate traps, oxidation catalysts, and other suitable control devices on all drilling/construction equipment used at the project site.

- Use diesel fuel having a sulfur content of 15 parts per million or less, or other suitable alternative diesel fuel, unless such fuel cannot be reasonably procured in the market area.
- Include control devices to reduce air emissions. The determination of which equipment is suitable for control devices should be made by an independent Licensed Mechanical Engineer. Equipment suitable for control devices may include drilling equipment, work over and service rigs, mud pumps, generators, compressors, graders, bulldozers, and dump trucks.

Vegetation and Fish and Wildlife

- Installation of any equipment or well drilling shall be scheduled to avoid disruption of wildlife reproductive activities or other important behaviors.
- Operators shall review existing information on species and habitats in the vicinity of the project area to identify potential concerns.
- A habitat restoration plan shall be developed to avoid (if possible), minimize, or mitigate negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. The plan shall identify revegetation, soil stabilization, and erosion reduction measures that shall be implemented to ensure that all temporary use areas are restored. The plan shall require that restoration occur as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to speed up the recovery to natural habitats.
- Existing roads should be used to the maximum extent feasible to access a proposed project area.
- If new access roads are necessary, they should be designed and constructed to the appropriate standard.
- Existing or new roads should be maintained to the condition needed for facility use.
- The area disturbed during exploration and development (i.e., temperature gradient wells, well pads, roadways) should be minimized.
- Drill pads should not be located in or near sensitive habitats or in areas where vegetation or important habitats are known to be sensitive to human activities.
- Mitigation measures should be considered during planning and design to ensure that the siting of geothermal projects and associated roadways and structures do not result in unacceptable impacts on important habitats.

- Operators should identify important, sensitive, or unique habitat and biota in the project vicinity and site and should design the project to avoid (if possible), minimize, or mitigate potential impacts on these resources. The design and siting of the facility should follow appropriate guidance and requirements from the BLM, FS, and other resource agencies, as available and applicable.
- The BLM, FS, and operators should contact appropriate agencies early in the planning process to identify potentially sensitive ecological resources that may be present in the area of proposed geothermal development.
- The operators should conduct surveys for federal- and state-protected species and other species of concern within the project area.
- The project should be planned to avoid (if possible), minimize, or mitigate impacts on wildlife and habitat.
- Habitat disturbance should be minimized by locating facilities such as pipelines and access roads in previously disturbed areas (i.e., locate transmission lines within or adjacent to existing powerline corridors).
- Existing roads and utility corridors should be used to the maximum extent feasible.
- New access roads and utility corridors should be configured to avoid high-quality habitats and minimize habitat fragmentation.
- Site access roads and utility corridors should minimize stream crossings.
- Where applicable, the extent of habitat disturbance should be reduced by keeping vehicles on access roads and minimizing foot and vehicle traffic through undisturbed areas.
- Erosion controls that comply with county, state, and federal standards should be applied. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.
- All areas of disturbed soil should be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities should be undertaken as early as possible on disturbed areas.
- Dust abatement techniques should be used on unpaved, unvegetated surfaces to minimize airborne dust.
- Construction materials and stockpiled soil should be covered if they are a source of fugitive dust.
- Erosion and fugitive dust control measures should be inspected and maintained regularly.

- All refueling should occur in a designated fueling area that includes a temporary berm to limit the spread of any spill.
- Drip pans should be used during refueling to contain accidental releases.
- Drip pans should be used under fuel pump and valve mechanisms of any bulk fueling vehicles parked at the construction site.
- Access roads and newly established utility and transmission line corridors should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
- Fill materials that originate from areas with known invasive vegetation problems should not be used.
- Certified weed-free mulch should be used when stabilizing areas of disturbed soil.
- Habitat restoration activities and invasive vegetation monitoring and control activities should be initiated as soon as possible after construction activities are completed.
- All areas of disturbed soil should be reclaimed using weed-free native shrubs, grasses, and forbs.
- Pesticide use should be limited to nonpersistent, immobile pesticides and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.
- Spills should be immediately addressed per the appropriate spill management plan, and soil cleanup and removal should be initiated, if needed.
- Access roads, utility and transmission line corridors, and geothermal plant sites should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
- Employees, contractors, and site visitors should be instructed to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. In addition, pets should be controlled to avoid harassment and disturbance of wildlife.
- BMPs to avoid or minimize the possibility of the unintentional take of migratory birds should be applied to all practices and projects. Practices should be applied to provide long-term benefits and improved vegetation community condition. If the proposed project or action does have the potential to impact migratory bird species populations which have been identified as occurring within the

project or action area, evaluate options to mitigate the project to minimize or eliminate the identified impacts during periods of concentrated nesting activity. Appropriate BMPs include:

a. Minimize/avoid impacts to nesting migratory birds by imposing a Timing Limitation on use authorizations to mitigate vegetative disturbing activities during the primary portion of the nesting season.

   Most migratory birds nest between May 15 to July 15, but dates should be adjusted for the species and environmental conditions. Timing limitations may be modified based upon the species affected and the timing or intensity of breeding activity of the species of Birds of Conservation Concern involved.

b. Where disturbance cannot be avoided, the scale and the length of time of disturbance may be considered mitigating circumstances.

c. Inspect and clear an area for migratory bird nesting. These clearances could be performed by qualified personnel. Factors to weigh in considering this option include vegetation type, vegetation density, timing and cost.

d. Explore opportunities to replace and prioritize habitat and habitat changes on or off site based upon the needs of Birds of Conservation Concern.

- Operators shall develop a plan for control of noxious weeds and invasive species, which could occur as a result of new surface disturbance activities at the site. The most recent recommendations at the state and local level should be incorporated into any operating plan for the geothermal exploration and development. The plan shall address monitoring, education of personnel on weed identification, the manner in which weeds spread, and methods for treating infestations. The use of certified weed-free mulching shall be required. If trucks and construction equipment are arriving from locations with known invasive vegetation problems, a controlled inspection and cleaning area shall be established to visually inspect construction equipment arriving at the project area and to remove and collect seeds that may be adhering to tires and other equipment surfaces.
- If pesticides are used on the site, an integrated pest management plan shall be developed to ensure that applications would be conducted within the framework of all Federal, State, and local laws and regulations and entail only the use of EPA-registered pesticides.
- Pesticide use shall be limited to nonpersistent, immobile pesticides and shall only be applied in accordance with label and application

permit directions and stipulations for terrestrial and aquatic applications.

- Explosives shall be used only within specified times and at specified distances from sensitive wildlife or streams and lakes, as established by the BLM or other federal and state agencies.

Wild Horses and Burros

- Employees, contractors, and site visitors shall be instructed to avoid harassment and disturbance of wild horses and burros, especially during reproductive (e.g., breeding and birthing) seasons. In addition, any pets shall be controlled to avoid harassment and disturbance of wild horses and burros.
- Observations of potential problems regarding wild horses or burros, including animal mortality, shall be reported to the authorized officer immediately.

Livestock Grazing

- Dust control measures would reduce impacts on livestock forage during construction and demolition activities;
- Development should minimize the number of structures required;
- Litter and noxious weeds should be controlled and removed regularly during construction and operation.

Cultural Resources

- Unexpected discovery of cultural or paleontological resources during construction shall be brought to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.
- Before any specific permits are issued under leases, treatment of cultural resources will follow the procedures established by the Advisory Council on Historic Preservation for compliance with Section 106 of the National Historic Preservation Act. A pedestrian inventory will be undertaken of all portions that have not been previously surveyed or are identified by BLM as requiring inventory to identify properties that are eligible for the NRHP. Those sites not already evaluated for NRHP eligibility will be evaluated based on surface remains, subsurface testing, archival, and/or ethnographic sources. Subsurface testing will be kept to a minimum whenever possible if sufficient information is available to evaluate the site or if avoidance is an expected mitigation outcome. Recommendations regarding the eligibility of sites will be submitted to the BLM, and a treatment plan will be prepared to detail methods for avoidance of

impacts or mitigation of effects. The BLM will make determinations of eligibility and effect and consult with SHPO as necessary based on each proposed lease application and project plans. The BLM may require modification to exploration or development proposals to protect such properties, or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized or mitigated. Avoidance of impacts through project design will be given priority over data recovery as the preferred mitigation measure. Avoidance measures include moving project elements away from site locations or to areas of previous impacts, restricting travel to existing roads, and maintaining barriers and signs in areas of cultural sensitivity. Any data recovery will be preceded by approval of a detailed research design, Native American Consultation, and other requirements for BLM issuance of a permit under the Archaeological Resources Protection Act (BLM 2007a).

- If cultural resources are present at the site, or if areas with a high potential to contain cultural material have been identified, a cultural resources management plan (CRMP) shall be developed. This plan shall address mitigation activities to be taken for cultural resources found at the site. Avoidance of the area is always the preferred mitigation option. Other mitigation options include archaeological survey and excavation (as warranted) and monitoring. If an area exhibits a high potential, but no artifacts were observed during an archaeological survey, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area. A report shall be prepared documenting these activities. The CRMP also shall (1) establish a monitoring program, (2) identify measures to prevent potential looting/vandalism or erosion impacts, and (3) address the education of workers and the public to make them aware of the consequences of unauthorized collection of artifacts and destruction of property on public land (BLM 2005).

National Scenic and Historic Trails

When any ROW application includes remnants of a National Historic Trail, is located within the viewshed of a National Historic Trail's designated centerline, or includes or is within the viewshed of a trail eligible for listing on the NRHP, the operator shall evaluate the potential visual impacts to the trail associated with the proposed project and identify appropriate mitigation measures for inclusion as stipulations in the operation plan.

Visual Resources

- The BLM will consider the visual resource values of the public lands involved in proposed projects, consistent with BLM Visual Resource Management (VRM) policies and guidance.

- The public shall be involved and informed about the visual site design elements of the proposed geothermal energy facilities. Possible approaches include conducting public forums for disseminating information, offering organized tours of operating geothermal developments, and using computer simulation and visualization techniques in public presentations.
- The BLM will work with the applicant to incorporate visual design considerations into the planning and design of the project to minimize potential visual impacts of the proposal and to meet the VRM objectives of the area. Power plants would be sited using terrain to obstruct visual impacts to the extent possible. Design elements would also include nonreflective paints, and prohibition of commercial messages on structures.
- Other site design elements shall be integrated with the surrounding landscape. Elements to address include minimizing the profile of the ancillary structures, burial of cables, prohibition of commercial symbols, and lighting. Regarding lighting, efforts shall be made to minimize the need for and amount of lighting on ancillary structures. Where practical, wells should be co-located to reduce road, pad and utility surface area and tank batteries centralized.
- Minimize the number of structures required;
- Construct low-profile structures whenever possible to reduce structure visibility;
- Select and design materials and surface treatments to repeat or blend with landscape elements;
- Control litter and noxious weeds and remove them regularly during construction and operation;
- Implement dust abatement measures to minimize the impacts of vehicular and pedestrian traffic, construction and operation, and wind on exposed surface soils;
- Operators shall reduce visual impacts during construction by minimizing areas of surface disturbance, controlling erosion, using dust suppression techniques, and restoring exposed soils as closely as possible to their original contour and vegetation.
- Nighttime lighting will be limited to areas necessary for the safe operation of the project and, where applicable, will include motion sensors to reduce nighttime lighting when not necessary.

Noise

- Proponents of a geothermal energy development project shall take measurements to assess the existing background noise levels at a

given site and compare them with the anticipated noise levels associated with the proposed project.

- Whenever reasonably possible, geothermal well drilling or major facility construction operations should be restricted to non-sleeping hours (7:00 am to 10:00 pm).
- All equipment shall have sound-control devices no less effective than those provided on the original equipment. All construction equipment used shall be adequately muffled and maintained.
- All stationary construction equipment (i.e., compressors and generators) shall be located as far as practicable from nearby residences.
- If blasting or other noisy activities are required during the construction period, nearby residents shall be notified in advance.

Health and Safety

- Any equipment installed for site monitoring and testing shall be inspected periodically for structural integrity.
- Operators shall develop a hazardous materials management plan addressing storage, use, transportation, and disposal of each hazardous material anticipated to be used at the site. The plan shall identify all hazardous materials that would be used, stored, or transported at the site. It shall establish inspection procedures, storage requirements, storage quantity limits, inventory control, nonhazardous product substitutes, and disposition of excess materials. The plan shall also identify requirements for notices to federal and local emergency response authorities and include emergency response plans.
- Operators shall develop a waste management plan identifying the waste streams that are expected to be generated at the site and addressing hazardous waste determination procedures, waste storage locations, waste-specific management and disposal requirements, inspection procedures, and waste minimization procedures. This plan shall address all solid and liquid wastes that may be generated at the site.
- Operators shall develop a spill prevention and response plan identifying where hazardous materials and wastes are stored on site, spill prevention measures to be implemented, training requirements, appropriate spill response actions for each material or waste, the locations of spill response kits on site, a procedure for ensuring that the spill response kits are adequately stocked at all times, and procedures for making timely notifications to authorities.

- A safety assessment shall be conducted to describe potential safety issues and the means that would be taken to mitigate them, including issues such as site access, construction, safe work practices, security, heavy equipment transportation, traffic management, emergency procedures, and fire control.
- A health and safety program shall be developed to protect both workers and the general public during construction and operation of geothermal projects.
- Regarding occupational health and safety, the program shall identify all applicable federal and state occupational safety standards; establish safe work practices for each task (e.g., requirements for personal protective equipment and safety harnesses; Occupational Safety and Health Administration [OSHA] standard practices for safe use of explosives and blasting agents; and measures for reducing occupational electric and magnetic fields [EMF] exposures); establish fire safety evacuation procedures; and define safety performance standards (e.g., electrical system standards and lightning protection standards). The program shall include a training program to identify hazard training requirements for workers for each task and establish procedures for providing required training to all workers. Documentation of training and a mechanism for reporting serious accidents to appropriate agencies shall be established.
- Regarding public health and safety, the health and safety program shall establish a safety zone or setback for generators from residences and occupied buildings, roads, ROWs, and other public access areas that is sufficient to prevent accidents resulting from the operation of generators. It shall identify requirements for temporary fencing around staging areas, storage yards, and excavations during construction or rehabilitation activities. It shall also identify measures to be taken during the operation phase to limit public access to hazardous facilities (e.g., permanent fencing would be installed only around electrical substations, and facility access doors would be locked).
- Operators shall consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) shall be identified and addressed in the traffic management plan.
- Operators shall develop a fire management strategy to implement measures to minimize the potential for a human-caused fire.
- Secondary containment shall be provided for all on-site hazardous materials and waste storage, including fuel. In particular, fuel storage

(for construction vehicles and equipment) shall be a temporary activity occurring only for as long as is needed to support construction activities.

- Wastes shall be properly containerized and removed periodically for disposal at appropriate off-site permitted disposal facilities.
- In the event of an accidental release to the environment, the operator shall document the event, including a root cause analysis, appropriate corrective actions taken, and a characterization of the resulting environmental or health and safety impacts. Documentation of the event shall be provided to the BLM authorized officer and other federal and state agencies, as required.
- Any wastewater generated in association with temporary, portable sanitary facilities shall be periodically removed by a licensed hauler and introduced into an existing municipal sewage treatment facility. Temporary, portable sanitary facilities provided for construction crews shall be adequate to support expected on-site personnel and shall be removed at completion of construction activities.
- Temporary fencing shall be installed around staging areas, storage yards, and excavations during construction to limit public access.

PHASE 2: DRILLING AND CONSTRUCTION

General

- The area disturbed monitoring and testing (i.e., footprint) shall be kept to a minimum.
- Existing roads shall be used to the maximum extent feasible. If new roads are necessary, they shall be designed and constructed to the appropriate standard.
- Available information describing the environmental and sociocultural conditions in the vicinity of the proposed project shall be collected and reviewed as needed to predict potential impacts of the project.
- The project shall be planned to utilize existing roads and utility corridors to the maximum extent feasible, and to minimize the number and length/size of new roads, lay-down areas, and borrow areas.
- A monitoring program shall be developed to ensure that environmental conditions are monitored during the well drilling, testing, and construction phases. The monitoring program requirements, including adaptive management strategies, shall be established at the project level to ensure that potential adverse impacts of geothermal development are mitigated. The monitoring program shall identify the monitoring requirements for each

environmental resource present at the site, establish metrics against which monitoring observations can be measured, identify potential mitigation measures, and establish protocols for incorporating monitoring observations and additional mitigation measures into standard operating procedures and BMPs.

- "Good housekeeping" procedures shall be developed to ensure that during operation the site will be kept clean of debris, garbage, fugitive trash or waste, and graffiti; to prohibit scrap heaps and dumps; and to minimize storage yards.
- All control and mitigation measures established for the project in the operation plan and the resource-specific management plans that are part of the operation plan shall be maintained and implemented throughout construction and operation of the project, as appropriate.
- Existing sites shall be used in preference to new sites.
- Site monitoring protocols defined in the operation plan shall be implemented. These will incorporate monitoring program observations and additional mitigation measures into standard operating procedures and BMPs to minimize future environmental impacts.
- Results of monitoring program efforts shall be provided to the BLM authorized officer.
- Operators shall identify unstable slopes and local factors that can induce slope instability (such as groundwater conditions, precipitation, earthquake activities, slope angles, and the dip angles of geologic strata). Operators also shall avoid creating excessive slopes during excavation and blasting operations. Special construction techniques shall be used where applicable in areas of steep slopes, erodible soil, and stream channel crossings.

Land Use, Recreation, and Special Designations

- The Secretary of Agriculture's rules and regulations must be complied with for all use and occupancy of the NFS lands prior to approval of an exploration plan by the Secretary of Interior and for uses of all existing improvements, such as forest development roads, within and outside the area permitted by the Secretary of Interior; and use and occupancy of the NFS lands not authorized by an exploration plan approved by the Secretary of Interior.
- To plan for efficient use of the land, necessary infrastructure requirements shall be consolidated wherever possible, and current transmission and market access shall be evaluated carefully.

- An access road siting and management plan shall be prepared incorporating existing BLM standards regarding road design, construction, and maintenance such as those described in the BLM 9113 Manual and the *Surface Operating Standards for Oil and Gas Exploration and Development* (i.e., the Gold Book).
- A traffic management plan shall be prepared for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan shall incorporate measures such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any necessary changes in temporary lane configuration.
- Existing roads shall be used, but only if in safe and environmentally sound locations. If new roads are necessary, they shall be designed and constructed to the appropriate standard and be no higher than necessary to accommodate their intended functions (e.g., traffic volume and weight of vehicles).
- Excessive grades on roads, road embankments, ditches, and drainages shall be avoided, especially in areas with erodible soils. Special construction techniques shall be used, where applicable. Abandoned roads and roads that are no longer needed shall be recontoured and revegetated.
- Access roads and on-site roads shall be surfaced with aggregate materials, wherever appropriate.
- Access roads shall be located to follow natural contours and minimize side hill cuts.
- Roads shall be designed so that changes to surface water runoff are avoided and erosion is not initiated.
- Road use shall be restricted during the wet season if road surfacing is not adequate to prevent soil displacement, rutting, etc., and resultant stream sedimentation.
- Potential soil erosion shall be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts shall be cleaned and maintained regularly.
- Project personnel and contractors shall be instructed and required to adhere to speed limits commensurate with road types, traffic volumes, vehicle types, and site-specific conditions, to ensure safe and efficient traffic flow and to reduce wildlife collisions and disturbance and airborne dust.
- Traffic shall be restricted to the roads developed for the project. Use of other unimproved roads shall be restricted to emergency situations.

- Signs shall be placed along construction roads to identify speed limits, travel restrictions, and other standard traffic control information. To minimize impacts on local commuters, consideration shall be given to limiting construction vehicles traveling on public roadways during the morning and late afternoon commute time.
- Signs directing vehicles to alternative park access and parking would be posted in the event construction temporarily obstructs recreational parking areas near trailheads.
- Whenever active work is being performed, the area would be posted with "construction ahead" signs on any adjacent access roads or trails that might be affected.
- Whenever possible, construction activities would be avoided during high recreational use periods.
- Operators shall consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) shall be identified and addressed in the traffic management plan;
- Access roads shall be located to minimize stream crossings. All structures crossing streams shall be located and constructed so that they do not decrease channel stability or increase water velocity. Operators shall obtain all applicable federal and state permits.
- Stream crossings on newly constructed roads should be designed to handle a 100 year flood event, and also provide for fish passage
- Existing drainage systems shall not be altered, especially in sensitive areas such as erodible soils or steep slopes.
- Roads shall be located away from drainage bottoms and avoid wetlands, if practicable.

Geologic Resources and Seismic Setting

- A detailed geotechnical analysis would be performed prior to the construction of any structures; so they could be sited to avoid any hazards from subsidence or liquefaction (i.e., the changing of a saturated soil from a relatively stable solid state to a liquid during earthquakes or nearby blasting).

Paleontological Resources

- Operators shall determine whether paleontological resources exist in a project area on the basis of the sedimentary context of the area, a records search for past paleontological finds in the area,

and/or, depending on the extent of existing information, a paleontological survey.

- If paleontological resources are present at the site, or if areas with a high potential to contain paleontological material have been identified, a paleontological resources management plan shall be developed. This plan shall include a mitigation plan for collection of the fossils; mitigation could include avoidance, removal of fossils, or monitoring. If an area exhibits a high potential but no fossils were observed during survey, monitoring by a qualified paleontologist could be required during all excavation and earthmoving in the sensitive area. A report shall be prepared documenting these activities. The paleontological resources management plan also shall (1) establish a monitoring program, (2) identify measures to prevent potential looting/vandalism or erosion impacts, and (3) address the education of workers and the public to make them aware of the consequences of unauthorized collection of fossils on public land.
- Unexpected discovery of cultural or paleontological resources during construction shall be brought to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.

Soil Resources

- Foundations and trenches shall be backfilled with originally excavated material as much as possible. Excess excavation materials shall be disposed of only in approved areas or, if suitable, stockpiled for use in reclamation activities.
- Borrow material shall be obtained only from authorized and permitted sites.

Water Resources

- Operators shall develop a storm water management plan for the site to ensure compliance with applicable regulations and prevent off-site migration of contaminated storm water or increased soil erosion.
- Operators shall gain a clear understanding of the local hydrogeology. Areas of groundwater discharge and recharge and their potential relationships with surface water bodies shall be identified.
- Operators shall avoid creating hydrologic conduits between two aquifers during foundation excavation and other activities.

Air Quality and Climate

The following BMPs would be incorporated into lease terms to minimize air quality impacts from fugitive dust:

- The number and size/length of roads, temporary fences, lay-down areas, and borrow areas shall be minimized.
- Topsoil from all excavations and construction activities shall be salvaged and reapplied during reclamation.
- All areas of disturbed soil shall be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities shall be undertaken as early as possible on disturbed areas.
- Erosion controls that comply with county, state, and federal standards shall be applied. Practices such as jute netting, silt fences, and check dams shall be applied near disturbed areas.
- Dust abatement techniques shall be used on unpaved, unvegetated surfaces to minimize airborne dust.
- Speed limits (e.g., 25 mph [40 kph]) shall be posted and enforced to reduce airborne fugitive dust.
- Construction materials and stockpiled soils shall be covered if they are a source of fugitive dust.
- Dust abatement techniques shall be used before and during surface clearing, excavation, or blasting activities.

For managing diesel exhaust, each individual project proponent should be required to prepare and submit to the BLM an Equipment Emissions Mitigation Plan. Requirements for emissions controls should be incorporated into the lease terms for individual geothermal leases. An Equipment Emissions Mitigation Plan will identify actions to reduce diesel particulate, carbon monoxide, hydrocarbons, and nitrogen oxides associated with construction and drilling activities. The Equipment Emissions Mitigation Plan should apply to all lands authorized for lease and should require that all drilling/construction-related engines are maintained and operated as follows:

- Are tuned to the engine manufacturer's specification in accordance with an appropriate time frame.
- Do not idle for more than five minutes (unless, in the case of certain drilling engines, it is necessary for the operating scope).
- Are not tampered with in order to increase engine horsepower.
- Include particulate traps, oxidation catalysts, and other suitable control devices on all drilling/construction equipment used at the project site.

- Use diesel fuel having a sulfur content of 15 parts per million or less, or other suitable alternative diesel fuel, unless such fuel cannot be reasonably procured in the market area.
- Include control devices to reduce air emissions. The determination of which equipment is suitable for control devices should be made by an independent Licensed Mechanical Engineer. Equipment suitable for control devices may include drilling equipment, work over and service rigs, mud pumps, generators, compressors, graders, bulldozers, and dump trucks.

Vegetation and Fish and Wildlife

- Installation of any equipment or well drilling shall be scheduled to avoid disruption of wildlife reproductive activities or other important behaviors.
- Operators shall review existing information on species and habitats in the vicinity of the project area to identify potential concerns.
- A habitat restoration plan shall be developed to avoid (if possible), minimize, or mitigate negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. The plan shall identify revegetation, soil stabilization, and erosion reduction measures that shall be implemented to ensure that all temporary use areas are restored. The plan shall require that restoration occur as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to speed up the recovery to natural habitats.
- Existing roads should be used to the maximum extent feasible to access a proposed project area.
- If new access roads are necessary, they should be designed and constructed to the appropriate standard.
- Existing or new roads should be maintained to the condition needed for facility use.
- The area disturbed during exploration and development (i.e., temperature gradient wells, well pads, roadways) should be minimized.
- Drill pads should not be located in or near sensitive habitats or in areas where vegetation or important habitats are known to be sensitive to human activities.
- Mitigation measures should be considered during planning and design to ensure that the siting of geothermal projects and associated roadways and structures do not result in unacceptable impacts on important habitats.

- Operators should identify important, sensitive, or unique habitat and biota in the project vicinity and site and should design the project to avoid (if possible), minimize, or mitigate potential impacts on these resources. The design and siting of the facility should follow appropriate guidance and requirements from the BLM, FS, and other resource agencies, as available and applicable.
- The BLM, FS, and operators should contact appropriate agencies early in the planning process to identify potentially sensitive ecological resources that may be present in the area of proposed geothermal development.
- The operators should conduct surveys for federal- and state-protected species and other species of concern within the project area.
- The project should be planned to avoid (if possible), minimize, or mitigate impacts on wildlife and habitat.
- Habitat disturbance should be minimized by locating facilities such as pipelines and access roads in previously disturbed areas (i.e., locate transmission lines within or adjacent to existing powerline corridors).
- Existing roads and utility corridors should be used to the maximum extent feasible.
- New access roads and utility corridors should be configured to avoid high-quality habitats and minimize habitat fragmentation.
- Site access roads and utility corridors should minimize stream crossings.
- Where applicable, the extent of habitat disturbance should be reduced by keeping vehicles on access roads and minimizing foot and vehicle traffic through undisturbed areas.
- Erosion controls that comply with county, state, and federal standards should be applied. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.
- All areas of disturbed soil should be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities should be undertaken as early as possible on disturbed areas.
- Dust abatement techniques should be used on unpaved, unvegetated surfaces to minimize airborne dust.
- Construction materials and stockpiled soil should be covered if they are a source of fugitive dust.
- Erosion and fugitive dust control measures should be inspected and maintained regularly.

- All refueling should occur in a designated fueling area that includes a temporary berm to limit the spread of any spill.
- Drip pans should be used during refueling to contain accidental releases.
- Drip pans should be used under fuel pump and valve mechanisms of any bulk fueling vehicles parked at the construction site.
- Access roads and newly established utility and transmission line corridors should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
- Fill materials that originate from areas with known invasive vegetation problems should not be used.
- Certified weed-free mulch should be used when stabilizing areas of disturbed soil.
- Habitat restoration activities and invasive vegetation monitoring and control activities should be initiated as soon as possible after construction activities are completed.
- All areas of disturbed soil should be reclaimed using weed-free native shrubs, grasses, and forbs.
- Pesticide use should be limited to nonpersistent, immobile pesticides and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.
- Spills should be immediately addressed per the appropriate spill management plan, and soil cleanup and removal should be initiated, if needed.
- Access roads, utility and transmission line corridors, and geothermal plant sites should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
- Employees, contractors, and site visitors should be instructed to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. In addition, pets should be controlled to avoid harassment and disturbance of wildlife.
- BMPs to avoid or minimize the possibility of the unintentional take of migratory birds should be applied to all practices and projects. Practices should be applied to provide long-term benefits and improved vegetation community condition. If the proposed project or action does have the potential to impact migratory bird species populations which have been identified as occurring within the

project or action area, evaluate options to mitigate the project to minimize or eliminate the identified impacts during periods of concentrated nesting activity. Appropriate BMPs include:

a. Minimize/avoid impacts to nesting migratory birds by imposing a Timing Limitation on use authorizations to mitigate vegetative disturbing activities during the primary portion of the nesting season.

Most migratory birds nest between May 15 to July 15, but dates should be adjusted for the species and environmental conditions. Timing limitations may be modified based upon the species affected and the timing or intensity of breeding activity of the species of Birds of Conservation Concern involved.

b. Where disturbance cannot be avoided, the scale and the length of time of disturbance may be considered mitigating circumstances.

c. Inspect and clear an area for migratory bird nesting. These clearances could be performed by qualified personnel. Factors to weigh in considering this option include vegetation type, vegetation density, timing and cost.

d. Explore opportunities to replace and prioritize habitat and habitat changes on or off site based upon the needs of Birds of Conservation Concern.

- Operators shall develop a plan for control of noxious weeds and invasive species, which could occur as a result of new surface disturbance activities at the site. The most recent recommendations at the state and local level should be incorporated into any operating plan for the geothermal exploration and development. The plan shall address monitoring, education of personnel on weed identification, the manner in which weeds spread, and methods for treating infestations. The use of certified weed-free mulching shall be required. If trucks and construction equipment are arriving from locations with known invasive vegetation problems, a controlled inspection and cleaning area shall be established to visually inspect construction equipment arriving at the project area and to remove and collect seeds that may be adhering to tires and other equipment surfaces.
- Should a development or occupancy and use site have invasive plant infestations prior to development or use, proponents should confer with the land administrator to develop an invasive plant treatment plan to eliminate and/or prevent the propagation of the species.
- If pesticides are used on the site, an integrated pest management plan shall be developed to ensure that applications would be

conducted within the framework of all Federal, State, and local laws and regulations and entail only the use of EPA-registered pesticides.

- Pesticide use shall be limited to nonpersistent, immobile pesticides and shall only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.
- Explosives shall be used only within specified times and at specified distances from sensitive wildlife or streams and lakes, as established by the BLM or other federal and state agencies.

Wild Horse and Burros

- Employees, contractors, and site visitors shall be instructed to avoid harassment and disturbance of wild horses and burros, especially during reproductive (e.g., breeding and birthing) seasons. In addition, any pets shall be controlled to avoid harassment and disturbance of wild horses and burros.
- Observations of potential problems regarding wild horses or burros, including animal mortality, shall be reported to the authorized officer immediately.

Livestock Grazing

- Dust control measures would reduce impacts on livestock forage during construction and demolition activities;
- Development should minimize the number of structures required;
- Litter and noxious weeds should be controlled and removed regularly during construction and operation.

Cultural Resources

- Unexpected discovery of cultural or paleontological resources during construction shall be brought to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.
- Before any specific permits are issued under leases, treatment of cultural resources will follow the procedures established by the Advisory Council on Historic Preservation for compliance with Section 106 of the National Historic Preservation Act. A pedestrian inventory will be undertaken of all portions that have not been previously surveyed or are identified by BLM as requiring inventory to identify properties that are eligible for the NRHP. Those sites not already evaluated for NRHP eligibility will be evaluated based on surface remains, subsurface testing, archival, and/or ethnographic

sources. Subsurface testing will be kept to a minimum whenever possible if sufficient information is available to evaluate the site or if avoidance is an expected mitigation outcome. Recommendations regarding the eligibility of sites will be submitted to the BLM, and a treatment plan will be prepared to detail methods for avoidance of impacts or mitigation of effects. The BLM will make determinations of eligibility and effect and consult with SHPO as necessary based on each proposed lease application and project plans. The BLM may require modification to exploration or development proposals to protect such properties, or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized or mitigated. Avoidance of impacts through project design will be given priority over data recovery as the preferred mitigation measure. Avoidance measures include moving project elements away from site locations or to areas of previous impacts, restricting travel to existing roads, and maintaining barriers and signs in areas of cultural sensitivity. Any data recovery will be preceded by approval of a detailed research design, Native American Consultation, and other requirements for BLM issuance of a permit under the Archaeological Resources Protection Act (BLM 2007a).

- If cultural resources are present at the site, or if areas with a high potential to contain cultural material have been identified, a cultural resources management plan (CRMP) shall be developed. This plan shall address mitigation activities to be taken for cultural resources found at the site. Avoidance of the area is always the preferred mitigation option. Other mitigation options include archaeological survey and excavation (as warranted) and monitoring. If an area exhibits a high potential, but no artifacts were observed during an archaeological survey, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area. A report shall be prepared documenting these activities. The CRMP also shall (1) establish a monitoring program, (2) identify measures to prevent potential looting/vandalism or erosion impacts, and (3) address the education of workers and the public to make them aware of the consequences of unauthorized collection of artifacts and destruction of property on public land (BLM 2005).

National Scenic and Historic Trails

- When any ROW application includes remnants of a National Historic Trail, is located within the viewshed of a National Historic Trail's designated centerline, or includes or is within the viewshed of a trail eligible for listing on the NRHP, the operator shall evaluate the potential visual impacts to the trail associated with the proposed

project and identify appropriate mitigation measures for inclusion as stipulations in the operation plan.

Visual Resources

Assessment of visual resources needs to be factored into the early stages project pre-planning and continued throughout the life of the project for proposed activities within VRM Class I, II, III and IV areas in accordance with VRM manuals, handbooks and Instructional Memorandums.

- The BLM will consider the visual resource values of the public lands involved in proposed projects, consistent with BLM Visual Resource Management (VRM) policies and guidance.
- All proposals on BLM lands located in VRM Class II and III are to be evaluated for compliance with VRM objectives using the Contrast Rating System described within the BLM Handbook – Visual Resource Contrast Rating H-8431-1.
- The public shall be involved and informed about the visual site design elements of the proposed geothermal energy facilities. Possible approaches include conducting public forums for disseminating information, offering organized tours of operating geothermal developments, and using computer simulation and visualization techniques in public presentations.
- The BLM will work with the applicant to incorporate visual design considerations into the planning and design of the project to minimize potential visual impacts of the proposal and to meet the VRM objectives of the area. Power plants would be sited using terrain to obstruct visual impacts to the extent possible. Design elements would also include nonreflective paints, and prohibition of commercial messages on structures.
- Other site design elements shall be integrated with the surrounding landscape. Elements to address include minimizing the profile of the ancillary structures, burial of cables, prohibition of commercial symbols, and lighting. Regarding lighting, efforts shall be made to minimize the need for and amount of lighting on ancillary structures. Where practical, wells should be co-located to reduce road, pad and utility surface area and tank batteries centralized.
- Minimize the number of structures required;
- Construct low-profile structures whenever possible to reduce structure visibility;
- Select and design materials and surface treatments to repeat or blend with landscape elements;
- Control litter and noxious weeds and remove them regularly during construction and operation;

- Implement dust abatement measures to minimize the impacts of vehicular and pedestrian traffic, construction and operation, and wind on exposed surface soils;
- Operators shall reduce visual impacts during construction by minimizing areas of surface disturbance, controlling erosion, using dust suppression techniques, and restoring exposed soils as closely as possible to their original contour and vegetation.
- Nighttime lighting will be limited to areas necessary for the safe operation of the project and, where applicable, will include motion sensors to reduce nighttime lighting when not necessary.

Noise

- Proponents of a geothermal energy development project shall take measurements to assess the existing background noise levels at a given site and compare them with the anticipated noise levels associated with the proposed project.
- Whenever reasonably possible, geothermal well drilling or major facility construction operations should be restricted to non-sleeping hours (7:00 am to 10:00 pm).
- All equipment shall have sound-control devices no less effective than those provided on the original equipment. All construction equipment used shall be adequately muffled and maintained.
- All stationary construction equipment (i.e., compressors and generators) shall be located as far as practicable from nearby residences.
- If blasting or other noisy activities are required during the construction period, nearby residents shall be notified in advance.

Health and Safety

- Any equipment installed for site monitoring and testing shall be inspected periodically for structural integrity.
- Operators shall develop a hazardous materials management plan addressing storage, use, transportation, and disposal of each hazardous material anticipated to be used at the site. The plan shall identify all hazardous materials that would be used, stored, or transported at the site. It shall establish inspection procedures, storage requirements, storage quantity limits, inventory control, nonhazardous product substitutes, and disposition of excess materials. The plan shall also identify requirements for notices to federal and local emergency response authorities and include emergency response plans.
- Operators shall develop a waste management plan identifying the waste streams that are expected to be generated at the site and

addressing hazardous waste determination procedures, waste storage locations, waste-specific management and disposal requirements, inspection procedures, and waste minimization procedures. This plan shall address all solid and liquid wastes that may be generated at the site.

- Operators shall develop a spill prevention and response plan identifying where hazardous materials and wastes are stored on site, spill prevention measures to be implemented, training requirements, appropriate spill response actions for each material or waste, the locations of spill response kits on site, a procedure for ensuring that the spill response kits are adequately stocked at all times, and procedures for making timely notifications to authorities.
- A safety assessment shall be conducted to describe potential safety issues and the means that would be taken to mitigate them, including issues such as site access, construction, safe work practices, security, heavy equipment transportation, traffic management, emergency procedures, and fire control.
- A health and safety program shall be developed to protect both workers and the general public during construction and operation of geothermal projects.
- Regarding occupational health and safety, the program shall identify all applicable federal and state occupational safety standards; establish safe work practices for each task (e.g., requirements for personal protective equipment and safety harnesses; Occupational Safety and Health Administration [OSHA] standard practices for safe use of explosives and blasting agents; and measures for reducing occupational electric and magnetic fields [EMF] exposures); establish fire safety evacuation procedures; and define safety performance standards (e.g., electrical system standards and lightning protection standards). The program shall include a training program to identify hazard training requirements for workers for each task and establish procedures for providing required training to all workers. Documentation of training and a mechanism for reporting serious accidents to appropriate agencies shall be established.
- Regarding public health and safety, the health and safety program shall establish a safety zone or setback for generators from residences and occupied buildings, roads, ROWs, and other public access areas that is sufficient to prevent accidents resulting from the operation of generators. It shall identify requirements for temporary fencing around staging areas, storage yards, and excavations during construction or rehabilitation activities. It shall also identify measures to be taken during the operation phase to limit public access to hazardous facilities (e.g., permanent fencing would be

installed only around electrical substations, and facility access doors would be locked).

- Operators shall consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) shall be identified and addressed in the traffic management plan.
- Operators shall develop a fire management strategy to implement measures to minimize the potential for a human-caused fire.
- Secondary containment shall be provided for all on-site hazardous materials and waste storage, including fuel. In particular, fuel storage (for construction vehicles and equipment) shall be a temporary activity occurring only for as long as is needed to support construction activities.
- Wastes shall be properly containerized and removed periodically for disposal at appropriate off-site permitted disposal facilities.
- Hydrogen sulfide (H2S) emissions would be abated, for example, through the injection of hydrogen peroxide and sodium hydroxide into the test line.
- Dust emissions from well testing would be reduced by injecting water into the test line.
- In the event of an accidental release to the environment, the operator shall document the event, including a root cause analysis, appropriate corrective actions taken, and a characterization of the resulting environmental or health and safety impacts. Documentation of the event shall be provided to the BLM authorized officer and other federal and state agencies, as required.
- Any wastewater generated in association with temporary, portable sanitary facilities shall be periodically removed by a licensed hauler and introduced into an existing municipal sewage treatment facility. Temporary, portable sanitary facilities provided for construction crews shall be adequate to support expected on-site personnel and shall be removed at completion of construction activities.
- Temporary fencing shall be installed around staging areas, storage yards, and excavations during construction to limit public access.

PHASE 3: UTILIZATION

General

- Existing roads shall be used to the maximum extent feasible. If new roads are necessary, they shall be designed and constructed to the appropriate standard.
- Available information describing the environmental and sociocultural conditions in the vicinity of the proposed project shall be collected and reviewed as needed to predict potential impacts of the project.
- The project shall be planned to utilize existing roads and utility corridors to the maximum extent feasible, and to minimize the number and length/size of new roads, lay-down areas, and borrow areas.
- A monitoring program shall be developed to ensure that environmental conditions are monitored during the well drilling, testing, and construction phases. The monitoring program requirements, including adaptive management strategies, shall be established at the project level to ensure that potential adverse impacts of geothermal development are mitigated. The monitoring program shall identify the monitoring requirements for each environmental resource present at the site, establish metrics against which monitoring observations can be measured, identify potential mitigation measures, and establish protocols for incorporating monitoring observations and additional mitigation measures into standard operating procedures and BMPs.
- "Good housekeeping" procedures shall be developed to ensure that during operation the site will be kept clean of debris, garbage, fugitive trash or waste, and graffiti; to prohibit scrap heaps and dumps; and to minimize storage yards.
- All control and mitigation measures established for the project in the operation plan and the resource-specific management plans that are part of the operation plan shall be maintained and implemented throughout construction and operation of the project, as appropriate.
- Existing sites shall be used in preference to new sites.
- Site monitoring protocols defined in the operation plan shall be implemented. These will incorporate monitoring program observations and additional mitigation measures into standard operating procedures and BMPs to minimize future environmental impacts.
- Results of monitoring program efforts shall be provided to the BLM authorized officer.

- Operators shall identify unstable slopes and local factors that can induce slope instability (such as groundwater conditions, precipitation, earthquake activities, slope angles, and the dip angles of geologic strata). Operators also shall avoid creating excessive slopes during excavation and blasting operations. Special construction techniques shall be used where applicable in areas of steep slopes, erodible soil, and stream channel crossings.

Land Use, Recreation, and Special Designations

- The Secretary of Agriculture's rules and regulations must be complied with for all use and occupancy of the NFS lands prior to approval of an exploration plan by the Secretary of Interior and for uses of all existing improvements, such as forest development roads, within and outside the area permitted by the Secretary of Interior; and use and occupancy of the NFS lands not authorized by an exploration plan approved by the Secretary of Interior.
- To plan for efficient use of the land, necessary infrastructure requirements shall be consolidated wherever possible, and current transmission and market access shall be evaluated carefully.
- An access road siting and management plan shall be prepared incorporating existing BLM standards regarding road design, construction, and maintenance such as those described in the BLM 9113 Manual and the *Surface Operating Standards for Oil and Gas Exploration and Development* (i.e., the Gold Book).
- A transportation plan shall be developed, particularly for the transport of power plant components, main assembly cranes, and other large pieces of equipment. The plan shall consider specific object sizes, weights, origin, destination, and unique handling requirements and shall evaluate alternative transportation approaches. In addition, the process to be used to comply with unique state requirements and to obtain all necessary permits shall be clearly identified.
- A traffic management plan shall be prepared for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan shall incorporate measures such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any necessary changes in temporary lane configuration.
- Existing roads shall be used, but only if in safe and environmentally sound locations. If new roads are necessary, they shall be designed and constructed to the appropriate standard and be no higher than necessary to accommodate their intended functions (e.g., traffic volume and weight of vehicles).

- Excessive grades on roads, road embankments, ditches, and drainages shall be avoided, especially in areas with erodible soils. Special construction techniques shall be used, where applicable. Abandoned roads and roads that are no longer needed shall be recontoured and revegetated.
- Access roads and on-site roads shall be surfaced with aggregate materials, wherever appropriate.
- Access roads shall be located to follow natural contours and minimize side hill cuts.
- Roads shall be designed so that changes to surface water runoff are avoided and erosion is not initiated.
- Road use shall be restricted during the wet season if road surfacing is not adequate to prevent soil displacement, rutting, etc., and resultant stream sedimentation.
- Potential soil erosion shall be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts shall be cleaned and maintained regularly.
- Project personnel and contractors shall be instructed and required to adhere to speed limits commensurate with road types, traffic volumes, vehicle types, and site-specific conditions, to ensure safe and efficient traffic flow and to reduce wildlife collisions and disturbance and airborne dust.
- Traffic shall be restricted to the roads developed for the project. Use of other unimproved roads shall be restricted to emergency situations.
- Signs shall be placed along construction roads to identify speed limits, travel restrictions, and other standard traffic control information. To minimize impacts on local commuters, consideration shall be given to limiting construction vehicles traveling on public roadways during the morning and late afternoon commute time.
- Signs directing vehicles to alternative park access and parking would be posted in the event construction temporarily obstructs recreational parking areas near trailheads.
- Whenever active work is being performed, the area would be posted with "construction ahead" signs on any adjacent access roads or trails that might be affected.
- Whenever possible, construction activities would be avoided during high recreational use periods.
- Operators shall consult with local planning authorities regarding increased traffic during the construction phase, including an

assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) shall be identified and addressed in the traffic management plan;

- Access roads shall be located to minimize stream crossings. All structures crossing streams shall be located and constructed so that they do not decrease channel stability or increase water velocity. Operators shall obtain all applicable federal and state permits.
- Stream crossings on newly constructed roads should be designed to handle a 100 year flood event, and also provide for fish passage.
- Existing drainage systems shall not be altered, especially in sensitive areas such as erodible soils or steep slopes.
- Roads shall be located away from drainage bottoms and avoid wetlands, if practicable.

Geologic Resources and Seismic Setting

- A detailed geotechnical analysis would be performed prior to the construction of any structures; so they could be sited to avoid any hazards from subsidence or liquefaction (i.e., the changing of a saturated soil from a relatively stable solid state to a liquid during earthquakes or nearby blasting).

Paleontological Resources

- Operators shall determine whether paleontological resources exist in a project area on the basis of the sedimentary context of the area, a records search for past paleontological finds in the area, and/or, depending on the extent of existing information, a paleontological survey.
- If paleontological resources are present at the site, or if areas with a high potential to contain paleontological material have been identified, a paleontological resources management plan shall be developed. This plan shall include a mitigation plan for collection of the fossils; mitigation could include avoidance, removal of fossils, or monitoring. If an area exhibits a high potential but no fossils were observed during survey, monitoring by a qualified paleontologist could be required during all excavation and earthmoving in the sensitive area. A report shall be prepared documenting these activities. The paleontological resources management plan also shall (1) establish a monitoring program, (2) identify measures to prevent potential looting/vandalism or erosion impacts, and (3) address the education of workers and the public to make them aware of the consequences of unauthorized collection of fossils on public land.

- Unexpected discovery of cultural or paleontological resources during construction shall be brought to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.

Soil Resources

- Foundations and trenches shall be backfilled with originally excavated material as much as possible. Excess excavation materials shall be disposed of only in approved areas or, if suitable, stockpiled for use in reclamation activities.
- Borrow material shall be obtained only from authorized and permitted sites.

Water Resources

- Operators shall develop a storm water management plan for the site to ensure compliance with applicable regulations and prevent off-site migration of contaminated storm water or increased soil erosion.
- Operators shall gain a clear understanding of the local hydrogeology. Areas of groundwater discharge and recharge and their potential relationships with surface water bodies shall be identified.
- Operators shall avoid creating hydrologic conduits between two aquifers during foundation excavation and other activities.

Air Quality and Climate

The following BMPs would be incorporated into lease terms to minimize air quality impacts from fugitive dust:

- The area disturbed by construction and operation of a geothermal energy development project (i.e., footprint) shall be kept to a minimum by centralizing operation facilities.
- The number and size/length of roads, temporary fences, lay-down areas, and borrow areas shall be minimized.
- Topsoil from all excavations and construction activities shall be salvaged and reapplied during reclamation.
- All areas of disturbed soil shall be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities shall be undertaken as early as possible on disturbed areas.
- All electrical collector lines shall be buried in a manner that minimizes additional surface disturbance (e.g., along roads or other

paths of surface disturbance). Overhead lines may be used in cases where burial of lines would result in further habitat disturbance.

- Erosion controls that comply with county, state, and federal standards shall be applied. Practices such as jute netting, silt fences, and check dams shall be applied near disturbed areas.
- Dust abatement techniques shall be used on unpaved, unvegetated surfaces to minimize airborne dust.
- Speed limits (e.g., 25 mph [40 kph]) shall be posted and enforced to reduce airborne fugitive dust.
- Construction materials and stockpiled soils shall be covered if they are a source of fugitive dust.
- Dust abatement techniques shall be used before and during surface clearing, excavation, or blasting activities.

For managing diesel exhaust, each individual project proponent should be required to prepare and submit to the BLM an Equipment Emissions Mitigation Plan. Requirements for emissions controls should be incorporated into the lease terms for individual geothermal leases. An Equipment Emissions Mitigation Plan will identify actions to reduce diesel particulate, carbon monoxide, hydrocarbons, and nitrogen oxides associated with construction and drilling activities. The Equipment Emissions Mitigation Plan should apply to all lands authorized for lease and should require that all drilling/construction-related engines are maintained and operated as follows:

- Are tuned to the engine manufacturer's specification in accordance with an appropriate time frame.
- Do not idle for more than five minutes (unless, in the case of certain drilling engines, it is necessary for the operating scope).
- Are not tampered with in order to increase engine horsepower.
- Include particulate traps, oxidation catalysts, and other suitable control devices on all drilling/construction equipment used at the project site.
- Use diesel fuel having a sulfur content of 15 parts per million or less, or other suitable alternative diesel fuel, unless such fuel cannot be reasonably procured in the market area.
- Include control devices to reduce air emissions. The determination of which equipment is suitable for control devices should be made by an independent Licensed Mechanical Engineer. Equipment suitable for control devices may include drilling equipment, work over and service rigs, mud pumps, generators, compressors, graders, bulldozers, and dump trucks.

Vegetation and Fish and Wildlife

- Installation of any equipment or well drilling shall be scheduled to avoid disruption of wildlife reproductive activities or other important behaviors.
- Operators shall review existing information on species and habitats in the vicinity of the project area to identify potential concerns.
- A habitat restoration plan shall be developed to avoid (if possible), minimize, or mitigate negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. The plan shall identify revegetation, soil stabilization, and erosion reduction measures that shall be implemented to ensure that all temporary use areas are restored. The plan shall require that restoration occur as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to speed up the recovery to natural habitats.
- Existing roads should be used to the maximum extent feasible to access a proposed project area.
- If new access roads are necessary, they should be designed and constructed to the appropriate standard.
- Existing or new roads should be maintained to the condition needed for facility use.
- The area disturbed during exploration and development (i.e., temperature gradient wells, well pads, roadways) should be minimized.
- Drill pads should not be located in or near sensitive habitats or in areas where vegetation or important habitats are known to be sensitive to human activities.
- Mitigation measures should be considered during planning and design to ensure that the siting of geothermal projects and associated roadways and structures do not result in unacceptable impacts on important habitats.
- Operators should identify important, sensitive, or unique habitat and biota in the project vicinity and site and should design the project to avoid (if possible), minimize, or mitigate potential impacts on these resources. The design and siting of the facility should follow appropriate guidance and requirements from the BLM, FS, and other resource agencies, as available and applicable.
- The BLM, FS, and operators should contact appropriate agencies early in the planning process to identify potentially sensitive ecological resources that may be present in the area of proposed geothermal development.

- The operators should conduct surveys for federal- and state-protected species and other species of concern within the project area.
- The project should be planned to avoid (if possible), minimize, or mitigate impacts on wildlife and habitat.
- Habitat disturbance should be minimized by locating facilities such as pipelines and access roads in previously disturbed areas (i.e., locate transmission lines within or adjacent to existing powerline corridors).
- Existing roads and utility corridors should be used to the maximum extent feasible.
- New access roads and utility corridors should be configured to avoid high-quality habitats and minimize habitat fragmentation.
- Site access roads and utility corridors should minimize stream crossings.
- Power lines should be configured to minimize the potential for electrocution of birds by following established guidelines (e.g., APLIC 1996; APLIC and USFWS 2005).
- Where applicable, the extent of habitat disturbance should be reduced by keeping vehicles on access roads and minimizing foot and vehicle traffic through undisturbed areas.
- Erosion controls that comply with county, state, and federal standards should be applied. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.
- All areas of disturbed soil should be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities should be undertaken as early as possible on disturbed areas.
- Dust abatement techniques should be used on unpaved, unvegetated surfaces to minimize airborne dust.
- Construction materials and stockpiled soil should be covered if they are a source of fugitive dust.
- Erosion and fugitive dust control measures should be inspected and maintained regularly.
- All refueling should occur in a designated fueling area that includes a temporary berm to limit the spread of any spill.
- Drip pans should be used during refueling to contain accidental releases.
- Drip pans should be used under fuel pump and valve mechanisms of any bulk fueling vehicles parked at the construction site.

- Access roads and newly established utility and transmission line corridors should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
- Fill materials that originate from areas with known invasive vegetation problems should not be used.
- Certified weed-free mulch should be used when stabilizing areas of disturbed soil.
- Habitat restoration activities and invasive vegetation monitoring and control activities should be initiated as soon as possible after construction activities are completed.
- All areas of disturbed soil should be reclaimed using weed-free native shrubs, grasses, and forbs.
- Pesticide use should be limited to nonpersistent, immobile pesticides and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.
- Spills should be immediately addressed per the appropriate spill management plan, and soil cleanup and removal should be initiated, if needed.
- Access roads, utility and transmission line corridors, and geothermal plant sites should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
- Employees, contractors, and site visitors should be instructed to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. In addition, pets should be controlled to avoid harassment and disturbance of wildlife.
- BMPs to avoid or minimize the possibility of the unintentional take of migratory birds should be applied to all practices and projects. Practices should be applied to provide long-term benefits and improved vegetation community condition. If the proposed project or action does have the potential to impact migratory bird species populations which have been identified as occurring within the project or action area, evaluate options to mitigate the project to minimize or eliminate the identified impacts during periods of concentrated nesting activity. Appropriate BMPs include:

    a. Minimize/avoid impacts to nesting migratory birds by imposing a Timing Limitation on use authorizations to mitigate vegetative disturbing activities during the primary portion of the nesting season.

Most migratory birds nest between May 15 to July 15, but dates should be adjusted for the species and environmental conditions. Timing limitations may be modified based upon the species affected and the timing or intensity of breeding activity of the species of Birds of Conservation Concern involved.

b. Where disturbance cannot be avoided, the scale and the length of time of disturbance may be considered mitigating circumstances.

c. Inspect and clear an area for migratory bird nesting. These clearances could be performed by qualified personnel. Factors to weigh in considering this option include vegetation type, vegetation density, timing and cost.

d. Explore opportunities to replace and prioritize habitat and habitat changes on or off site based upon the needs of Birds of Conservation Concern.

- Operators shall develop a plan for control of noxious weeds and invasive species, which could occur as a result of new surface disturbance activities at the site. The most recent recommendations at the state and local level should be incorporated into any operating plan for the geothermal exploration and development. The plan shall address monitoring, education of personnel on weed identification, the manner in which weeds spread, and methods for treating infestations. The use of certified weed-free mulching shall be required. If trucks and construction equipment are arriving from locations with known invasive vegetation problems, a controlled inspection and cleaning area shall be established to visually inspect construction equipment arriving at the project area and to remove and collect seeds that may be adhering to tires and other equipment surfaces.
- Should a development or occupancy and use site have invasive plant infestations prior to development or use, proponents should confer with the land administrator to develop an invasive plant treatment plan to eliminate and/or prevent the propagation of the species.
- If pesticides are used on the site, an integrated pest management plan shall be developed to ensure that applications would be conducted within the framework of all Federal, State, and local laws and regulations and entail only the use of EPA-registered pesticides.
- Pesticide use shall be limited to nonpersistent, immobile pesticides and shall only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

- All electrical collector lines shall be buried in a manner that minimizes additional surface disturbance (e.g., along roads or other paths of surface disturbance). Overhead lines may be used in cases where burial of lines would result in further habitat disturbance.
- Explosives shall be used only within specified times and at specified distances from sensitive wildlife or streams and lakes, as established by the BLM or other federal and state agencies.

Wild Horse and Burros

- Employees, contractors, and site visitors shall be instructed to avoid harassment and disturbance of wild horses and burros, especially during reproductive (e.g., breeding and birthing) seasons. In addition, any pets shall be controlled to avoid harassment and disturbance of wild horses and burros.
- Observations of potential problems regarding wild horses or burros, including animal mortality, shall be reported to the authorized officer immediately.

Livestock Grazing

- Dust control measures would reduce impacts on livestock forage during construction and demolition activities;
- Development should minimize the number of structures required;
- Utility cables should be buried, where feasible; and
- Litter and noxious weeds should be controlled and removed regularly during construction and operation.

Cultural Resources

- Unexpected discovery of cultural or paleontological resources during construction shall be brought to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.
- Before any specific permits are issued under leases, treatment of cultural resources will follow the procedures established by the Advisory Council on Historic Preservation for compliance with Section 106 of the National Historic Preservation Act. A pedestrian inventory will be undertaken of all portions that have not been previously surveyed or are identified by BLM as requiring inventory to identify properties that are eligible for the NRHP. Those sites not already evaluated for NRHP eligibility will be evaluated based on surface remains, subsurface testing, archival, and/or ethnographic sources. Subsurface testing will be kept to a minimum whenever

possible if sufficient information is available to evaluate the site or if avoidance is an expected mitigation outcome. Recommendations regarding the eligibility of sites will be submitted to the BLM, and a treatment plan will be prepared to detail methods for avoidance of impacts or mitigation of effects. The BLM will make determinations of eligibility and effect and consult with SHPO as necessary based on each proposed lease application and project plans. The BLM may require modification to exploration or development proposals to protect such properties, or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized or mitigated. Avoidance of impacts through project design will be given priority over data recovery as the preferred mitigation measure. Avoidance measures include moving project elements away from site locations or to areas of previous impacts, restricting travel to existing roads, and maintaining barriers and signs in areas of cultural sensitivity. Any data recovery will be preceded by approval of a detailed research design, Native American Consultation, and other requirements for BLM issuance of a permit under the Archaeological Resources Protection Act (BLM 2007a).

- If cultural resources are present at the site, or if areas with a high potential to contain cultural material have been identified, a cultural resources management plan (CRMP) shall be developed. This plan shall address mitigation activities to be taken for cultural resources found at the site. Avoidance of the area is always the preferred mitigation option. Other mitigation options include archaeological survey and excavation (as warranted) and monitoring. If an area exhibits a high potential, but no artifacts were observed during an archaeological survey, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area. A report shall be prepared documenting these activities. The CRMP also shall (1) establish a monitoring program, (2) identify measures to prevent potential looting/vandalism or erosion impacts, and (3) address the education of workers and the public to make them aware of the consequences of unauthorized collection of artifacts and destruction of property on public land (BLM 2005).

National Scenic and Historic Trails

- When any ROW application includes remnants of a National Historic Trail, is located within the viewshed of a National Historic Trail's designated centerline, or includes or is within the viewshed of a trail eligible for listing on the NRHP, the operator shall evaluate the potential visual impacts to the trail associated with the proposed

project and identify appropriate mitigation measures for inclusion as stipulations in the operation plan.

Visual Resources

- Implement a Visual Resource Protection Program. The purpose of the program is to establish the criteria and methodologies to manage visual resource protection measures throughout the life of a project (from design, construction, and operation of the project through reclamation). The program would be implemented as a part of the project design criteria and mitigation measures for the project through the Record of Decision. The objectives of the program would be to prevent adverse visual impacts whenever possible, reduce the severity and extent of the adverse impacts that cannot be prevented, and rehabilitate adverse effects.
- The applicant shall include and identify a VRM specialist with demonstrated qualified credentials (e.g., licensed landscape architect) as a part of the planning team for evaluating visual resource issues and opportunities for siting options of project facilities.
- VRM treatments are to be fully integrated into the overall site development program and construction documents, including but not limited to, revegetation plans, supplemental watering plans, vegetation thinning/feathering plans, contour grading plans that quantify and provide means for measuring compliance with VRM objectives and mitigation commitments.
- The contrast rating procedures described within BLM Handbook H-8431-1, Visual Resource Contrast Rating are to be followed for proposed activities within VRM Class I, II, and III areas.
- For proposed projects within VRM Class I, II, and III, develop suitable geo-reference terrain data covering the project area and the full context of viewshed adequate for designing and evaluating visual impacts of the proposed activities using cadd, 3-D GIS modeling, and visualization software.
- Perform evaluation using electronic 3-dimensional modeling and design capability and visual simulation tools.
- All evaluations shall also be field verified.
- Proposals determined to be out of compliance will need to be mitigated until demonstrated to be in compliance.

- Mitigation plans demonstrating VRM class objective compliance need to quantify mitigation activities and be field measurable during construction and post-project completion.

- A VRM mitigation monitoring and compliance checking strategy shall be included in the mitigation plan with activities monitored and maintained through life of the project.

- VRM best management practices may need to extend beyond the project boundary lending to additional modification to the landscape in order to fully integrate the facilities visually into the viewshed and meet VRM objectives. These modifications may require EA/EIS level analysis along with the other resource considerations and project activities. Early identification of VRM measures will help facilitate impact disclosure.

- BLM/ USFS landscape architects shall be consulted before construction begins to coordinate on VRM mitigation strategy that may include treatments to occur early in construction such as project edge treatments by thinning and feathering vegetation, enhanced contour grading, salvaging landscape materials from within construction areas, etc. Proponents will coordinate in advance to have BLM/ USFS landscape architects on site during construction to work with implementing BMPs.
- Site projects outside of the viewsheds of publically accessible vantage points, or if this cannot be avoided, as far away as possible;
- Site projects to take advantage of both topography and vegetation as screening devices to restrict views of projects from visually sensitive areas;
- Site facilities away from and not adjacent to prominent landscape features (e.g., knobs and water features);
- Avoid placing facilities on ridgelines, summits, or other locations such that they will be silhouetted against the sky from important viewing locations;
- Collocate facilities to the extent possible to use existing and shared rights-of-way, existing and shared access and maintenance roads, and other infrastructure to reduce visual they do not bisect ridge tops or run down the center of valley bottoms.
- Site linear features (aboveground pipelines, rights-of-way, and roads) to follow natural land contours rather than straight lines (particularly up slopes) when possible. Fall-line cuts should be avoided.

- Site facilities, especially linear facilities, to take advantage of natural topographic breaks (i.e., pronounced changes in slope) to avoid siting facilities on steep side slopes.
- Where possible, site linear features such as rights-of-ways and roads to follow the edges of clearings (where they will be less conspicuous) rather than passing through the centers of clearings.
- Site facilities to take advantage of existing clearings to reduce vegetation clearing and ground disturbance, where possible.
- Site linear features (e.g., trails, roads, rivers) to cross other linear features at right angles whenever possible to minimize viewing area and duration.
- Site and design structures and roads to minimize and balance cuts and fills and to preserve existing rocks, vegetation, and drainage patterns to the maximum extent possible.
- Use appropriately colored materials for structures or appropriate stains and coatings to blend with the project's backdrop.
- Use non-reflective or low-reflectivity materials, coatings, or paints whenever possible.
- Paint grouped structures the same color to reduce visual complexity and color contrast.
- Design and install efficient facility lighting so that the minimum amount of lighting required for safety and security is provided but not exceeded and so that upward light scattering (light pollution) is minimized. This may include, for example, installing shrouds to minimize light from straying off-site, properly directing light to only illuminate necessary areas, and installing motion sensors to only illuminate areas when necessary.
- Site construction staging areas and laydown areas outside of the viewsheds of publically accessible vantage points and visually sensitive areas, where possible, including siting in swales, around bends, and behind ridges and vegetative screens.
- Discuss visual impact mitigation objectives and activities with equipment operators prior to commencement of construction activities.
- Mulch slash from vegetation removal and spread it to cover fresh soil disturbances or, if not possible, bury or compost slash.
- If slash piles are necessary, stage them out of sight of sensitive viewing areas.
- Avoid installing gravel and pavement where possible to reduce color and texture contrasts with existing landscape.

- Use excess fill to fill uphill-side swales resulting from road construction in order to reduce unnatural-appearing slope interruption and to reduce fill piles.
- Avoid downslope wasting of excess fill material.
- Round road-cut slopes, vary cut and fill pitch to reduce contrasts in form and line, and vary slope to preserve specimen trees and nonhazardous rock outcroppings.
- Leave planting pockets on slopes where feasible.
- Combine methods of re-establishing native vegetation through seeding, planting of nursery stock, transplanting of local vegetation within the proposed disturbance areas and staging of construction enabling direct transplanting.
- Revegetate with native vegetation establishing a composition consistent with the form, line, color, and texture of the surrounding undisturbed landscape."
- Provide benches in rock cuts to accent natural strata.
- Use split-face rock blasting to minimize unnatural form and texture resulting from blasting.
- Segregate topsoil from cut and fill activities and spread it on freshly disturbed areas to reduce color contrast and to aid rapid revegetation.
- If topsoil piles are necessary, stage them out of sight of sensitive viewing areas.
- Where feasible, remove excess cut and fill from the site to minimize ground disturbance and impacts from fill piles.
- Bury utility cables where feasible.
- Minimize signage and paint or coat reverse sides of signs and mounts to reduce color contrast with existing landscape.
- Prohibit trash burning; store trash in containers to be hauled off-site for disposal.
- Undertake interim restoration during the operating life of the project as soon as possible after disturbances. During road maintenance activities, avoid blading existing forbs and grasses in ditches and along roads.
- Randomly scarify cut slopes to reduce texture contrast with existing landscape and to aid in revegetation.

- Cover disturbed areas with stockpiled topsoil or mulch, and revegetate with a mix of native species selected for visual compatibility with existing vegetation.
- Restore rocks, brush, and natural debris whenever possible to approximate preexisting visual conditions.
- The BLM will consider the visual resource values of the public lands involved in proposed projects, consistent with BLM Visual Resource Management (VRM) policies and guidance.
- The public shall be involved and informed about the visual site design elements of the proposed geothermal energy facilities. Possible approaches include conducting public forums for disseminating information, offering organized tours of operating geothermal developments, and using computer simulation and visualization techniques in public presentations.
- The BLM will work with the applicant to incorporate visual design considerations into the planning and design of the project to minimize potential visual impacts of the proposal and to meet the VRM objectives of the area. Power plants would be sited using terrain to obstruct visual impacts to the extent possible. Design elements would also include nonreflective paints, and prohibition of commercial messages on structures.
- Other site design elements shall be integrated with the surrounding landscape. Elements to address include minimizing the profile of the ancillary structures, burial of cables, prohibition of commercial symbols, and lighting. Regarding lighting, efforts shall be made to minimize the need for and amount of lighting on ancillary structures. Where practical, wells should be co-located to reduce road, pad and utility surface area and tank batteries centralized.
- Minimize the number of structures required;
- Construct low-profile structures whenever possible to reduce structure visibility.
- Select and design materials and surface treatments to repeat or blend with landscape elements.
- Control litter and noxious weeds and remove them regularly during construction and operation.
- Implement dust abatement measures to minimize the impacts of vehicular and pedestrian traffic, construction and operation, and wind on exposed surface soils.
- Operators shall reduce visual impacts during construction by minimizing areas of surface disturbance, controlling erosion, using

dust suppression techniques, and restoring exposed soils as closely as possible to their original contour and vegetation.

- Nighttime lighting will be limited to areas necessary for the safe operation of the project and, where applicable, will include motion sensors to reduce nighttime lighting when not necessary.

Noise

- Proponents of a geothermal energy development project shall take measurements to assess the existing background noise levels at a given site and compare them with the anticipated noise levels associated with the proposed project.
- The geothermal plants would be sited using terrain to further shield noise impacts to the greatest extent possible.
- Whenever reasonably possible, geothermal well drilling or major facility construction operations should be restricted to non-sleeping hours (7:00 am to 10:00 pm).
- All equipment shall have sound-control devices no less effective than those provided on the original equipment. All construction equipment used shall be adequately muffled and maintained.
- All stationary construction equipment (i.e., compressors and generators) shall be located as far as practicable from nearby residences.
- If blasting or other noisy activities are required during the construction period, nearby residents shall be notified in advance.

Health and Safety

- Operators shall develop a hazardous materials management plan addressing storage, use, transportation, and disposal of each hazardous material anticipated to be used at the site. The plan shall identify all hazardous materials that would be used, stored, or transported at the site. It shall establish inspection procedures, storage requirements, storage quantity limits, inventory control, nonhazardous product substitutes, and disposition of excess materials. The plan shall also identify requirements for notices to federal and local emergency response authorities and include emergency response plans.
- Operators shall develop a waste management plan identifying the waste streams that are expected to be generated at the site and addressing hazardous waste determination procedures, waste storage locations, waste-specific management and disposal requirements, inspection procedures, and waste minimization procedures. This plan shall address all solid and liquid wastes that may be generated at the site.

- Operators shall develop a spill prevention and response plan identifying where hazardous materials and wastes are stored on site, spill prevention measures to be implemented, training requirements, appropriate spill response actions for each material or waste, the locations of spill response kits on site, a procedure for ensuring that the spill response kits are adequately stocked at all times, and procedures for making timely notifications to authorities.
- A safety assessment shall be conducted to describe potential safety issues and the means that would be taken to mitigate them, including issues such as site access, construction, safe work practices, security, heavy equipment transportation, traffic management, emergency procedures, and fire control.
- A health and safety program shall be developed to protect both workers and the general public during construction and operation of geothermal projects.
- Regarding occupational health and safety, the program shall identify all applicable federal and state occupational safety standards; establish safe work practices for each task (e.g., requirements for personal protective equipment and safety harnesses; Occupational Safety and Health Administration [OSHA] standard practices for safe use of explosives and blasting agents; and measures for reducing occupational electric and magnetic fields [EMF] exposures); establish fire safety evacuation procedures; and define safety performance standards (e.g., electrical system standards and lightning protection standards). The program shall include a training program to identify hazard training requirements for workers for each task and establish procedures for providing required training to all workers. Documentation of training and a mechanism for reporting serious accidents to appropriate agencies shall be established.
- Regarding public health and safety, the health and safety program shall establish a safety zone or setback for generators from residences and occupied buildings, roads, ROWs, and other public access areas that is sufficient to prevent accidents resulting from the operation of generators. It shall identify requirements for temporary fencing around staging areas, storage yards, and excavations during construction or rehabilitation activities. It shall also identify measures to be taken during the operation phase to limit public access to hazardous facilities (e.g., permanent fencing would be installed only around electrical substations, and facility access doors would be locked).
- Operators shall consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and

stops) shall be identified and addressed in the traffic management plan.

- The project shall be planned to minimize electromagnetic interference (EMI) (e.g., impacts to radar, microwave, television, and radio transmissions) and comply with Federal Communications Commission [FCC] regulations. Signal strength studies shall be conducted when proposed locations have the potential to impact transmissions. Potential interference with public safety communication systems (e.g., radio traffic related to emergency activities) shall be avoided.
- Operators shall develop a fire management strategy to implement measures to minimize the potential for a human-caused fire.
- Secondary containment shall be provided for all on-site hazardous materials and waste storage, including fuel. In particular, fuel storage (for construction vehicles and equipment) shall be a temporary activity occurring only for as long as is needed to support construction activities.
- Wastes shall be properly containerized and removed periodically for disposal at appropriate off-site permitted disposal facilities.
- Hydrogen sulfide (H2S) emissions would be abated, for example, through the injection of hydrogen peroxide and sodium hydroxide into the test line.
- Dust emissions from well testing would be reduced by injecting water into the test line.
- In the event of an accidental release to the environment, the operator shall document the event, including a root cause analysis, appropriate corrective actions taken, and a characterization of the resulting environmental or health and safety impacts. Documentation of the event shall be provided to the BLM authorized officer and other federal and state agencies, as required.
- Any wastewater generated in association with temporary, portable sanitary facilities shall be periodically removed by a licensed hauler and introduced into an existing municipal sewage treatment facility. Temporary, portable sanitary facilities provided for construction crews shall be adequate to support expected on-site personnel and shall be removed at completion of construction activities.
- Temporary fencing shall be installed around staging areas, storage yards, and excavations during construction to limit public access.
- Permanent fencing shall be installed and maintained around electrical substations, and facility access doors shall be locked to limit public access.

PHASE 4: RECLAMATION AND ABANDONMENT

General

- Existing roads shall be used to the maximum extent feasible. If new roads are necessary, they shall be designed and constructed to the appropriate standard.
- "Good housekeeping" procedures shall be developed to ensure that during operation the site will be kept clean of debris, garbage, fugitive trash or waste, and graffiti; to prohibit scrap heaps and dumps; and to minimize storage yards.
- All control and mitigation measures established for the project in the operation plan and the resource-specific management plans that are part of the operation plan shall be maintained and implemented throughout construction and operation of the project, as appropriate.
- Existing sites shall be used in preference to new sites.
- Site monitoring protocols defined in the operation plan shall be implemented. These will incorporate monitoring program observations and additional mitigation measures into standard operating procedures and BMPs to minimize future environmental impacts.
- Results of monitoring program efforts shall be provided to the BLM authorized officer.
- Operators shall identify unstable slopes and local factors that can induce slope instability (such as groundwater conditions, precipitation, earthquake activities, slope angles, and the dip angles of geologic strata). Operators also shall avoid creating excessive slopes during excavation and blasting operations. Special construction techniques shall be used where applicable in areas of steep slopes, erodible soil, and stream channel crossings.
- Prior to the termination of the ROW authorization, a decommissioning plan shall be developed and approved by the BLM. The decommissioning plan shall include a site reclamation plan and monitoring program.
- All management plans, BMPs, and stipulations developed for the construction phase shall be applied to similar activities during the decommissioning phase.
- All structures shall be removed from the site.

Land Use, Recreation, and Special Designations

- An access road siting and management plan shall be prepared incorporating existing BLM standards regarding road design,

construction, and maintenance such as those described in the BLM 9113 Manual and the *Surface Operating Standards for Oil and Gas Exploration and Development* (i.e., the Gold Book).

- A traffic management plan shall be prepared for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan shall incorporate measures such as informational signs, flaggers when equipment may result in blocked throughways, and traffic cones to identify any necessary changes in temporary lane configuration.
- Existing roads shall be used, but only if in safe and environmentally sound locations. If new roads are necessary, they shall be designed and constructed to the appropriate standard and be no higher than necessary to accommodate their intended functions (e.g., traffic volume and weight of vehicles).
- Excessive grades on roads, road embankments, ditches, and drainages shall be avoided, especially in areas with erodible soils. Special construction techniques shall be used, where applicable. Abandoned roads and roads that are no longer needed shall be recontoured and revegetated.
- Access roads and on-site roads shall be surfaced with aggregate materials, wherever appropriate.
- Access roads shall be located to follow natural contours and minimize side hill cuts.
- Roads shall be designed so that changes to surface water runoff are avoided and erosion is not initiated.
- Road use shall be restricted during the wet season if road surfacing is not adequate to prevent soil displacement.
- Potential soil erosion shall be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts shall be cleaned and maintained regularly.
- Project personnel and contractors shall be instructed and required to adhere to speed limits commensurate with road types, traffic volumes, vehicle types, and site-specific conditions, to ensure safe and efficient traffic flow and to reduce wildlife collisions and disturbance and airborne dust.
- Traffic shall be restricted to the roads developed for the project. Use of other unimproved roads shall be restricted to emergency situations.
- Signs shall be placed along construction roads to identify speed limits, travel restrictions, and other standard traffic control

information. To minimize impacts on local commuters, consideration shall be given to limiting construction vehicles traveling on public roadways during the morning and late afternoon commute time.

- Signs directing vehicles to alternative park access and parking would be posted in the event construction temporarily obstructs recreational parking areas near trailheads.
- Whenever active work is being performed, the area would be posted with "construction ahead" signs on any adjacent access roads or trails that might be affected.
- Whenever possible, construction activities would be avoided during high recreational use periods.
- Operators shall consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) shall be identified and addressed in the traffic management plan;
- Access roads shall be located to minimize stream crossings. All structures crossing streams shall be located and constructed so that they do not decrease channel stability or increase water velocity. Operators shall obtain all applicable federal and state permits.
- Stream crossings on newly constructed roads should be designed to handle a 100 year flood event, and also provide for fish passage.
- Existing drainage systems shall not be altered, especially in sensitive areas such as erodible soils or steep slopes.
- Roads shall be located away from drainage bottoms and avoid wetlands, if practicable.

Paleontological Resources

- Unexpected discovery of cultural or paleontological resources during construction shall be brought to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.

Soil Resources

- Foundations and trenches shall be backfilled with originally excavated material as much as possible. Excess excavation materials shall be disposed of only in approved areas or, if suitable, stockpiled for use in reclamation activities.

- Borrow material shall be obtained only from authorized and permitted sites.
- Topsoil from all decommissioning activities shall be salvaged and reapplied during final reclamation.

Water Resources

- Operators shall develop a storm water management plan for the site to ensure compliance with applicable regulations and prevent off-site migration of contaminated storm water or increased soil erosion.

Air Quality and Climate

The following BMPs would be incorporated into lease terms to minimize air quality impacts from fugitive dust:

- The number and size/length of roads, temporary fences, lay-down areas, and borrow areas shall be minimized.
- Topsoil from all excavations and construction activities shall be salvaged and reapplied during reclamation.
- All areas of disturbed soil shall be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities shall be undertaken as early as possible on disturbed areas.
- Erosion controls that comply with county, state, and federal standards shall be applied. Practices such as jute netting, silt fences, and check dams shall be applied near disturbed areas.
- Dust abatement techniques shall be used on unpaved, unvegetated surfaces to minimize airborne dust.
- Speed limits (e.g., 25 mph [40 kph]) shall be posted and enforced to reduce airborne fugitive dust.
- Construction materials and stockpiled soils shall be covered if they are a source of fugitive dust.
- Dust abatement techniques shall be used before and during surface clearing, excavation, or blasting activities.

For managing diesel exhaust, each individual project proponent should be required to prepare and submit to the BLM an Equipment Emissions Mitigation Plan. Requirements for emissions controls should be incorporated into the lease terms for individual geothermal leases. An Equipment Emissions Mitigation Plan will identify actions to reduce diesel particulate, carbon monoxide, hydrocarbons, and nitrogen oxides associated with construction and drilling activities. The Equipment Emissions Mitigation Plan should apply to all lands authorized for lease and should require that all drilling/construction-related engines are maintained and operated as follows:

- Are tuned to the engine manufacturer's specification in accordance with an appropriate time frame.
- Do not idle for more than five minutes (unless, in the case of certain drilling engines, it is necessary for the operating scope).
- Are not tampered with in order to increase engine horsepower.
- Include particulate traps, oxidation catalysts, and other suitable control devices on all drilling/construction equipment used at the project site.
- Use diesel fuel having a sulfur content of 15 parts per million or less, or other suitable alternative diesel fuel, unless such fuel cannot be reasonably procured in the market area.
- Include control devices to reduce air emissions. The determination of which equipment is suitable for control devices should be made by an independent Licensed Mechanical Engineer. Equipment suitable for control devices may include drilling equipment, work over and service rigs, mud pumps, generators, compressors, graders, bulldozers, and dump trucks.

Vegetation and Fish and Wildlife

- Operators shall review existing information on species and habitats in the vicinity of the project area to identify potential concerns.
- A habitat restoration plan shall be developed to avoid (if possible), minimize, or mitigate negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. The plan shall identify revegetation, soil stabilization, and erosion reduction measures that shall be implemented to ensure that all temporary use areas are restored. The plan shall require that restoration occur as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to speed up the recovery to natural habitats.
- Existing roads should be used to the maximum extent feasible to access a proposed project area.
- If new access roads are necessary, they should be designed and constructed to the appropriate standard.
- Existing or new roads should be maintained to the condition needed for facility use.
- Existing roads and utility corridors should be used to the maximum extent feasible.
- New access roads and utility corridors should be configured to avoid high-quality habitats and minimize habitat fragmentation.

- Site access roads and utility corridors should minimize stream crossings.
- Where applicable, the extent of habitat disturbance should be reduced by keeping vehicles on access roads and minimizing foot and vehicle traffic through undisturbed areas.
- Erosion controls that comply with county, state, and federal standards should be applied. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.
- All areas of disturbed soil should be reclaimed using weed-free native grasses, forbs, and shrubs. Reclamation activities should be undertaken as early as possible on disturbed areas.
- Dust abatement techniques should be used on unpaved, unvegetated surfaces to minimize airborne dust.
- Construction materials and stockpiled soil should be covered if they are a source of fugitive dust.
- Erosion and fugitive dust control measures should be inspected and maintained regularly.
- All refueling should occur in a designated fueling area that includes a temporary berm to limit the spread of any spill.
- Drip pans should be used during refueling to contain accidental releases.
- Drip pans should be used under fuel pump and valve mechanisms of any bulk fueling vehicles parked at the construction site.
- Access roads and newly established utility and transmission line corridors should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
- Fill materials that originate from areas with known invasive vegetation problems should not be used.
- Certified weed-free mulch should be used when stabilizing areas of disturbed soil.
- Habitat restoration activities and invasive vegetation monitoring and control activities should be initiated as soon as possible after construction activities are completed.
- All areas of disturbed soil should be reclaimed using weed-free native shrubs, grasses, and forbs.
- Pesticide use should be limited to nonpersistent, immobile pesticides and should only be applied in accordance with label and

application permit directions and stipulations for terrestrial and aquatic applications.

- Spills should be immediately addressed per the appropriate spill management plan, and soil cleanup and removal should be initiated, if needed.
- Access roads, utility and transmission line corridors, and geothermal plant sites should be monitored regularly for invasive species establishment, and weed control measures should be initiated immediately upon evidence of invasive species introduction.
- Employees, contractors, and site visitors should be instructed to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons. In addition, pets should be controlled to avoid harassment and disturbance of wildlife.
- BMPs to avoid or minimize the possibility of the unintentional take of migratory birds should be applied to all practices and projects. Practices should be applied to provide long-term benefits and improved vegetation community condition. If the proposed project or action does have the potential to impact migratory bird species populations which have been identified as occurring within the project or action area, evaluate options to mitigate the project to minimize or eliminate the identified impacts during periods of concentrated nesting activity. Appropriate BMPs include:

    a. Minimize/avoid impacts to nesting migratory birds by imposing a Timing Limitation on use authorizations to mitigate vegetative disturbing activities during the primary portion of the nesting season.

    Most migratory birds nest between May 15 to July 15, but dates should be adjusted for the species and environmental conditions. Timing limitations may be modified based upon the species affected and the timing or intensity of breeding activity of the species of Birds of Conservation Concern involved.

    b. Where disturbance cannot be avoided, the scale and the length of time of disturbance may be considered mitigating circumstances.

    c. Inspect and clear an area for migratory bird nesting. These clearances could be performed by qualified personnel. Factors to weigh in considering this option include vegetation type, vegetation density, timing and cost.

    d. Explore opportunities to replace and prioritize habitat and habitat changes on or off site based upon the needs of Birds of Conservation Concern.

- Operators shall develop a plan for control of noxious weeds and invasive species, which could occur as a result of new surface disturbance activities at the site. The most recent recommendations at the state and local level should be incorporated into any operating plan for the geothermal exploration and development. The plan shall address monitoring, education of personnel on weed identification, the manner in which weeds spread, and methods for treating infestations. The use of certified weed-free mulching shall be required. If trucks and construction equipment are arriving from locations with known invasive vegetation problems, a controlled inspection and cleaning area shall be established to visually inspect construction equipment arriving at the project area and to remove and collect seeds that may be adhering to tires and other equipment surfaces.
- If pesticides are used on the site, an integrated pest management plan shall be developed to ensure that applications would be conducted within the framework of all Federal, State, and local laws and regulations and entail only the use of EPA-registered pesticides.
- Pesticide use shall be limited to nonpersistent, immobile pesticides and shall only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.
- Explosives shall be used only within specified times and at specified distances from sensitive wildlife or streams and lakes, as established by the BLM or other federal and state agencies.
- All areas of disturbed soil shall be reclaimed using weed-free native shrubs, grasses, and forbs.
- The vegetation cover, composition, and diversity shall be restored to values commensurate with the ecological setting.

Wild Horse and Burros

- Employees, contractors, and site visitors shall be instructed to avoid harassment and disturbance of wild horses and burros, especially during reproductive (e.g., breeding and birthing) seasons. In addition, any pets shall be controlled to avoid harassment and disturbance of wild horses and burros.
- Observations of potential problems regarding wild horses or burros, including animal mortality, shall be reported to the authorized officer immediately.

Livestock Grazing

- Dust control measures would reduce impacts on livestock forage during construction and demolition activities;

- Development should minimize the number of structures required;
- Litter and noxious weeds should be controlled and removed regularly during construction and operation.

Cultural Resources

- Unexpected discovery of cultural or paleontological resources during construction shall be brought to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the find to avoid further disturbance to the resources while they are being evaluated and appropriate mitigation measures are being developed.
- If cultural resources are present at the site, or if areas with a high potential to contain cultural material have been identified, a cultural resources management plan (CRMP) shall be developed. This plan shall address mitigation activities to be taken for cultural resources found at the site. Avoidance of the area is always the preferred mitigation option. Other mitigation options include archaeological survey and excavation (as warranted) and monitoring. If an area exhibits a high potential, but no artifacts were observed during an archaeological survey, monitoring by a qualified archaeologist could be required during all excavation and earthmoving in the high-potential area. A report shall be prepared documenting these activities. The CRMP also shall (1) establish a monitoring program, (2) identify measures to prevent potential looting/vandalism or erosion impacts, and (3) address the education of workers and the public to make them aware of the consequences of unauthorized collection of artifacts and destruction of property on public land (BLM 2005).

Visual Resources

- During final reclamation reestablish visual composition and characteristics.
- Ensure the overall form, line, color, texture, scale, and location and orientation of major landscape features blends into the adjacent area and meets the needs of the planned post disturbance land use.
- The reclaimed landscape shall not result in a change in the Scenic Quality Rating of the area. See BLM Handbook H-8410 Visual Resource Inventory.
- The reclaimed landscape shall not generate a noticeable visual contrast when comparing it to the adjacent undisturbed landscape. See BLM Handbook H-8431, Visual Resource Contrast Rating.
- Control litter and noxious weeds and remove them regularly during construction and operation.

- Implement dust abatement measures to minimize the impacts of vehicular and pedestrian traffic, construction and operation, and wind on exposed surface soils.
- Nighttime lighting will be limited to areas necessary for the safe operation of the project and, where applicable, will include motion sensors to reduce nighttime lighting when not necessary.

Noise

- Proponents of a geothermal energy development project shall take measurements to assess the existing background noise levels at a given site and compare them with the anticipated noise levels associated with the proposed project.
- All equipment shall have sound-control devices no less effective than those provided on the original equipment. All construction equipment used shall be adequately muffled and maintained.
- All stationary construction equipment (i.e., compressors and generators) shall be located as far as practicable from nearby residences.
- If blasting or other noisy activities are required during the construction period, nearby residents shall be notified in advance.

Health and Safety

- Operators shall develop a hazardous materials management plan addressing storage, use, transportation, and disposal of each hazardous material anticipated to be used at the site. The plan shall identify all hazardous materials that would be used, stored, or transported at the site. It shall establish inspection procedures, storage requirements, storage quantity limits, inventory control, nonhazardous product substitutes, and disposition of excess materials. The plan shall also identify requirements for notices to federal and local emergency response authorities and include emergency response plans.
- Operators shall develop a waste management plan identifying the waste streams that are expected to be generated at the site and addressing hazardous waste determination procedures, waste storage locations, waste-specific management and disposal requirements, inspection procedures, and waste minimization procedures. This plan shall address all solid and liquid wastes that may be generated at the site.
- Operators shall develop a spill prevention and response plan identifying where hazardous materials and wastes are stored on site, spill prevention measures to be implemented, training requirements, appropriate spill response actions for each material or waste, the locations of spill response kits on site, a procedure for ensuring that

the spill response kits are adequately stocked at all times, and procedures for making timely notifications to authorities.

- A safety assessment shall be conducted to describe potential safety issues and the means that would be taken to mitigate them, including issues such as site access, construction, safe work practices, security, heavy equipment transportation, traffic management, emergency procedures, and fire control.
- A health and safety program shall be developed to protect both workers and the general public during construction and operation of geothermal projects.
- Regarding occupational health and safety, the program shall identify all applicable federal and state occupational safety standards; establish safe work practices for each task (e.g., requirements for personal protective equipment and safety harnesses; Occupational Safety and Health Administration [OSHA] standard practices for safe use of explosives and blasting agents; and measures for reducing occupational electric and magnetic fields [EMF] exposures); establish fire safety evacuation procedures; and define safety performance standards (e.g., electrical system standards and lightning protection standards). The program shall include a training program to identify hazard training requirements for workers for each task and establish procedures for providing required training to all workers. Documentation of training and a mechanism for reporting serious accidents to appropriate agencies shall be established.
- Regarding public health and safety, the health and safety program shall establish a safety zone or setback for generators from residences and occupied buildings, roads, ROWs, and other public access areas that is sufficient to prevent accidents resulting from the operation of generators. It shall identify requirements for temporary fencing around staging areas, storage yards, and excavations during construction or rehabilitation activities. It shall also identify measures to be taken during the operation phase to limit public access to hazardous facilities (e.g., permanent fencing would be installed only around electrical substations, and facility access doors would be locked).
- Operators shall consult with local planning authorities regarding increased traffic during the construction phase, including an assessment of the number of vehicles per day, their size, and type. Specific issues of concern (e.g., location of school bus routes and stops) shall be identified and addressed in the traffic management plan.
- Operators shall develop a fire management strategy to implement measures to minimize the potential for a human-caused fire.

- Secondary containment shall be provided for all on-site hazardous materials and waste storage, including fuel. In particular, fuel storage (for construction vehicles and equipment) shall be a temporary activity occurring only for as long as is needed to support construction activities.
- Wastes shall be properly containerized and removed periodically for disposal at appropriate off-site permitted disposal facilities.
- In the event of an accidental release to the environment, the operator shall document the event, including a root cause analysis, appropriate corrective actions taken, and a characterization of the resulting environmental or health and safety impacts. Documentation of the event shall be provided to the BLM authorized officer and other federal and state agencies, as required.
- Any wastewater generated in association with temporary, portable sanitary facilities shall be periodically removed by a licensed hauler and introduced into an existing municipal sewage treatment facility. Temporary, portable sanitary facilities provided for construction crews shall be adequate to support expected on-site personnel and shall be removed at completion of construction activities.
- Temporary fencing shall be installed around staging areas, storage yards, and excavations during construction to limit public access.

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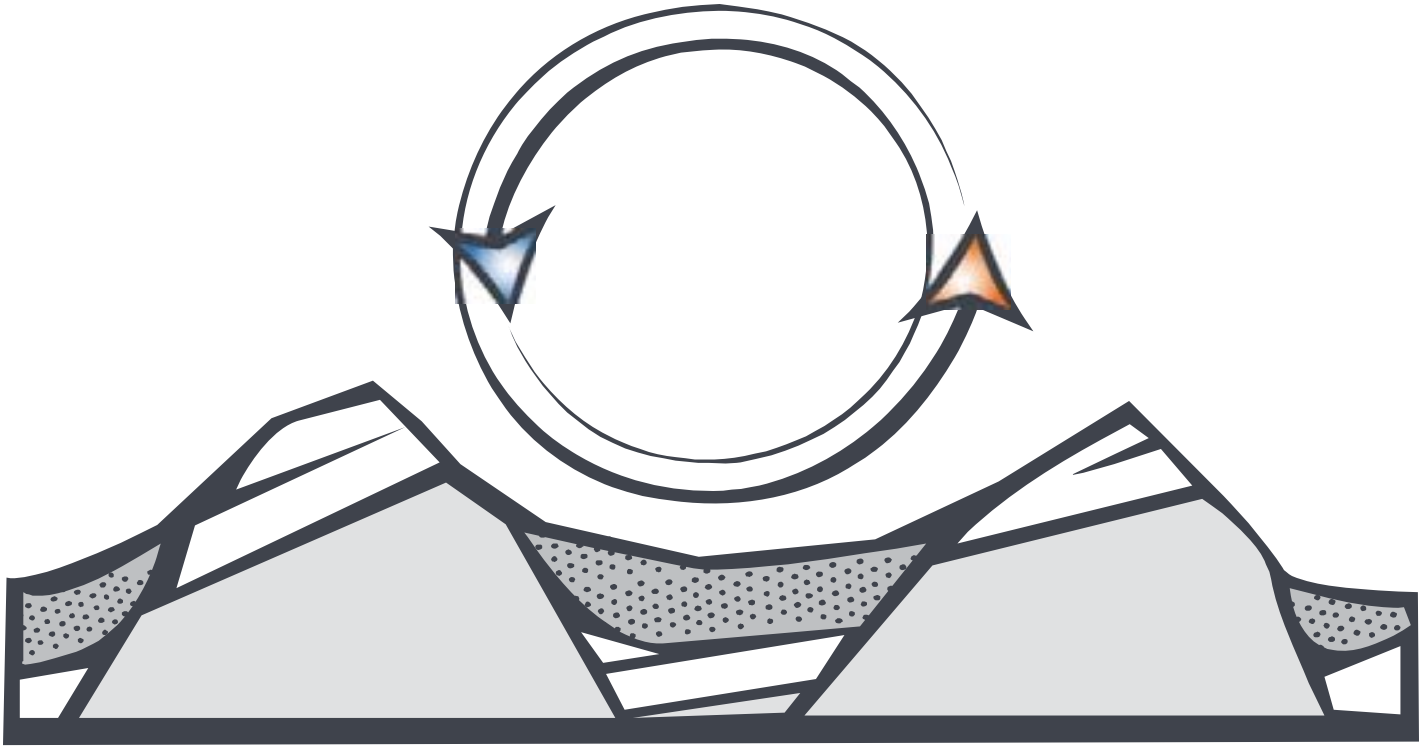

Appendix E

Review of Paleontological resource Sections of BLM Resource Management Plans in the Project Area

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APPENDIX E
REVIEW OF PALEONTOLOGICAL RESOURCE SECTIONS OF BLM RMPS IN THE PROJECT AREA

This appendix defines the potential fossil yield classification (PFYC) System (BLM-IM 2008-009) that the BLM applies to paleontological resources and includes a summary review and PFYC estimate for readily available RMPs within the project area.

Occurrences of paleontological resources are closely tied to the geologic units (i.e., formations, members, or beds) that contain them. The probability for finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Therefore, geologic mapping can be used for assessing the potential for the occurrence of paleontological resources.

Using the Potential Fossil Yield Classification (PFYC) system, geologic units are classified based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts, with a higher class number indicating a higher potential. This classification is applied to the geologic formation, member, or other distinguishable unit, preferably at the most detailed mappable level. It is not intended to be applied to specific paleontological localities or small areas within units. Although significant localities may occasionally occur in a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher class; instead, the relative abundance of significant localities is intended to be the major determinant for the class assignment.

The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources. The classification should be

considered at an intermediate point in the analysis, and should be used to assist in determining the need for further mitigation assessment or actions.

The descriptions for the classes below are written to serve as guidelines rather than as strict definitions. Knowledge of the geology and the paleontological potential for individual units or preservational conditions should be considered when determining the appropriate class assignment. Assignments are best made by collaboration between land managers and knowledgeable researchers.

Class 1 – **Very Low**. Geologic units that are not likely to contain recognizable fossil remains.

- Units that are igneous or metamorphic, excluding reworked volcanic ash units.
- Units that are Precambrian in age or older.

(1) Management concern for paleontological resources in Class 1 units is usually negligible or not applicable.

(2) Assessment or mitigation is usually unnecessary except in very rare or isolated circumstances.

The probability for impacting any fossils is negligible. Assessment or mitigation of paleontological resources is usually unnecessary. The occurrence of significant fossils is non-existent or extremely rare.

Class 2 – **Low**. Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant nonvertebrate fossils.

- Vertebrate or significant invertebrate or plant fossils not present or very rare.
- Units that are generally younger than 10,000 years before present.
- Recent aeolian deposits.
- Sediments that exhibit significant physical and chemical changes (i.e., diagenetic alteration).

(1) Management concern for paleontological resources is generally low.

(2) Assessment or mitigation is usually unnecessary except in rare or isolated circumstances.

The probability for impacting vertebrate fossils or scientifically significant invertebrate or plant fossils is low. Assessment or mitigation of paleontological resources is not likely to be necessary. Localities containing important resources may exist, but would be rare and would not influence the

classification. These important localities would be managed on a case-by-case basis.

Class 3 – **Moderate** or **Unknown**. Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence; or sedimentary units of unknown fossil potential.

- Often marine in origin with sporadic known occurrences of vertebrate fossils.
- Vertebrate fossils and scientifically significant invertebrate or plant fossils known to occur intermittently; predictability known to be low.

  (or)
- Poorly studied and/or poorly documented. Potential yield cannot be assigned without ground reconnaissance.

Class 3a – **Moderate Potential.** Units are known to contain vertebrate fossils or scientifically significant nonvertebrate fossils, but these occurrences are widely scattered. Common invertebrate or plant fossils may be found in the area, and opportunities may exist for hobby collecting. The potential for a project to be sited on or impact a significant fossil locality is low, but is somewhat higher for common fossils.

Class 3b – **Unknown Potential.** Units exhibit geologic features and preservational conditions that suggest significant fossils could be present, but little information about the paleontological resources of the unit or the area is known. This may indicate the unit or area is poorly studied, and field surveys may uncover significant finds. The units in this Class may eventually be placed in another Class when sufficient survey and research is performed. The unknown potential of the units in this Class should be carefully considered when developing any mitigation or management actions.

(1) Management concern for paleontological resources is moderate; or cannot be determined from existing data.

(2) Surface-disturbing activities may require field assessment to determine appropriate course of action.

This classification includes a broad range of paleontological potential. It includes geologic units of unknown potential, as well as units of moderate or infrequent occurrence of significant fossils. Management considerations cover a broad range of options as well, and could include pre-disturbance surveys, monitoring, or avoidance. Surface-disturbing activities will require sufficient assessment to determine whether significant paleontological resources occur in the area of a proposed action, and whether the action could affect the paleontological

resources. These units may contain areas that would be appropriate to designate as hobby collection areas due to the higher occurrence of common fossils and a lower concern about affecting significant paleontological resources.

Class 4 – **High**. Geologic units containing a high occurrence of significant fossils. Vertebrate fossils or scientifically significant invertebrate or plant fossils are known to occur and have been documented, but may vary in occurrence and predictability. Surface disturbing activities may adversely affect paleontological resources in many cases.

Class 4a – Unit is exposed with little or no soil or vegetative cover. Outcrop areas are extensive with exposed bedrock areas often larger than two acres. Paleontological resources may be susceptible to adverse impacts from surface disturbing actions. Illegal collecting activities may impact some areas.

Class 4b – These are areas underlain by geologic units with high potential but have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation due to moderating circumstances. The bedrock unit has high potential, but a protective layer of soil, thin alluvial material, or other conditions may lessen or prevent potential impacts to the bedrock resulting from the activity.

- Extensive soil or vegetative cover; bedrock exposures are limited or not expected to be impacted.
- Areas of exposed outcrop are smaller than two contiguous acres.
- Outcrops form cliffs of sufficient height and slope so that impacts are minimized by topographic conditions.
- Other characteristics are present that lower the vulnerability of both known and unidentified paleontological resources.

(1) Management concern for paleontological resources in Class 4 is moderate to high, depending on the proposed action.

(2) A field survey by a qualified paleontologist is often needed to assess local conditions.

(3) Management prescriptions for resource preservation and conservation through controlled access or special management designation should be considered.

(4) Class 4 and Class 5 units may be combined as Class 5 for broad applications, such as planning efforts or preliminary assessments, when geologic mapping at an appropriate scale is not available. Resource assessment, mitigation, and other management considerations are similar at this level of analysis, and impacts and alternatives can be addressed at a level appropriate to the application.

The probability for impacting significant paleontological resources is moderate to high, and is dependent on the proposed action. Mitigation considerations must include assessment of the disturbance, such as removal or penetration of protective surface alluvium or soils, potential for future accelerated erosion, or increased ease of access resulting in greater looting potential. If impacts to significant fossils can be anticipated, on-the-ground surveys prior to authorizing the surface disturbing action will usually be necessary. On-site monitoring or spot-checking may be necessary during construction activities.

Class 5 – **Very High**. Highly fossiliferous geologic units that consistently and predictably produce vertebrate fossils or scientifically significant invertebrate or plant fossils, and that are at risk of human-caused adverse impacts or natural degradation.

Class 5a – Unit is exposed with little or no soil or vegetative cover. Outcrop areas are extensive with exposed bedrock areas often larger than two contiguous acres. Paleontological resources are highly susceptible to adverse impacts from surface disturbing actions. Unit is frequently the focus of illegal collecting activities.

Class 5b – These are areas underlain by geologic units with very high potential but have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation due to moderating circumstances. The bedrock unit has very high potential, but a protective layer of soil, thin alluvial material, or other conditions may lessen or prevent potential impacts to the bedrock resulting from the activity.

- Extensive soil or vegetative cover; bedrock exposures are limited or not expected to be impacted.
- Areas of exposed outcrop are smaller than two contiguous acres.
- Outcrops form cliffs of sufficient height and slope so that impacts are minimized by topographic conditions.
- Other characteristics are present that lower the vulnerability of both known and unidentified paleontological resources.

(1) Management concern for paleontological resources in Class 5 areas is high to very high.

(2) A field survey by a qualified paleontologist is usually necessary prior to surface disturbing activities or land tenure adjustments. Mitigation will often be necessary before and/or during these actions.

(3) Official designation of areas of avoidance, special interest, and concern may be appropriate.

The probability for impacting significant fossils is high. Vertebrate fossils or scientifically significant invertebrate fossils are known or can reasonably be expected to occur in the impacted area. On-the-ground surveys prior to authorizing any surface disturbing activities will usually be necessary. On-site monitoring may be necessary during construction activities.

Table E-1
Review of RMPs and PFYC Estimates

State	Field Office/District	Area	Date of RMP	Paleontological Resources Analyzed?	PFYC Class Estimate[1]	Comments
AK	Anchorage	Bay	July 2006	yes	2, 4 and 5	Short section with no specific information. Paleontological resources assessed by Lindsey (1986).
AK	Anchorage	Ring of Fire	June 2006	yes	2, 4 and 5	Moderately thorough description (by sub-area) of paleontological resources and previous work.
AK	Fairbanks and Anchorage	Kobuk-Seward	February 2006	yes	cannot be determined	Short section with little specific information. Paleontological resources assessed by Lindsey (1986).
AK	Glennallen	East Alaska	April 2006	yes	3, 4 and 5	Moderately thorough description (by sub-area) of paleontological resources and previous work.
AZ	Arizona Strip	Arizona Strip	January 2007	Appendix 3b	2, 3, 4 and 5	Virtually no paleontologic discussion within the AE chapter. Appendix 3B contains information on paleontological resource occurrences, and a geologic map is provided (map 3.10). Figures 3.1 and 3.2 are stratigraphic sections.
AZ	Arizona Strip	Vermillion Cliffs and Grand Canyon-Parashant Nat. Mons.	January 2007	yes	2, 3, 4 and 5	Essentially the same paleontological report as the Arizona Strip RMP
AZ	Lake Havasu	Arizona and California	May 2007	yes	cannot be determined	Paleontological resources are discussed, but no specific details of fossils, geologic formations, or paleontological sensitivity is included. Paleontological resource classification system used is not the current PFYC. Insufficient information is provided to assess paleontological sensitivity or to provide PFYC designations. Paleontology section written by an archaeologist.
AZ	Tucson	Ironwood Forest Nat. Mon.	March 2007	yes	1 and 2	Brief paleontological resource section that concludes that only PFYC class 1 and 2 are present. Paleontological resources analyzed by Cultural Resource and Geological Staff (not by a paleontologist). Insufficient information is included to properly assess paleontological sensitivity.
AZ	Yuma	Arizona and California	December 2006	yes	2, 3, 4 and 5	Broad paleontological discussion with short list of known fossils provided, but no specifics on geologic formation associations, and no information about

Table E-1
Review of RMPs and PFYC Estimates

State	Field Office/District	Area	Date of RMP	Paleontological Resources Analyzed?	PFYC Class Estimate[1]	Comments
						formations and their fossil occurrences. Paleontological resource evaluation conducted by a geologist/archaeologist.
CA	Arcata	Headwaters Forest Reserve	September 2003	no	cannot be determined	No mention of paleontological resources.
CA	Arcata	King Range	November 2004	yes	cannot be determined	Short paragraph concluding that paleontological resources would not be affected, and thus are not discussed or analyzed in the RMP. Based on the geologic map provided, and the information included in the geology section, paleontologic resources may actually be affected. No paleontologist input included in RMP.
CA	Bakersfield district	Caliente Resource Area	August 2007	no	2, 3, 4 and 5	Virtually no mention of paleontological resources and no specific AE chapter provided. Fossil occurrences are mentioned within three of the 16 ACEC sections (chapter 11). These provided sufficient information to tentatively provide PFYC designations.
CA	California Desert District	South Coast Resource	June 1994	no	cannot be determined	No mention of paleontological resources.
CA	California Desert District	California Desert Conservation area	March 1999	no	cannot be determined	Paleontological resources discussed in the context of "cultural and paleontological resources." However, no specific discussion of paleontological resources is provided, nor is there any mention of specific paleontological resources within the management area.
CA	Eagle Lake		May 2007	no	cannot be determined	Paleontological resources are included in the AE chapter section 3.2 (Cultural Resources and Paleontology), but no discussion of paleontology is provided, nor is there any mention of paleontological resources within the management area.
CA	El Centro	Eastern San Diego Co.	February 2007	yes	cannot be determined	A paleontological resources discussion is included, but with no reference to the types of paleontological resources occurring in the management area, or to exposures of specific formations. Furthermore, the paleontological resource classification system used in

Table E-1
Review of RMPs and PFYC Estimates

State	Field Office/District	Area	Date of RMP	Paleontological Resources Analyzed?	PFYC Class Estimate[1]	Comments
						this RMP is not the PFYC.
CA	Folsom	Sierra	not available	yes	cannot be determined	One short paragraph concluding that paleontological resources are limited to plant microfossils. No information about specific geologic formations is provided.
CA	Palm Springs-South Coast	Santa Rosa and San Jacinto Mnts	February 2004	no	cannot be determined	No assessment of paleontological resources.
CA	Surprise		May 2007	no	cannot be determined	Paleontological resources included in the AE chapter section 3.2 (Cultural Resources and Paleontology), but no discussion of paleontological resources is provided, nor is there any mention of paleontological resources within the management area.
CA	Ukiah District	Redding resource	July 1992	no	cannot be determined	No assessment of paleontological resources.
CO		McInnis Canyon/ Colorado Canyons Conservation area	July 2004	yes	2, 3, 4 and 5	General description of paleontological resources in the area with some reference to fossil types and mapped formations. No citations of primary literature used in analysis.
CO	Canon City District	Northeast Resource area	May 1985	no	cannot be determined	Paleontological resources discussed in the context of management and mitigation. However, there is no specific discussion about, nor specific reference to, fossils or formations.
CO	Canon City District	Royal Gorge	January 1995	no	cannot be determined	Paleontological resources discussed in the context of management and mitigation. However, no specific discussion about, nor specific reference to, fossils or formations is provided.
CO	Canon City District	San Luis	September 1991	no	cannot be determined	Paleontological resources discussed in the context of management and mitigation. However, no specific discussion about, nor specific reference to, fossils or formations is provided.
CO	Craig District	Kremmling	1983	no	cannot be determined	Paleontological resources discussed in the context of management and mitigation. However, no specific discussion about, nor specific reference to, fossils or formations is provided.

Table E-1
Review of RMPs and PFYC Estimates

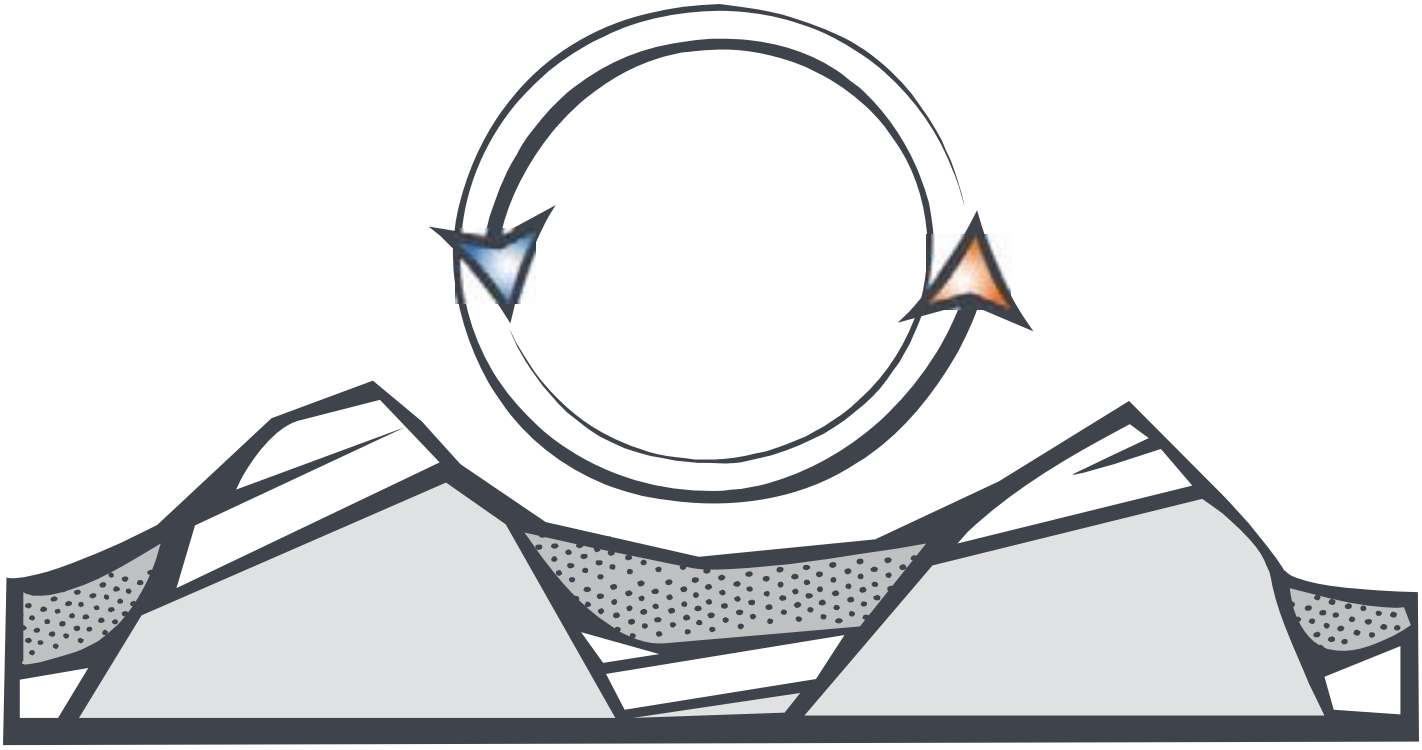
State	Field Office/District	Area	Date of RMP	Paleontological Resources Analyzed?	PFYC Class Estimate[1]	Comments
CO	Craig District	White River	July 1997	no	cannot be determined	Paleontological resources discussed in the context of management and mitigation. However, no specific discussion about, nor specific reference to, fossils or formations is provided.
CO	Glenwood Springs	Roan Plateau	August 2006	yes	2, 3, 4 and 5	Fairly complete review of paleontological resources in the field office.
CO	Montrose District	San Juan/San Miguel	December 1984	yes	2, 3, 4 and 5	Paleontological resources section is brief, and references some specific formations, but lists no specific fossil types.
CO	Montrose District	Uncompahgre	September 1998	no	cannot be determined	Paleontological resources discussed in response to public comment; however, there is no specific discussion about, nor specific reference to, fossils or formations.
CO	San Juan	Silverton	August 2004	no	cannot be determined	No assessment of paleontological resources.
ID	Twin Falls District	Craters of the Moon	July 2005	yes	2	Very general discussion of types of fossils found in various Pleistocene deposits and tree molds in lava flows.
ID	Boise district	Snake River Birds of Prey	April 2006	yes	cannot be determined	Report concluded that paleontological resources would not be impacted. No specific information on the fossils or formations in the management area is provided.
ID	Boise district	Cascade Resource area	not available	yes	cannot be determined	Very brief paleontological resources section with no specifics on fossil types or formations.
ID	Burley	Cassia	January 1985	no	cannot be determined	No assessment of paleontological resources.
ID	Challis	Challis Resource area	July 1999	no	cannot be determined	Very brief (6 pages) RMP with no mention of paleontological resources other than a statement of protection.
ID	Coeur d'Alene		October 2006	yes	1 and ?5	Paleontological resources determined to be of low significance, but no reference to specific formations was made. Report references an old PFYC classification system.
ID	Cottonwood		May 2006	yes	2, 3	Brief paleontological resources section with general description of types of fossils and rocks found in the

Table E-1
Review of RMPs and PFYC Estimates

State	Field Office/District	Area	Date of RMP	Paleontological Resources Analyzed?	PFYC Class Estimate[1]	Comments
						management area.
ID	Jarbidge	Jarbidge Resource Area	1987- Under revision	yes	cannot be determined	Brief review of areas of paleontological resources in the management area.
ID	Idaho Falls district	Medicine Lodge	December 1985	no	cannot be determined	No assessment of paleontological resources.
ID	Lower Snake River Dist.	Bureau	August 2001	no	cannot be determined	2 page Environmental Statement; Notice of intent
ID	Lower Snake River Dist.	Owyhee	December 1999	no	cannot be determined	No assessment of paleontological resources.
ID	Pocatello		October 2006	yes	2, 3, 4 and 5	Thorough review of paleontological resources in the management area.
ID	Salmon	Lemhi	August 2001	no	cannot be determined	No assessment of paleontological resources.
ID	Shoshone and Burley	Monument	January 1986	no	cannot be determined	No assessment of paleontological resources.
MT	Butte	Butte Resource area	June, 2007	yes	2, 3, 4 and 5	Brief review of paleontological resources in the management area.
MT	Butte District	Garnet	January 1986	no	cannot be determined	No assessment of paleontological resources.
MT	Butte District	Headwaters	November 1983	no	cannot be determined	No assessment of paleontological resources.
MT	Dillon	Dillon	March 2004	yes	2, 3, 4 and 5	Thorough review of paleontological resources in the management area.
MT	Lewiston District	West HiLine	1988	yes	2, 3, 4 and 5	Brief review of paleontological resources in the management area.
MT	Lewiston District	Upper Missouri River Breaks	September 2005	yes	2, 3, 4 and 5	Brief review of paleontological resources in the management area.
MT	Miles City District	Big Dry	February 1995	yes	2, 3, 4 and 5	Thorough review of paleontological resources in the management area.
MT	Miles City District	Billings Resource area	November 1983	no	2, 3, 4 and 5	Estimated PFYC classes based on stratigraphic section (Figure 3.1) included in chapter 3 geology section.
MT	Miles City District	Powder River	December 1984	yes	2, 3, 4 and 5	Brief review of paleontological resources in the management area.

Table E-1
Review of RMPs and PFYC Estimates

State	Field Office/District	Area	Date of RMP	Paleontological Resources Analyzed?	PFYC Class Estimate[1]	Comments
			1984			management area.
UT		Grand Staircase-Escalante	February 2000	yes	2, 3, 4 and 5	Brief review of paleontological resources in the management area.
WA	Spokane District	Iceberg Point	June 1990	no	cannot be determined	No assessment of paleontological resources.
WA	Spokane District	Spokane	June 1992	no	cannot be determined	No assessment of paleontological resources.
WA	Spokane District	Yakima Firing Center	June 1993	no	cannot be determined	No assessment of paleontological resources.
WY	Casper	Platte River	July 1985	no	cannot be determined	No assessment of paleontological resources.
WY	Casper	Newcastle/ Nebraska	May 1992	no	cannot be determined	No assessment of paleontological resources.
WY	Newcastle		September 2000	no	cannot be determined	No assessment of paleontological resources.
WY	Pinedale	Snake River	April 2004	no	cannot be determined	No assessment of paleontological resources.
WY	Rawlins	Lander	June 1987	no	cannot be determined	No assessment of paleontological resources.
WY	Rawlins	Great Divide	November 1990	no	cannot be determined	No assessment of paleontological resources.
WY	Rock Springs	Green River	October 1997	no	cannot be determined	No assessment of paleontological resources.
WY	Rock Springs	Kemmerer	June 1986	no	cannot be determined	No assessment of paleontological resources.
WY	Rock Springs	Pinedale	December 1988	no	cannot be determined	No assessment of paleontological resources.
WY	Worland	Grass Creek	September 1998	no	cannot be determined	No assessment of paleontological resources.
WY	Worland	Washakie	September 1988	no	cannot be determined	No assessment of paleontological resources.
WY	Worland	Cody	November 1990	no	cannot be determined	No assessment of paleontological resources.



Appendix F

Hot and Warm Springs in the Project Area

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APPENDIX F
HOT AND WARM SPRINGS IN THE PROJECT AREA

Source: US Department of Commerce, National Oceanic and Atmospheric Administration 2008

KEY:
TF = Maximum surface temperature in degrees Fahrenheit
TC = Maximum surface temperature in degrees Celsius
P.P. 492 = "Thermal Springs of the United States and Other Countries of the World – A Summary," U.S.G.S. Professional Paper 492 (Waring, 1965)
Circ. 790 = "Assessment of geothermal resources of the United States," U.S.G.S. Circular 790 (Muffler, 1979)
NOAA = 1:250,000-scale overlays in "Thermal Springs List for the United States," NOAA KGRD 12 (Berry, Grim, Ikelman, 1980)
AMS = 1:250,000 AMS Maps
USGS quadrangle = The USGS 15-minute or 7.5-minute quadrangle on which spring may be found

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
AK	53.8920	-166.930	MAKUSHIN VOLCANO FUMAROLES	310	154	45	null	1	UNALASKA	null
AK	51.9250	-177.160	FUMAROLES ON KANAGA ISLAND	219	104	32	null	1	ADAK	null
AK	53.2130	-168.463	HOT SPRINGS NEAR GEYSER BIGHT	216	102	41	18	7	UMNAK	null
AK	53.2230	-168.477	HOT SPRINGS NEAR GEYSER BIGHT	214	101	41	18	6	UMNAK	null
AK	53.4430	-168.092	THERMAL SPRINGS IN OKMOK CALDERA	212	100	null	null	2	UMNAK	null
AK	52.0420	-176.108	HOT SPRINGS ON GREAT	210	99	34	16	1	ADAK	null

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
			SITKIN ISLAND							
AK	55.9830	-131.661	BAILEY HOT SPRING	198	92	76	27	1	KETCHIKAN	KETCHIKAN (D-5) 15
AK	53.2420	-168.365	HOT SPRINGS NEAR HOT SPRINGS COVE	192	89	43	17	4	UMNAK	null
AK	54.1570	-165.850	HOT SPRINGS NEAR HOT SPRINGS BAY	181	83	46	20	3	UNIMAK	null
AK	58.0330	-136.017	HOT SPRINGS NORTH END TENAKEE INLET	180	82	null	22	1	MT. FAIRWEATHE R	(MT. FAIRWEATHER (A-1) 15)
AK	65.0930	-164.922	PILGRIM SPRINGS	178	81	6	3	2	BENDELEBEN	BENDELEBEN (A-6) 15
AK	57.8310	-156.513	W UKINEK SPRING	178	81	null	null	2	UGASHIK	(UGASHIK (D-2) 15)
AK	65.4590	-153.312	LITTLE MELOZITNA HOT SPRINGS	176	80	11	9	1	MELOZITNA	MELOZITNA (B-1) 15
AK	65.8580	-164.710	SERPENTINE HOT SPRINGS	171	77	4	2	1	BENDELEBEN	BENDELEBEN (D-6) 15
AK	52.1900	-174.250	HOT SPRINGS ON ATKA ISLAND	167	75	37	null	3	ATKA	null
AK	55.9330	-131.559	BELL ISLAND HOT SPRINGS	165	74	79	28	2	KETCHIKAN	KETCHIKAN (D-5) 15
AK	55.8630	-160.493	HOT SPRING NEAR PORT MOLLER	160	71	54	null	1	PORT MOLLER	PORT MOLLER (D-2) 15
AK	53.2530	-168.358	HOT SPRINGS NEAR HOT SPRINGS COVE	158	70	43	17	3	UMNAK	null
AK	51.9700	-176.610	HOT SPRINGS ON ADAK ISLAND	154	68	33	null	1	ADAK	null
AK	65.0530	-146.057	CHENA HOT SPRINGS	153	67	18	14	1	CIRCLE	CIRCLE (A-5) 15
AK	56.8360	-135.374	GODDARD HOT SPRINGS	153	67	70	25	1	PORT ALEXANDER	PORT ALEXANDER (D-5) 15
AK	58.3700	-137.090	HOT SPRINGS NEAR ICY POINT	153	67	null	null	1	MT. FAIRWEATHE R	(MT. FAIRWEATHER (B-4) 15)
AK	66.3420	-150.850	KANUTI HOT SPRINGS	151	66	null	11	1	BETTLES	(BETTLES (B-2) 15)
AK	64.8500	-162.300	CLEAR CREEK HOT SPRINGS	149	65	null	5	1	SOLOMON	(SOLOMON (D-1) 15)
AK	53.2330	-168.300	HOT SPRING ON UMNAK ISLAND	149	65	42	19	5	UMNAK	null
AK	54.9440	-163.251	HOT SPRINGS NEAR MORZHOVOI	145	63	50	null	1	FALSE PASS	null
AK	61.2000	-159.863	HOT SPRINGS NEAR OPHIR CREEK	145	63	26	null	1	RUSSIAN MISSION	(RUSSIAN MISSION (A-2) 15)
AK	51.7620	-178.770	FUMAROLES ON GARELOI ISLAND	144	62	null	null	2	GARELOI ISLAND	null
AK	65.9830	-150.560	HOT SPRINGS ON LOWER RAY RIVER	142	61	null	null	1	TANANA	(TANANA (D-2) 15)

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
AK	66.3670	-156.767	HOT SPRINGS NEAR DIVISION BM	140	60	3	null	1	SHUNGNAK	null
AK	65.2740	-148.847	TOLOVANA HOT SPRINGS	140	60	17	12	1	LIVENGOOD	LIVENGOOD (B-4) 15
AK	57.1780	-157.015	HOT SPRING NEAR MOTHER GOOSE LAKE	138	59	null	null	1	UGASHIK	(UGASHIK (A-4) 15)
AK	56.2330	-131.267	BRADFIELD CANAL HOT SPRINGS	135	57	null	null	2	BRADFIELD CANAL	(BRADFIELD CANAL (A-4) 15)
AK	65.4830	-144.637	CIRCLE HOT SPRINGS	135	57	19	15	1	CIRCLE	CIRCLE (B-2) 15
AK	65.0060	-150.633	MANLEY HOT SPRINGS	133	56	14	13	4	TANANA	TANANA (A-2)
AK	65.1290	-154.692	MELOZI (MELOZITNA) SPRINGS	131	55	10	8	3	MELOZITNA	MELOZITNA (A-4) 15
AK	66.2170	-149.547	DALL HOT SPRINGS	129	54	null	null	1	BEAVER	(BEAVER (A-6) 15)
AK	55.2170	-162.483	HOT SPRINGS EAST OF COLD BAY	129	54	null	21	2	COLD BAY	null
AK	57.8650	-156.499	GAS ROCKS HOT SPRING	127	53	56	null	1	UGASHIK	(UGASHIK (D-2) 15)
AK	65.2170	-162.900	HOT SPRINGS NEAR LAVA CREEK	127	53	null	4	1	BENDELEBEN	(BENDELEBEN (A-2) 15)
AK	65.2670	-155.280	HOT SPRINGS NEAR DULBI RIVER	126	52	null	7	1	MELOZITNA	(MELOZITNA (B-5) 15)
AK	57.0850	-134.839	BARANOF WARM SPRINGS	124	51	69	null	1	SITKA	SITKA (A-3) 15
AK	56.7170	-132.005	CHIEF SHAKES HOT SPRINGS	122	50	73	26	1	PETERSBURG	(PETERSBURG (C-1) 15)
AK	66.1500	-157.117	HOT SPRINGS NEAR SOUTH BM	122	50	null	6	3	SHUNGNAK	null
AK	66.2330	-157.583	HOT SPRINGS ON HAWK RIVER	122	50	null	null	2	SHUNGNAK	null
AK	65.8100	-151.237	KILO HOT SPRING	122	50	null	null	1	TANANA	TANANA (D-3)
AK	67.2830	-155.067	REED RIVER HOT SPRING	122	50	1	10	1	SURVEY PASS	null
AK	52.8400	-169.900	CHUGINADAK HOT SPRINGS	H	H	39	null	2	SAMALGA ISLAND	null
AK	65.9080	-154.993	DENIKTOW RIDGE HOT SPRINGS	H	H	null	null	2	MELOZITNA	MELOZITNA (D-4) 15
AK	55.3680	-161.961	FUMAROLE	H	H	52	null	1	PORT MOLLER	null
AK	51.7750	-178.793	FUMAROLES ON GARELOI ISLAND	H	H	null	null	1	GARELOI ISLAND	null
AK	51.9670	178.444	FUMAROLES ON LITTLE SITKIN ISLAND	H	H	null	null	1	RAT ISLANDS	null
AK	51.9440	178.547	FUMAROLES ON LITTLE SITKIN ISLAND	H	H	null	null	3	RAT ISLANDS	null
AK	51.9630	178.491	FUMAROLES ON LITTLE SITKIN ISLAND	H	H	null	null	2	RAT ISLANDS	null

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
AK	61.2670	-151.238	HOT LAKE IN BOTTOM OF CRATER PEAK	H	H	null	null	1	TYONEK	(TYONEK (B-6) 15)
AK	58.2400	-155.090	HOT SPRING NEAR KATMAI PASS	H	H	57	null	1	MT. KATMAI	(MT. KATMAI (A-4) 15)
AK	65.4500	-150.000	HOT SPRING NEAR LITTLE MINOOK CR	H	H	16	null	3	TANANA	(TANANA (B-1) 15)
AK	61.0580	-160.692	HOT SPRING NEAR TULUKSAK RIVER	H	H	25	null	1	RUSSIAN MISSION	(RUSSIAN MISSION (A-5) 15)
AK	54.9000	-162.885	HOT SPRING ON AMAGAT ISLAND	H	H	51	null	1	FALSE PASS	(FALSE PASS (D-3) 15)
AK	52.9600	-169.710	HOT SPRING ON KAGAMIL ISLAND	H	H	40	null	1	SAMALGA ISLAND	null
AK	51.9400	178.500	HOT SPRING ON LITTLE SITKIN ISLAND	H	H	29	null	4	RAT ISLANDS	null
AK	52.3580	-172.317	HOT SPRING ON SEGUAM ISLAND	H	H	38	null	1	SEGUAM	null
AK	51.8100	-177.790	HOT SPRING ON TANAGA ISLAND	H	H	31	null	2	ADAK	null
AK	64.0020	-156.300	HOT SPRING ON TRIBUTARY OF INNOKO R	H	H	13	null	1	NULATO	(NULATO (A-1) 15)
AK	54.6600	-164.550	HOT SPRING ON UNIMAK ISLAND	H	H	49	null	1	UNIMAK	null
AK	58.9200	-153.980	HOT SPRING WEST OF CAPE DOUGLAS	H	H	59	null	1	AFOGNAK	(AFOGNAK (D-6) 15)
AK	53.2070	-168.445	HOT SPRINGS NEAR GEYSER BIGHT	H	H	41	18	8	UMNAK	null
AK	53.8510	-166.918	HOT SPRINGS NEAR MAKUSHIN VOLCANO	H	H	45	null	3	UNALASKA	null
AK	58.2700	-154.890	HOT SPRINGS NEAR MT KATMAI	H	H	58	null	1	MT. KATMAI	(MT. KATMAI (B-3) 15)
AK	53.8770	-166.448	HOT SPRINGS NEAR SUMMER BAY	H	H	null	null	2	UNALASKA	null
AK	54.2300	-165.660	HOT SPRINGS ON AKUN ISLAND	H	H	null	null	1	UNIMAK	null
AK	54.1800	-165.410	HOT SPRINGS ON AKUN ISLAND	H	H	null	null	2	UNIMAK	null
AK	52.3400	-174.260	HOT SPRINGS ON ATKA ISLAND	H	H	35	null	1	ATKA	null
AK	52.2700	-174.042	HOT SPRINGS ON ATKA ISLAND	H	H	36	null	2	ATKA	null
AK	65.2330	-144.483	HOT SPRINGS ON BIG WINDY CREEK	H	H	20	null	2	CIRCLE	(CIRCLE (A-1) 15)
AK	53.9500	-168.037	HOT SPRINGS ON BOGOSLOF ISLAND	H	H	44	null	1	UMNAK	null
AK	61.3630	-157.733	HOT SPRINGS ON UPPER CHUILNUK RIVER	H	H	null	null	1	SLEETMUTE	(SLEETMUTE (B-4) 15)

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
AK	65.9700	-154.033	POCAHONTAS HOT SPRINGS	H	H	null	null	I	MELOZITNA	MELOZITNA (D-3) 15

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
AZ	32.9710	-109.350	GILLARD HOT SPRINGS	180	82	null	32	2	SILVER CITY	GUTHRIE 15
AZ	32.7410	-114.068	RADIUM HOT SPRINGS	140	60	null	null	1	EL CENTRO	WELLTON MESA 7.5
AZ	33.0800	-109.303	HOT SPRING	138	59	null	31	2	CLIFTON	CLIFTON 15
AZ	33.4000	-109.152	HANNAH HOT SPRING	133	56	null	null	1	CLIFTON	DUTCH BLUE CREEK 7.5
AZ	32.3360	-110.240	HOOKERS HOT SPRINGS	127	53	19	null	4	TUCSON	WINCHESTER MTS. 15
AZ	35.9840	-114.742	HOT SPRING	H	H	null	null	1	KINGMAN	RINGBOLT RAPIDS 7.5

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
CA	38.8020	-122.810	THE GEYSERS	214	101	72	48	21	SANTA ROSA	THE GEYSERS 7.5
CA	38.7670	-122.748	LITTLE GEYSERS	210	99	74	48	27	SANTA ROSA	(WHISPERING PINES 7.5)
CA	41.5340	-120.078	HOT SPRINGS (SURPRISE VALLEY)	208	98	18	35	8	ALTURAS	CEDARVILLE 15
CA	36.0450	-117.769	COSO HOT SPRINGS	207	97	142	57	8	DEATH VALLEY	HAIWEE RESERVOIR 15
CA	36.0360	-117.802	DEVILS KITCHEN	207	97	141	57	9	DEATH VALLEY	HAIWEE RESERVOIR 15
CA	41.6700	-120.206	LAKE CITY HOT SPRINGS	207	97	14	35	4	ALTURAS	CEDARVILLE 15
CA	40.3640	-120.243	HOT SPRING	204	96	null	42	3	SUSANVILLE	WENDEL 15
CA	40.3820	-121.513	MORGAN HOT SPRING	205	96	33	41	10	SUSANVILLE	LASSEN PEAK 15
CA	40.4210	-121.375	TERMINAL GEYSER	205	96	38	40	8	SUSANVILLE	MT. HARKNESS 15
CA	40.3550	-120.257	WENDEL HOT SPRINGS	205	96	30	42	4	SUSANVILLE	LITCHFIELD 15
CA	40.3020	-120.195	AMEDEE HOT SPRINGS	203	95	31	42	5	SUSANVILLE	WENDEL 15
CA	40.4400	-121.434	DEVILS KITCHEN	203	95	34	40	5	SUSANVILLE	MT. HARKNESS 15
CA	36.0310	-117.833	FUMAROLE	203	95	141	57	10	DEATH VALLEY	HAIWEE RESERVOIR 15
CA	40.3930	-121.507	GROWLER HOT SPRING	203	95	null	41	9	SUSANVILLE	LASSEN PEAK 15
CA	40.4550	-121.501	BUMPASS HELL	199	93	27	40	2	SUSANVILLE	LASSEN PEAK 15
CA	37.6480	-118.914	CASA DIABLO HOT SPRINGS AND GEYSER	199	93	123	56	13	MARIPOSA	MT. MORRISON 15
CA	37.6650	-118.828	HOT CREEK GORGE SPRINGS	199	93	null	56	8	MARIPOSA	MT. MORRISON 15
CA	40.4470	-121.536	SULPHUR WORKS, TOPHET HOT SPRINGS	199	93	26	40	3	SUSANVILLE	LASSEN PEAK 15
CA	41.4500	-120.834	KELLY HOT SPRING	198	92	8	38	12	ALTURAS	CANBY 15
CA	34.1850	-117.262	ARROWHEAD SPRINGS, WATERMAN HOT SPR	194	90	162	62	3	SAN BERNARDINO	SAN BERNARDINO NORTH 7.5
CA	34.5960	-118.998	SESPE HOT SPRINGS	194	90	111	61	2	LOS ANGELES	DEVILS HEART PEAK 7.5
CA	40.4340	-121.399	BOILING SPRINGS LAKE	190	88	37	40	7	SUSANVILLE	MT. HARKNESS 15
CA	41.6070	-121.523	HOT SPOT	191	88	3	null	1	ALTURAS	MEDICINE LAKE 15
CA	41.6150	-120.102	SEYFERTH HOT SPRINGS	185	85	16	35	5	ALTURAS	CEDARVILLE 15
CA	41.4070	-122.197	HOT SPRING, FUMAROLES	183	84	3	null	3	WEED	SHASTA 15
CA	37.9930	-119.028	PAOHA ISLAND SPRINGS	181	83	120	null	1	MARIPOSA	(MONO CRATERS 15)

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
CA	41.0250	-121.924	BIG BEND HOT SPRINGS	180	82	24	39	6	ALTURAS	BIG BEND 15
CA	38.3480	-119.400	FALES HOT SPRINGS	180	82	114	52	4	WALKER LAKE	FALES HOT SPRINGS 7.5
CA	37.6920	-118.839	LITTLE HOT CREEK SPRING	180	82	122	56	5	MARIPOSA	MT. MORRISON 15
CA	38.2450	-119.205	TRAVERTINE HOT SPRINGS	180	82	116	54	5	WALKER LAKE	BODIE 15
CA	41.1430	-121.110	BASSETT HOT SPRINGS	174	79	28	37	3	ALTURAS	BIEBER 15
CA	38.5800	-122.575	CALISTOGA HOT SPRINGS	172	78	81	50	30	SANTA ROSA	CALISTOGA 7.5
CA	41.1260	-121.028	KELLOG HOT SPRINGS	172	78	29	null	4	ALTURAS	BIEBER 15
CA	37.6560	-118.834	HOT CREEK SPRINGS	171	77	null	56	11	MARIPOSA	(MT. MORRISON 15)
CA	41.1900	-120.383	WEST VALLEY RESERVOIR HOT SPRING	171	77	null	36	19	ALTURAS	(TULE MOUNTAIN 7.5)
CA	41.2290	-121.405	LITTLE HOT SPRING	169	76	11	null	2	ALTURAS	FALL RIVER MILLS 15
CA	37.6640	-118.802	THE TUB	167	75	null	56	9	MARIPOSA	(MT. MORRISON 15)
CA	37.6470	-118.859	CASA DIABLO HOT POOL	165	74	124	56	15	MARIPOSA	MT. MORRISON 15
CA	38.7680	-122.717	CASTLE ROCK SPRINGS	163	73	62	48	26	SANTA ROSA	WHISPERING PINES 7.5
CA	39.0570	-122.475	ELGIN MINE	156	69	69	null	9	UKIAH	WILBUR SPRINGS 15
CA	41.9730	-122.202	KLAMATH HOT SPRING	156	69	2	null	1	WEED	MACDOEL 15
CA	39.0020	-122.664	SULPHUR BANK	156	69	57	46	17	UKIAH	CLEARLAKE OAKS 7.5
CA	39.0390	-122.421	WILBUR SPRINGS	153	67	68	44	11	UKIAH	WILBUR SPRINGS 15
CA	40.4440	-121.409	DRAKESBAD	151	66	36	40	4	SUSANVILLE	MT. HARKNESS 15
CA	38.0480	-119.081	HOT SPRING	151	66	null	null	9	WALKER LAKE	BODIE 15
CA	40.4570	-121.545	MILL CREEK SPRINGS	150	66	25	40	1	SUSANVILLE	(LASSEN PEAK 15)
CA	38.7730	-119.713	null	149	65	null	null	1	WALKER LAKE	(MT. SIEGEL 15)
CA	38.6990	-119.846	GROVERS HOT SPRINGS	147	64	113	51	2	WALKER LAKE	MARKLEEVILLE 15
CA	39.1830	-122.700	BARTLETT SPRINGS	144	62	null	null	7	UKIAH	CLEARLAKE OAKS 15
CA	41.6000	-120.088	LEONARDS HOT SPRINGS	144	62	17	35	6	ALTURAS	CEDARVILLE 15
CA	36.2340	-121.546	TASSAJARA HOT SPRINGS	144	62	91	null	6	SANTA CRUZ	TASSAJARA HOT SPRINGS 7.5
CA	39.0330	-122.445	JONES FOUNTAIN OF LIFE SPRING	142	61	null	null	12	UKIAH	WILBUR SPRINGS 15
CA	38.2370	-119.326	BUCKEYE HOT SPRING	140	60	115	53	6	WALKER LAKE	MATTERHORN PEAK 15
CA	33.2840	-116.631	WARNER HOT SPRING	138	59	179	null	7	SANTA ANA	WARNER SPRINGS 7.5

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CA	41.0360	-121.926	HUNT HOT SPRING	136	58	23	null	5	ALTURAS	BIG BEND 15
CA	37.8020	-118.532	BENTON HOT SPRINGS	134	57	127	null	2	MARIPOSA	GLASS MOUNTAIN 15
CA	37.6770	-118.790	DEHY HOT SPRING	134	57	null	56	6	MARIPOSA	(MT. MORRISON 15)
CA	41.2660	-120.080	HOT SPRINGS (MENLO BATHS)	135	57	20	null	14	ALTURAS	EAGLEVILLE 7.5
CA	34.5380	-119.560	AGUA CALIENTE SPRING	133	56	null	null	2	LOS ANGELES	HILDRETH PEAK 7.5
CA	33.5580	-117.154	MURRIETTA HOT SPRINGS	132	56	170	null	8	SANTA ANA	MURRIETTA 7.5
CA	35.6200	-118.473	SCOVERN HOT SPRINGS	133	56	149	60	3	BAKERSFIELD	LAKE ISABELLA SOUTH
CA	38.6910	-123.024	SKAGGS SPRINGS	135	56	71	49	3	SANTA ROSA	SKAGGS SPRINGS 7.5
CA	39.2260	-120.010	BROCKWAY HOT SPRINGS	131	55	44	null	5	CHICO	(KINGS BEACH 7.5)
CA	33.7530	-117.495	GLEN IVY HOT SPRINGS	131	55	167	null	4	SANTA ANA	LAKE MATTHEWS 7.5
CA	37.6480	-118.806	HOT SPRINGS	129	54	125	56	14	MARIPOSA	MT. MORRISON 15
CA	37.6670	-118.781	null	127	53	null	56	7	MARIPOSA	(MT. MORRISON 15)
CA	38.8730	-122.689	SEIGLER SPRINGS	126	52	59	47	14	SANTA ROSA	WHISPERING PINES 7.5
CA	33.6700	-117.325	WRENDEN HOT SPRS, ELSINORE HOT SPRS	125	52	168	null	5	SANTA ANA	(ELSINORE 7.5)
CA	36.2290	-118.302	JORDAN HOT SPRINGS	124	51	null	null	2	FRESNO	HOCKETT PEAK 15
CA	37.2530	-118.373	KEOUGH HOT SPRINGS	124	51	138	null	22	MARIPOSA	BISHOP 15
CA	34.4980	-119.341	STINGLEYS HOT SPRINGS	123	51	107	null	8	LOS ANGELES	MATILIJA 7.5
CA	34.5020	-119.346	VICKERS HOT SPRINGS	124	51	106	null	7	LOS ANGELES	(WHEELER SPRINGS 7.5)
CA	35.8810	-118.670	CALIFORNIA HOT SPRINGS	122	50	137	null	1	BAKERSFIELD	CALIFORNIA HOT SPRINGS 15
CA	36.1230	-121.640	SLATES HOT SPRINGS	122	50	93	null	7	SANTA CRUZ	LOPEZ POINT 7.5
CA	38.9790	-122.659	FUMAROLE	H	H	null	null	4	SANTA ROSA	(CLEARLAKE HIGHLANDS 7.5)
CA	37.6220	-119.028	FUMAROLES	H	H	null	null	5	MARIPOSA	(DEVILS POSTPILE 15)
CA	41.0120	-121.274	HOT SPRINGS	H	H	null	null	7	ALTURAS	FALL RIVER MILLS 15
CA	39.9220	-120.024	ZAMBONI HOT SPRINGS	H	H	null	null	2	CHICO	CONSTANTIA 7.5

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CO	38.7320	-106.178	HORTENSE HOT SPRING	181	83	null	74	5	MONTROSE	PONCHA SPRINGS 15
CO	38.5140	-106.508	UPPER WAUNITA HOT SPRINGS	176	80	14	76	9	MONTROSE	PITKIN 7.5
CO	38.5170	-106.515	LOWER WAUNITA HOT SPRINGS	167	75	null	76	8	MONTROSE	(PITKIN 7.5)
CO	38.4980	-106.076	PONCHA HOT SPRINGS	160	71	21	75	10	MONTROSE	BONANZA 15
CO	38.0210	-107.672	OURAY HOT SPRINGS	156	69	28	null	3	MONTROSE	(OURAY 7.5)
CO	40.5590	-106.849	ROUTT HOT SPRINGS	147	64	2	72	1	CRAIG	ROCKY PEAK 7.5
CO	38.1680	-105.924	MINERAL HOT SPRINGS	140	60	23	null	5	PUEBLO	VILLA GROVE 7.5
CO	38.8120	-106.226	COTTONWOOD HOT SPRINGS	136	58	19	null	3	MONTROSE	BUENA VISTA 15
CO	37.2630	-107.011	PAGOSA SPRINGS	136	58	39	null	7	DURANGO	PAGOSA SPRINGS 7.5
CO	37.7470	-106.831	WAGON WHEEL GAP HOT SPRINGS	135	57	31	79	2	DURANGO	SPAR CITY 15
CO	38.7330	-106.162	MOUNT PRINCETON HOT SPRINGS	133	56	20	74	4	MONTROSE	PONCHA SPRINGS 15
CO	39.2270	-107.224	PENNY HOT SPRINGS	133	56	null	73	4	LEADVILLE	REDSTONE 7.5
CO	39.0170	-105.793	HARTSEL HOT SPRINGS	126	52	17	null	3	DENVER	HARTSEL 7.5
CO	38.1330	-107.736	ORVIS HOT SPRING	126	52	27	null	2	MONTROSE	DALLAS 7.5
CO	39.5480	-107.322	GLENWOOD SPRINGS	124	51	6	null	3	LEADVILLE	GLENWOOD SPRINGS 7.5

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ID	42.1070	-113.390	BLM WELL (FRAZIER HOT SPRING)	203	95	184	115	7	POCATELLO	CHOKECHERRY CANYON 7.5
ID	45.3070	-114.338	BIG CREEK HOT SPRINGS	199	93	52	null	4	ELK CITY	SHOUP 15
ID	44.3060	-116.745	CRANE CREEK HOT SPRINGS	198	92	null	null	12	BAKER	(CRANE CREEK RESERVOIR 15)
ID	44.7990	-115.129	INDIAN CREEK HOT SPRING	190	88	null	null	6	CHALLIS	(BIG BALDY 7.5)
ID	44.5680	-115.695	VULCAN HOT SPRINGS	190	88	32	null	20	CHALLIS	WARM LAKE 15
ID	44.3640	-115.856	BOILING SPRINGS	185	85	38	null	29	CHALLIS	BOILING SPRINGS 15
ID	44.1570	-115.314	BONNEVILLE HOT SPRINGS	185	85	80	96	34	CHALLIS	EIGHTMILE MTN. 7.5
ID	42.1330	-111.928	BATTLE CREEK HOT SPRINGS	183	84	null	120	12	PRESTON	BANIDA 7.5
ID	43.5630	-114.798	WORSWICK HOT SPRINGS	180	82	136	110	12	HAILEY	SYDNEY BUTTE 7.5
ID	44.0920	-116.052	DEER HOT SPRINGS	176	80	null	97	14	BAKER	BANKS 15
ID	42.3080	-111.707	MAPLE GROVE HOT SPRINGS	172	78	null	118	11	PRESTON	ONEIDA NARROWS RESERVOIR 7.
ID	43.7550	-115.571	NINEMEYER HOT SPRINGS	169	76	116	98	11	HAILEY	BARBER FLAT 7.5
ID	44.2680	-114.748	SUNBEAM HOT SPRINGS	169	76	93	107	14	CHALLIS	SUNBEAM 7.5
ID	43.2930	-114.908	BARRONS HOT SPRING	167	75	139	112	18	HAILEY	(FAIRFIELD 15)
ID	44.1540	-115.993	WARM SPRINGS CREEK HOT SPRINGS	167	75	73	null	35	CHALLIS	GARDEN VALLEY 15
ID	43.3280	-114.399	MAGIC HOT SPRINGS	163	73	null	109	17	HAILEY	BELLEVUE 15
ID	42.1190	-111.928	SQUAW HOT SPRINGS	163	73	null	121	13	PRESTON	WESTON 7.5
ID	44.8130	-115.123	MIDDLE FORK INDIAN CREEK HOT SPRING	162	72	48	null	5	CHALLIS	PUNGO MOUNTAIN 7.5
ID	44.4160	-116.031	CABARTON HOT SPRING	160	71	null	null	11	BAKER	(SMITHS FERRY 15)
ID	42.3330	-115.650	INDIAN HOT SPRINGS	160	71	169	null	6	TWIN FALLS	null
ID	43.6840	-114.410	GUYER HOT SPRINGS	158	70	142	null	7	HAILEY	GRIFFIN BUTTE 7.5
ID	43.1550	-115.518	HOT SPRINGS	158	70	131	null	26	HAILEY	MOUNTAIN HOME 15
ID	44.5860	-116.630	LAKEY HOT SPRING	158	70	null	null	6	BAKER	(CAMBRIDGE 15)
ID	44.8310	-115.215	KWISKWIS HOT SPRING	156	69	null	null	4	CHALLIS	BIG BALDY 7.5
ID	44.6690	-116.305	COUNCIL MTN HOT SPRINGS	154	68	18	null	4	BAKER	COUNCIL 15
ID	43.7380	-115.583	VAUGHN HOT SPRING	154	68	115	null	12	HAILEY	SHEEP CREEK 7.5
ID	44.1600	-115.177	SACAJAWEA HOT SPRINGS	153	67	81	null	32	CHALLIS	GRANDJEAN 7.5

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ID	42.7040	-114.856	SALMON FALLS HOT SPRING	153	67	173	null	1	TWIN FALLS	(THOUSAND SPRINGS 7.5)
ID	42.3330	-111.716	CLEVELAND HOT SPRINGS	151	66	null	null	10	PRESTON	ONEIDA NARROWS RESERVOIR 7.
ID	43.9510	-116.353	ROYSTONE HOT SPRINGS	151	66	66	95	2	BOISE	MONTOUR 15
ID	43.6710	-115.696	TWIN SPRINGS	151	66	84	null	17	HAILEY	TWIN SPRINGS 7.5
ID	43.7890	-115.434	DUTCH FRANK HOT SPRING	149	65	119	null	7	HAILEY	GRAND MTN. 7.5
ID	44.0720	-115.543	KIRKHAM HOT SPRINGS	149	65	79	null	37	CHALLIS	LOWMAN 7.5
ID	44.7300	-114.993	SUNFLOWER HOT SPRINGS	149	65	null	null	6	CHALLIS	SLIDEROCK RIDGE 7.5
ID	44.0770	-115.553	HAVEN LODGE HOT SPRING	147	64	78	null	36	CHALLIS	(LOWMAN 7.5)
ID	43.3830	-114.931	WARDROP HOT SPRING	147	64	137	111	16	HAILEY	FAIRFIELD 15
ID	44.6450	-114.739	UPPER LOON CREEK HOT SPRINGS	145	63	56	null	10	CHALLIS	ROCK CREEK 7.5
ID	43.0490	-114.952	WHITE ARROW HOT SPRING	145	63	170	113	20	HAILEY	DAVIS MOUNTAIN 15
ID	43.1160	-115.305	LATTY HOT SPRING	144	62	131	99	28	HAILEY	BENNETT MTN. 15
ID	43.7880	-115.444	STRAIGHT CREEK HOT SPRING	144	62	118	null	8	HAILEY	(GRAND MTN. 7.5)
ID	45.0390	-116.291	ZIMS RESORT HOT SPRINGS	144	62	16	null	5	GRANGEVILLE	BALLY MOUNTAIN 7.5
ID	43.6960	-115.658	SHEEP CREEK BRIDGE HOT SPRING	142	61	110	null	16	HAILEY	TWIN SPRINGS 7.5
ID	44.9140	-115.722	TEAPOT HOT SPRING	142	61	25	null	1	CHALLIS	TEAPOT MTN. 7.5
ID	43.8110	-115.116	ATLANTA HOT SPRINGS	140	60	123	null	5	HAILEY	ATLANTA EAST 7.5
ID	45.5120	-115.046	BARTH HOT SPRINGS	140	60	11	null	2	ELK CITY	SHEEP HILL 7.5
ID	44.0510	-115.829	DAN HODGES HOT SPRING	140	60	75	null	41	CHALLIS	(GARDEN VALLEY 15)
ID	43.6470	-114.816	SKILLERN HOT SPRINGS	140	60	133	null	8	HAILEY	PARADISE PEAK 7.5
ID	44.6790	-116.231	WHITE LICKS HOT SPRING	140	60	19	null	3	BAKER	CASCADE 15
ID	42.6880	-114.826	BANBURY HOT SPRING	138	59	175	114	3	TWIN FALLS	THOUSAND SPRINGS 7.5
ID	43.5400	-115.288	BRIDGE HOT SPRINGS	138	59	128	null	23	HAILEY	(FEATHERVILLE 7.5)
ID	45.4310	-116.015	COW FLATS HOT SPRING	138	59	12	null	1	GRANGEVILLE	(KELLY MOUNTAIN 7.5)
ID	44.3820	-115.841	DASH CREEK HOT SPRINGS	138	59	37	null	28	CHALLIS	BOILING SPRINGS 15
ID	44.6420	-115.693	MOLLYS HOT SPRING	138	59	33	null	13	CHALLIS	(WARM LAKE 15)
ID	44.0620	-115.685	PINE FLAT HOT SPRINGS	138	59	77	null	38	CHALLIS	PINE FLAT 7.5

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ID	43.7200	-115.617	SMITH CABIN HOT SPRING	138	59	112	null	14	HAILEY	SHEEP CREEK 7.5
ID	44.7210	-115.010	THOMAS CREEK RANCH HOT SPRING	138	59	null	null	10	CHALLIS	GREYHOUND RIDGE 15
ID	44.2450	-114.885	ELKHORN HOT SPRING	136	58	90	null	19	CHALLIS	(STANLEY 7.5)
ID	45.0350	-115.561	SHEEP CREEK HOT SPRING	136	58	24	null	6	ELK CITY	(PARKS PEAK 7.5)
ID	43.1290	-115.340	COYOTE HOT SPRING	135	57	null	null	27	HAILEY	(BENNETT MTN. 15)
ID	44.6610	-114.652	FOSTER RANCH HOT SPRINGS	135	57	57	null	8	CHALLIS	ROCK CREEK 7.5
ID	44.2640	-114.818	BASIN CREEK HOT SPRING	133	56	92	null	15	CHALLIS	(EAST BASIN CREEK 7.5)
ID	43.6050	-114.948	LIGHTFOOT HOT SPRINGS	133	56	134	null	10	HAILEY	BOARDMAN CREEK 7.5
ID	44.6520	-114.734	OWEN CABIN HOT SPRING	133	56	56	null	9	CHALLIS	ROCK CREEK 7.5
ID	43.6050	-115.664	RATTLESNAKE HOT SPRING	133	56	null	null	19	HAILEY	(LONG GULCH 7.5)
ID	44.0450	-115.842	CORDER HOT SPRING	131	55	76	null	42	CHALLIS	GARDEN VALLEY 15
ID	44.2110	-116.710	COVE CREEK HOT SPRING	131	55	null	null	13	BAKER	(HOLLAND GULCH 7.5)
ID	44.7850	-114.855	COX HOT SPRINGS	131	55	49	null	5	CHALLIS	RAMEY HILL 7.5
ID	44.0440	-115.851	DONLAY RANCH HOT SPRING	131	55	null	null	43	CHALLIS	(GARDEN VALLEY 15)
ID	43.8030	-115.401	GRANITE CREEK HOT SPRING	131	55	120	null	6	HAILEY	GRAND MTN. 7.5
ID	43.5060	-114.354	HAILEY HOT SPRINGS	131	55	145	null	14	HAILEY	HAILEY 7.5
ID	42.6920	-114.859	HOT SULPHUR (MIRACLE HOT) SPRINGS	131	55	174	null	2	TWIN FALLS	THOUSAND SPRINGS 7.5
ID	45.7880	-115.198	RED RIVER HOT SPRINGS	131	55	10	null	1	ELK CITY	SABLE HILL 7.5
ID	44.2470	-114.676	ROBINSON BAR HOT SPRINGS	131	55	95	null	18	CHALLIS	ROBINSON BAR 7.5
ID	44.8530	-116.442	STARKEY HOT SPRINGS	131	55	null	null	2	BAKER	NEW MEADOWS 15
ID	43.6370	-115.130	WILLOW CREEK HOT SPRING	131	55	126	null	18	HAILEY	CAYUSE POINT 7.5
ID	43.7240	-115.604	LOFTUS HOT SPRING	129	54	113	null	13	HAILEY	SHEEP CREEK 7.5
ID	43.9740	-114.499	LOWER BOWERY HOT SPRING	129	54	null	null	3	HAILEY	(RYAN PEAK 7.5)
ID	44.6320	-115.697	SOUTH FORK PLUNGE	129	54	31	null	15	CHALLIS	(WARM LAKE 15)
ID	44.6760	-115.943	GOLD FORK HOT SPRING	127	53	28	null	12	CHALLIS	GOLD FORK 15
ID	43.5610	-114.415	CLARENDON HOT SPRINGS	126	52	151	null	13	HAILEY	MAHONEY BUTTE 7.5
ID	43.4230	-114.627	ELK CREEK HOT SPRING	126	52	138	null	15	HAILEY	BLAINE 15

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
ID	44.5310	-116.754	FAIRCHILD HOT SPRING	126	52	null	null	8	BAKER	STURGILL PEAK 15
ID	42.0320	-115.363	MURPHY HOT SPRINGS	126	52	169	103	7	TWIN FALLS	null
ID	43.5530	-115.267	PARADISE HOT SPRINGS	126	52	129	null	22	HAILEY	FEATHERVILLE 7.5
ID	45.0130	-113.605	SHARKEY HOT SPRING	126	52	60	106	2	DILLON	GOLDSTONE MTN. 15
ID	43.3270	-113.918	CONDIE HOT SPRINGS	124	51	147	null	3	IDAHO FALLS	null
ID	44.0540	-115.907	HOT SPRING CAMPGROUND	124	51	74	null	40	CHALLIS	GARDEN VALLEY 15
ID	44.1450	-112.554	LIDY HOT SPRINGS	124	51	150	null	3	DUBOIS	LIDY HOT SPRINGS 7.5
ID	43.6410	-114.487	WARFIELD HOT SPRING	124	51	143	null	9	HAILEY	GRIFFIN BUTTE 7.5
ID	43.9820	-114.486	WEST PASS HOT SPRING	124	51	103	null	2	HAILEY	RYAN PEAK 7.5
ID	43.7790	-115.486	BROWN CREEK HOT SPRING	122	50	117	null	9	HAILEY	(GRAND MTN. 7.5)
ID	45.3440	-114.463	OWL CREEK HOT SPRINGS	122	50	51	104	3	ELK CITY	SHOUP 15
ID	44.6280	-114.601	SHOWER BATH SPRINGS	122	50	58	null	11	CHALLIS	SHELDON PEAK 7.5
ID	44.1710	-114.624	SLATE CREEK HOT SPRING	122	50	99	108	21	CHALLIS	LIVINGSTON CREEK 7.5
ID	44.6260	-115.749	TRAIL CREEK HOT SPRING	122	50	30	null	17	CHALLIS	(WARM LAKE 15)
ID	43.7180	-115.563	BASSET HOT SPRING	H	H	null	null	15	HAILEY	(SHEEP CREEK 7.5)
ID	43.7010	-114.738	BIG SMOKEY HOT SPRING	H	H	132	null	6	HAILEY	BAKER PEAK 7.5
ID	44.7700	-115.663	BILLY HOT SPRING	H	H	null	null	7	CHALLIS	WHITE ROCK PEAK 7.5
ID	44.4300	-115.762	BULL CREEK HOT SPRINGS	H	H	39	null	24	CHALLIS	BOILING SPRINGS 15
ID	44.5830	-116.112	CASCADE RESERVOIR HOT SPRING	H	H	null	null	7	BAKER	(CASCADE 15)
ID	44.8960	-114.563	FORGE CREEK HOT SPRINGS	H	H	null	null	2	CHALLIS	YELLOWJACKET 7.5
ID	44.4000	-115.820	GOAT HOT SPRINGS	H	H	35	null	25	CHALLIS	BOILING SPRINGS 15
ID	44.1600	-115.167	GRANDJEAN HOT SPRING	H	H	null	null	33	CHALLIS	GRANDJEAN 7.5
ID	43.8170	-115.046	LEGGIT CREEK HOT SPRING	H	H	null	null	3	HAILEY	(ATLANTA EAST 7.5)
ID	46.0060	-115.021	MARTEN HOT SPRINGS	H	H	8	null	4	HAMILTON	MINK PEAK 7.5
ID	43.5880	-115.988	MORES CREEK HOT SPRING	H	H	null	null	21	HAILEY	(ARROWROCK DAM 7.5)
ID	44.9510	-114.704	MORMON RANCH WARM SPRING	H	H	54	null	1	CHALLIS	APAREJO POINT 7.5
ID	42.6370	-114.892	POISON SPRINGS	H	H	176	null	4	TWIN FALLS	BUHL 15

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ID	46.2350	-114.707	PROSPECTOR HOT SPRINGS	H	H	7	null	3	HAMILTON	(WAHOO PEAK 7.5)
ID	43.8310	-115.192	QUEENS RIVER HOT SPRING	H	H	null	null	1	HAILEY	ATLANTA WEST 7.5
ID	45.1700	-115.807	SECESH HOT SPRING	H	H	22	null	4	ELK CITY	(LOON LAKE 7.5)
ID	44.6280	-115.197	SHEEPEATER HOT SPRINGS	H	H	null	null	16	CHALLIS	GREYHOUND RIDGE 15
ID	46.1380	-115.090	STUART HOT SPRINGS	H	H	6	null	3	HAMILTON	BIG ROCK MTN. 7.5
ID	44.5850	-115.072	SULPHUR CREEK HOT SPRING	H	H	null	null	19	CHALLIS	(GREYHOUND RIDGE 15)
ID	44.5540	-115.301	SULPHUR CREEK HOT SPRING	H	H	43	null	21	CHALLIS	(CHINOOK MTN. 15)

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
MT	45.3670	-111.726	ENNIS HOT SPRINGS	181	83	null	129	5	BOZEMAN	(ENNIS 15)
MT	46.1780	-112.794	WARM SPRINGS (STATE HOSPITAL)	172	78	15	null	6	BUTTE	ANACONDA NE 7.5
MT	46.1980	-112.094	BOULDER HOT SPRINGS	169	76	19	125	5	BUTTE	BOULDER 15
MT	45.6850	-112.295	SILVER STAR HOT SPRINGS	163	73	30	128	3	DILLON	(TWIN BRIDGES 15)
MT	46.0440	-112.811	GREGSON HOT SPRINGS	158	70	17	126	8	BUTTE	ANACONDA 15
MT	45.0900	-110.774	LADUKE (CORWIN) HOT SPRING	154	68	38	null	6	BOZEMAN	MINER 15
MT	44.9840	-111.613	WOLF CREEK HOT SPRINGS	154	68	null	null	1	ASHTON	CLIFF LAKE 15
MT	46.5960	-112.108	BROADWATER (HELENA) HOT SPRINGS	151	66	7	123	3	BUTTE	(HELENA 15)
MT	45.7570	-110.256	HUNTERS HOT SPRINGS	140	60	36	null	1	BOZEMAN	HUNTERS HOT SPRINGS
MT	45.3680	-113.403	JARDINE HOT SPRING	140	60	25	null	3	DILLON	JACKSON 7.5
MT	46.4480	-111.982	ALHAMBRA HOT SPRINGS	138	59	18	124	1	WHITE SULPHUR	(CLANCY 15)
MT	46.5470	-110.903	WHITE SULPHUR SPRINGS	136	58	24	null	1	WHITE SULPHUR	WHITE SULPHUR SPRINGS 7.5
MT	45.8960	-112.233	PIPESTONE HOT SPRINGS	135	57	20	null	1	DILLON	DRY MOUNTAIN 7.5
MT	45.6600	-111.186	BOZEMAN HOT SPRINGS	131	55	35	null	1	BOZEMAN	BOZEMAN 15
MT	45.4620	-112.475	NEW BILTMORE HOT SPRINGS	127	53	null	null	4	DILLON	BEAVERHEAD ROCK 7.5
MT	45.5750	-111.683	NORRIS HOT SPRINGS	127	53	32	127	4	BOZEMAN	NORRIS 15
MT	45.6020	-111.900	POTOSI WARM SPRINGS	124	51	null	null	2	BOZEMAN	HARRISON 15
MT	45.5900	-111.899	POTOSI HOT SPRINGS	122	50	31	null	3	BOZEMAN	HARRISON 15
MT	45.7920	-112.126	RENOVA HOT SPRINGS	122	50	null	null	2	DILLON	(VENDOME 7.5)
MT	46.1060	-114.004	SLEEPING CHILD HOT SPRINGS	122	50	12	null	2	HAMILTON	DEER MOUNTAIN 7.5

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NM	35.9080	-106.615	SULPHUR SPRINGS	189	87	12	171	3	ALBUQUERQUE	VALLE SAN ANTONIO 7.5
NM	35.7720	-106.690	JEMEZ SPRINGS	169	76	15	172	7	ALBUQUERQUE	JEMEZ SPRINGS 7.5
NM	33.1080	-108.483	TURKEY CREEK HOT SPRING	165	74	29	null	15	CLIFTON	(CANYON HILL 7.5)
NM	33.1990	-108.209	GILA HOT SPRINGS	151	66	30	null	12	CLIFTON	GILA HOT SPRINGS 7.5
NM	33.2330	-108.235	SPRING (HOT)	149	65	27	null	10	CLIFTON	GILA HOT SPRINGS 7.5
NM	33.2120	-108.228	null	149	65	null	null	11	CLIFTON	(GILA HOT SPRINGS 7.5)
NM	35.6530	-105.290	MONTEZUMA HOT SPRINGS	138	59	20	null	1	SANTA FE	MONTEZUMA 7.5
NM	32.7480	-107.836	MIMBRES HOT SPRINGS	136	58	34	null	3	LAS CRUCES	DWYER 15
NM	32.5540	-107.994	FAYWOOD HOT SPRINGS	129	54	36	null	6	LAS CRUCES	DWYER 15
NM	35.9380	-106.646	SAN ANTONIO HOT SPRING	129	54	10	null	2	ALBUQUERQUE	SEVEN SPRINGS 7.5
NM	35.6460	-106.888	WARM SPRINGS	129	54	null	null	8	ALBUQUERQUE	HOLY GHOST SPRING 7.5
NM	32.5010	-106.926	RADIUM SPRINGS	127	53	38	175	1	LAS CRUCES	SAN DIEGO MOUNTAIN 15
NM	33.1920	-108.180	LYONS HUNTING LODGE HOT SPRINGS	126	52	31	null	13	CLIFTON	(GILA HOT SPRINGS 7.5)
NM	35.5920	-106.753	INDIAN SPRINGS	123	51	17	null	10	ALBUQUERQUE	(SAN YSIDRO 7.5)
NM	33.2370	-108.880	HOT SPRINGS	H	H	null	null	9	CLIFTON	WILSON MOUNTAIN 7.5

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
NV	39.5650	-118.856	(SODA LAKE AREA)	210	99	null	144	3	RENO	SODA LAKE 15
NV	40.5670	-116.588	BEOWAWE HOT SPRINGS (THE GEYSERS)	208	98	77	162	9	WINNEMUCCA	DUNPHY 15
NV	39.7870	-119.011	BRADYS HOT SPRINGS	209	98	72	147	4	RENO	FIREBALL RIDGE 15
NV	40.6620	-119.365	GREAT BOILING SPRING (GERLACH)	208	98	38	137	8	LOVELOCK	GERLACH 15
NV	40.1460	-119.673	THE NEEDLE ROCKS HOT SPRING	208	98	49	139	12	LOVELOCK	THE NEEDLE ROCKS 7.5
NV	40.1410	-119.687	THE NEEDLE ROCKS HOT SPRINGS	208	98	49	139	13	LOVELOCK	THE NEEDLE ROCKS 7.5
NV	40.6040	-117.648	LEACH HOT SPRINGS	207	97	64	154	9	WINNEMUCCA	LEACH HOT SPRINGS 15
NV	39.9540	-117.917	FUMAROLES	204	96	70	null	2	MILLETT	(HUMBOLDT SALT MARSH 15)
NV	39.3880	-119.743	STEAMBOAT SPRINGS	205	96	null	141	13	RENO	STEAMBOAT 7.5
NV	39.3800	-119.740	STEAMBOAT SPRINGS	205	96	56	141	14	RENO	STEAMBOAT 7.5
NV	40.5850	-115.285	SULPHUR HOT SPRINGS	205	96	null	169	6	ELKO	LAMOILLE 15
NV	41.0030	-119.008	null	204	96	null	null	26	VYA	null
NV	38.8220	-117.183	DARROUGHS HOT SPRINGS	203	95	118	161	3	TONOPAH	CARVERS 7.5
NV	40.3890	-119.402	HOT SEEPS (SAN EMIDIO DESERT)	203	95	null	138	10	LOVELOCK	(KUMIVA PEAK 15)
NV	39.1610	-119.183	WABUSKA HOT SPRINGS	201	94	62	142	17	RENO	WABUSKA 15
NV	39.4840	-119.804	MOANA SPRINGS	199	93	55	140	8	RENO	MT. ROSE NE 7.5
NV	41.3630	-118.788	PINTO HOT SPRINGS	199	93	null	132	13	VYA	PINTO MOUNTAIN 7.5
NV	39.3160	-117.549	HOT SPRINGS	198	92	85	159	4	MILLETT	CARROLL SUMMIT SE 7.5
NV	41.3570	-118.809	WEST PINTO HOT SPRING	198	92	null	132	14	VYA	PINTO MOUNTAIN 7.5
NV	41.4680	-116.150	HOT SULPHUR SPRINGS (TUSCARORA)	194	90	null	164	1	MCDERMITT	TUSCARORA 15
NV	40.9480	-119.002	null	194	90	null	134	2	LOVELOCK	null
NV	40.6740	-119.364	null	194	90	null	137	7	LOVELOCK	(GERLACH 15)
NV	40.8130	-115.778	ELKO HOT SPRING	190	88	32	166	3	ELKO	ELKO WEST 7.5
NV	39.2080	-118.723	LEE HOT SPRINGS, ALLEN SPRINGS	190	88	74	143	7	RENO	ALLEN SPRINGS 15
NV	40.2620	-119.379	BOILING SPRINGS	187	86	50	null	11	LOVELOCK	KUMIVA PEAK 15
NV	40.7700	-119.113	BUTTE SPRINGS (TREGO	187	86	63	135	5	LOVELOCK	null

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			HOT SPRINGS)							
NV	40.3160	-116.433	HOT SPRING	186	86	null	null	13	WINNEMUCCA	FRENCHIE CREEK 15
NV	39.5970	-119.110	PATUA HOT SPRINGS (FERNLEY)	187	86	null	146	6	RENO	(TWO TIPS 15)
NV	40.7610	-117.492	HOT SPRINGS	185	85	19	157	8	WINNEMUCCA	GOLDRUN CREEK 7.5
NV	40.0880	-117.725	SOU (SEVEN DEVILS) HOT SPRINGS	185	85	68	153	19	WINNEMUCCA	CAIN MOUNTAIN 15
NV	40.6530	-119.378	MUD SPRINGS	184	84	39	137	9	LOVELOCK	(GERLACH 15)
NV	38.7680	-119.174	WILSON HOT SPRING	183	84	null	null	6	WALKER LAKE	YERINGTON 15
NV	41.9210	-118.709	BALTAZOR HOT SPRING	181	83	null	130	3	VYA	DENIO 15
NV	39.3420	-118.578	BORAX SPRING	180	82	74	null	5	RENO	(CARSON LAKE 15)
NV	40.8570	-119.328	FLY RANCH (WARDS) HOT SPRINGS	180	82	37	136	3	LOVELOCK	null
NV	38.5210	-116.365	HOT CREEK RANCH HOT SPRING	180	82	null	null	7	TONOPAH	HOBBLE CANYON 7.5
NV	39.9410	-116.681	HOT SPRINGS	180	82	92	null	3	MILLETT	WALTI HOT SPRINGS 15
NV	39.0280	-117.136	MCLEOD RANCH HOT SPRING	180	82	114	null	6	MILLETT	MILLETT RANCH 15
NV	41.0510	-119.028	DOUBLE HOT SPRINGS	178	81	12	133	21	VYA	null
NV	40.0030	-117.718	HYDER HOT SPRINGS	176	80	69	null	23	WINNEMUCCA	CAIN MOUNTAIN 15
NV	39.6650	-114.807	MONTE NEVA HOT SPRINGS	176	80	98	null	5	ELY	null
NV	40.3680	-117.327	BUFFALO VALLEY HOT SPRINGS	174	79	78	158	13	WINNEMUCCA	BUFFALO SPRINGS 15
NV	40.6990	-116.133	HOT SPRINGS (CARLIN)	174	79	null	165	4	WINNEMUCCA	(CARLIN 15)
NV	41.0130	-119.010	null	172	78	null	null	25	VYA	null
NV	40.4080	-117.883	KYLE HOT SPRINGS	171	77	66	152	12	WINNEMUCCA	KYLE HOT SPRINGS 15
NV	41.0520	-118.717	MACFARLANE HOT SPRING	170	77	null	null	16	VYA	KING LEAR PEAK 15
NV	40.9610	-117.494	GOLCONDA HOT SPRING (NORTH)	165	74	19	155	2	WINNEMUCCA	GOLCONDA 7.5
NV	41.7220	-118.523	null	163	73	null	null	7	VYA	DUFFER PEAK 15
NV	40.4180	-117.415	BUFFALO SPRINGS	162	72	null	null	11	WINNEMUCCA	BUFFALO SPRINGS 15
NV	39.7970	-118.067	DIXIE HOT SPRINGS	162	72	71	149	2	RENO	DIXIE HOT SPRINGS 15
NV	39.3280	-116.858	SPENCER HOT SPRINGS	162	72	86	160	10	MILLETT	SPENCER HOT SPRINGS
NV	39.9040	-116.588	WALTI HOT SPRINGS	162	72	93	null	4	MILLETT	WALTI HOT SPRINGS 15

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NV	41.0220	-119.015	null	161	72	null	null	24	VYA	null
NV	40.5780	-117.219	null	162	72	null	null	10	WINNEMUCCA	(ANTLER PEAK 15)
NV	38.4640	-115.792	CHIMNEY WARM SPRING	160	71	127	null	11	LUND	THE WALL NE 7.5
NV	38.9810	-119.833	WALLEYS HOT SPRINGS	160	71	60	null	1	WALKER LAKE	MINDEN 7.5
NV	41.5670	-118.564	DYKE HOT SPRINGS	158	70	10	131	10	VYA	DUFFER PEAK 15
NV	41.1080	-117.578	HOT SPRINGS	158	70	null	null	2	MCDERMITT	(BLISS 15)
NV	39.4040	-116.347	KLOBE (BARTHOLOMAE) HOT SPRING	156	69	93	null	9	MILLETT	ANTELOPE PEAK 15
NV	41.1470	-119.022	null	153	67	null	null	18	VYA	null
NV	40.9540	-117.488	GOLCONDA HOT SPRING (SOUTH)	151	66	19	155	3	WINNEMUCCA	GOLCONDA 7.5
NV	41.5760	-115.181	HOT CREEK SPRINGS	151	66	30	null	4	WELLS	HOT CREEK 15
NV	41.1120	-119.002	null	151	66	null	null	20	VYA	null
NV	40.2200	-116.068	BRUFFEYS HOT SPRINGS	149	65	90	null	15	WINNEMUCCA	MINERAL HILL 15
NV	40.2490	-115.409	SMITH RANCH SPRINGS	149	65	34	null	7	ELKO	RUBY LAKE NW 7.5
NV	40.7650	-116.040	HOT SULPHUR SPRINGS	147	64	31	null	2	WINNEMUCCA	HUNTSMAN RANCH 7.5
NV	41.8670	-114.692	SAN JACINTO RANCH SPRING	148	64	22	null	5	WELLS	(DELAPLAIN 15)
NV	36.0020	-114.742	SPRING	145	63	null	null	7	LAS VEGAS	(HOOVER DAM 15)
NV	38.1880	-116.373	WARM SPRINGS	145	63	125	null	11	TONOPAH	WARM SPRINGS 7.5
NV	39.8830	-114.893	CHERRY CREEK HOT SPRINGS	144	62	95	170	2	ELY	null
NV	38.8990	-119.410	NEVADA (HINDS) HOT SPRINGS	144	62	61	null	3	WALKER LAKE	WELLINGTON 15
NV	38.9220	-118.198	WEDELL HOT SPRINGS	144	62	113	null	2	WALKER LAKE	null
NV	38.4370	-116.277	HOT CREEK VALLEY SPRING	142	61	124	null	8	TONOPAH	(BLUE JAY SPRING 7.5)
NV	41.1830	-114.991	HOT SPRINGS	142	61	30	null	12	WELLS	OXLEY PEAK 7.5
NV	37.8250	-117.337	ALKALI HOT SPRING	140	60	112	null	3	GOLDFIELD	ALKALI 7.5
NV	41.7880	-114.735	MINERAL HOT SPRING	140	60	22	167	6	WELLS	(DELAPLAIN 15)
NV	40.4170	-116.507	CRESCENT VALLEY HOT SPRINGS	138	59	null	163	10	WINNEMUCCA	CRESCENT VALLEY 15
NV	40.4040	-116.517	CRESCENT VALLEY HOT SPRINGS	138	59	88	163	11	WINNEMUCCA	CRESCENT VALLEY 15
NV	39.0310	-116.666	DIANAS PUNCH BOWL	138	59	null	null	14	MILLETT	DIANAS PUNCH BOWL 15

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NV	41.4120	-114.675	WINE CUP RANCH SPRINGS	138	59	null	null	7	WELLS	WINE CUP RANCH 7.5
NV	40.9720	-119.007	BLACK ROCK HOT SPRING	136	58	16	134	1	LOVELOCK	null
NV	40.6030	-116.463	HORSESHOE RANCH SPRINGS	136	58	88	null	7	WINNEMUCCA	(BEOWAWE 15)
NV	40.9220	-117.108	HOT POT (BLOSSOM HOT SPRINGS)	136	58	19	156	4	WINNEMUCCA	HOT POT 7.5
NV	41.3780	-119.182	SPRINGS (HOT)	136	58	null	null	7	VYA	SOLDIER MEADOW 7.5
NV	40.1780	-117.496	HOME STATION RANCH HOT SPRING	135	57	null	null	18	WINNEMUCCA	MT. MOSES 15
NV	41.7210	-118.505	HOWARD HOT SPRING	135	57	null	null	8	VYA	DUFFER PEAK 15
NV	41.4210	-117.388	THE HOT SPRINGS	135	57	11	null	1	MCDERMITT	HOT SPRINGS PEAK 15
NV	39.2860	-119.840	BOWERS MANSION HOT SPRING	133	56	57	null	15	RENO	WASHOE CITY 7.5
NV	40.8190	-115.777	HOT HOLE	133	56	null	166	2	ELKO	ELKO WEST 7.5
NV	41.3570	-119.188	SPRINGS (HOT)	133	56	null	null	9	VYA	MUD MEADOW 7.5
NV	41.9250	-118.805	BOG HOT SPRINGS	131	55	2	null	2	VYA	RAILROAD POINT 15
NV	41.8090	-118.861	PAINTED HILLS MINE	131	55	null	null	4	VYA	(RAILROAD POINT 15)
NV	40.1830	-117.102	HOT SPRINGS RANCH	129	54	81	null	17	WINNEMUCCA	THE CEDARS 15
NV	41.6470	-115.775	WILD HORSE HOT SPRINGS	129	54	null	null	3	WELLS	WILD HORSE 15
NV	41.3830	-119.187	null	130	54	null	null	6	VYA	(SOLDIER MEADOW 7.5)
NV	39.4200	-119.738	DIMONTE SPRING	127	53	55	null	12	RENO	(STEAMBOAT 7.5)
NV	40.1910	-117.107	HOT SPRINGS	127	53	null	null	16	WINNEMUCCA	THE CEDARS 15
NV	40.1980	-117.103	HOT SPRINGS	127	53	80	null	15	WINNEMUCCA	THE CEDARS 15
NV	41.3530	-119.216	SPRING (HOT)	127	53	null	null	11	VYA	MUD MEADOW 7.5
NV	41.3390	-119.192	SPRINGS (HOT)	127	53	null	null	12	VYA	MUD MEADOW 7.5
NV	38.9520	-115.230	WILLIAMS HOT SPRING	127	53	103	null	1	LUND	null
NV	41.2610	-115.305	HOT SPRINGS	126	52	28	null	5	WELLS	HOT SPRINGS CREEK 7.5
NV	39.0410	-116.663	HOT SPRING	124	51	null	null	13	MILLETT	DIANAS PUNCH BOWL 15
NV	40.6730	-116.838	HOT SPRINGS	122	50	null	null	6	WINNEMUCCA	BATTLE MOUNTAIN 15
NV	39.0580	-119.742	SARATOGA HOT SPRING	122	50	null	null	21	RENO	MC TARNAHAN HILL 7.5
NV	41.3650	-119.221	SPRING (HOT)	122	50	null	null	8	VYA	MUD MEADOW 7.5

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
NV	41.1590	-114.986	THREEMILE SPRING, SULPHUR HOT SPR	122	50	30	168	13	WELLS	OXLEY PEAK 7.5
NV	39.9950	-117.854	SENATOR FUMAROLES	B	B	null	null	1	MILLETT	(HUMBOLDT SALT MARSH 15)
NV	39.8660	-118.017	DIXIE COMSTOCK MINE	H	H	null	null	1	RENO	DIXIE HOT SPRINGS 15
NV	39.7330	-119.039	EAGLE SALT WORKS SPRING	H	H	73	null	5	RENO	(TWO TIPS 15)
NV	41.1480	-116.733	HOT LAKE	H	H	null	null	3	MCDERMITT	SQUAW VALLEY RANCH 7.5
NV	41.1750	-115.278	HOT SPRING	H	H	29	null	7	WELLS	TWIN BUTTES 7.5
NV	41.1450	-114.994	HOT SPRING	H	H	null	null	14	WELLS	OXLEY PEAK 7.5
NV	38.8590	-119.175	HOT SPRING	H	H	null	null	4	WALKER LAKE	YERINGTON 15
NV	39.8930	-116.649	LITTLE HOT SPRINGS	H	H	null	null	5	MILLETT	WALTI HOT SPRINGS 15
NV	39.5590	-117.427	PETERSONS MILL HOT SPRING	H	H	null	null	3	MILLETT	MOUNT AIRY 7.5
NV	39.2810	-118.420	SAND SPRINGS	H	H	75	null	6	RENO	FOURMILE FLAT 7.5
NV	40.8640	-117.349	SULPHUR SPRING	H	H	null	null	6	WINNEMUCCA	BROOKS SPRING 7.5
NV	41.1750	-119.957	null	H	H	36	null	17	VYA	null
NV	39.2420	-116.880	null	H	H	87	null	11	MILLETT	(WILDCAT PEAK 15)
NV	38.8600	-116.738	null	H	H	null	null	1	TONOPAH	(MOSQUITO CREEK 7.5)

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
OR	42.3380	-118.602	HOT SPRINGS	207	97	69	198	6	ADEL	BORAX LAKE 7.5
OR	42.2210	-120.368	HUNTERS HOT SPRINGS	205	96	45	189	7	KLAMATH FALLS	LAKEVIEW NE 7.5
OR	44.7820	-121.975	BREITENBUSH HOT SPRINGS	198	92	6	179	3	BEND	BREITENBUSH HOT SPRINGS 15
OR	42.2190	-119.877	WARNER VALLEY RANCH	198	92	49	null	6	ADEL	(ADEL 7.5)
OR	45.3720	-121.697	MOUNT HOOD FUMAROLES	194	90	1	177	1	THE DALLES	(MOUNT HOOD SOUTH 7.5)
OR	42.1560	-120.345	BARRY RANCH HOT SPRINGS	190	88	47	189	9	KLAMATH FALLS	LAKEVIEW NE 7.5
OR	44.0230	-117.460	NEAL HOT SPRINGS	189	87	75	203	7	BAKER	JAMIESON 15
OR	45.0210	-122.009	AUSTIN HOT SPRINGS	186	86	4	178	1	VANCOUVER	FISH CREEK MTN. 15
OR	42.6760	-118.344	MICKEY SPRINGS	187	86	null	196	4	ADEL	null
OR	44.1530	-122.098	FOLEY SPRINGS	178	81	19	182	4	SALEM	MCKENZIE BRIDGE 15
OR	45.2440	-117.958	HOT LAKE SPRINGS	176	80	11	null	3	GRANGEVILLE	CRAIG MOUNTAIN 7.5
OR	42.5440	-118.533	ALVORD HOT SPRINGS	174	79	68	197	5	ADEL	ALVORD HOT SPRINGS 7.5
OR	43.4410	-118.638	CRANE HOT SPRINGS	172	78	53	null	11	BURNS	CRANE 15
OR	42.2260	-119.881	CRUMP GEYSER (CRUMP SPRING)	172	78	49	190	5	ADEL	ADEL 7.5
OR	43.7270	-117.203	SNIVELY HOT SPRING	170	77	null	null	7	BOISE	OWYHEE DAM 7.5
OR	42.1740	-121.615	OLENE GAP HOT SPRINGS	165	74	28	187	4	KLAMATH FALLS	(MERRILL 15)
OR	43.8580	-118.544	null	165	74	null	null	3	BURNS	(VAN 15)
OR	43.7080	-122.288	MCCREDIE SPRINGS	163	73	22	183	2	ROSEBURG	OAKRIDGE 15
OR	43.9820	-117.233	VALE HOT SPRINGS	163	73	77	204	1	BOISE	(VALE EAST 7.5)
OR	42.1620	-120.344	LEITHEAD HOT SPRING	162	72	46	189	8	KLAMATH FALLS	LAKEVIEW NE 7.5
OR	44.1930	-122.049	BELKNAP SPRINGS	160	71	18	181	3	SALEM	MCKENZIE BRIDGE 15
OR	43.8930	-117.501	null	158	70	76	202	3	BOISE	(HARPER 15)
OR	42.2970	-119.776	FISHER HOT SPRINGS	154	68	49	191	3	ADEL	CRUMP LAKE 7.5
OR	43.1850	-119.058	null	154	68	64	193	17	BURNS	null
OR	43.4690	-118.202	LUCE HOT SPRINGS	145	63	84	195	10	BURNS	MCEWEN BUTTE 7.5
OR	43.7190	-121.209	EAST LAKE HOT SPRINGS	144	62	33	184	2	CRESCENT	null
OR	43.7630	-117.156	MITCHELL BUTTE HOT SPRING	144	62	79	null	5	BOISE	MITCHELL BUTTE 7.5

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
OR	43.6460	-118.251	null	144	62	54	null	9	BURNS	(UPTON MOUNTAIN 7.5)
OR	44.2410	-122.058	BIGELOW HOT SPRINGS	142	61	null	null	2	SALEM	(MCKENZIE BRIDGE 15)
OR	45.1510	-118.659	LEHMAN SPRINGS	142	61	8	null	2	PENDLETON	LEHMAN SPRINGS 7.5
OR	42.1160	-121.287	OREGON HOT SPRINGS (BIG HOT SPRING)	142	61	29	null	7	KLAMATH FALLS	MALIN 15
OR	43.9440	-118.136	BEULAH HOT SPRINGS	140	60	74	null	1	BURNS	BEULAH 15
OR	45.0180	-117.625	MEDICAL HOT SPRINGS	140	60	12	201	5	GRANGEVILLE	FLAGSTAFF BUTTE 7.5
OR	44.9360	-122.173	BAGBY HOT SPRINGS	136	58	5	null	1	SALEM	BATTLE AX 15
OR	44.3540	-118.574	BLUE MOUNTAIN HOT SPRINGS	136	58	16	null	3	CANYON CITY	PRAIRIE CITY 15
OR	44.9270	-117.939	RADIUM HOT SPRINGS	135	57	17	null	1	BAKER	HAINES 7.5
OR	42.1880	-118.383	FLAGSTAFF BUTTE HOT SPRING	126	52	72	199	10	ADEL	null
OR	44.8620	-121.201	KAHNEETA HOT SPRINGS	126	52	7	180	2	BEND	EAGLE BUTTE 7.5
OR	44.8670	-121.228	SPRINGS	125	52	7	null	1	BEND	EAGLE BUTTE 7.5
OR	42.0790	-117.760	null	126	52	86	200	5	JORDAN VALLEY	null
OR	44.2080	-117.455	JAMIESON HOT SPRINGS	H	H	73	null	5	BAKER	(JAMIESON 15)
OR	45.2060	-117.912	UNION STATION HOT SPRINGS	H	H	null	null	4	GRANGEVILLE	CRAIG MOUNTAIN 7.5
OR	43.2150	-117.502	null	H	H	84	null	11	BOISE	(THE HOLE IN THE GROUND 7.
OR	43.0730	-117.697	null	H	H	null	null	12	BOISE	(LAMBERT ROCKS 7.5)
OR	43.5890	-117.326	null	H	H	83	null	9	BOISE	(THE ELBOW 7.5)

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
UT	40.4880	-111.911	CRYSTAL HOT SPRINGS	187	86	13	null	9	SALT LAKE CITY	JORDAN NARROWS 7.5
UT	38.1860	-113.197	THERMO HOT SPRINGS	185	85	52	210	2	RICHFIELD	THERMO 15
UT	38.1720	-113.204	THERMO HOT SPRINGS	181	83	52	210	3	RICHFIELD	THERMO 15
UT	39.6130	-112.729	BAKER (ABRAHAM, CRATER) HOT SPRINGS	180	82	24	205	3	DELTA	BAKER HOT SPRINGS 7.5
UT	38.6390	-112.098	RED HILL HOT SPRING	171	77	null	206	7	RICHFIELD	MONROE 15
UT	38.6330	-112.107	MONROE (COOPER) HOT SPRINGS	169	76	48	206	8	RICHFIELD	MONROE 15
UT	38.6130	-112.202	JOSEPH HOT SPRINGS	147	64	49	207	9	RICHFIELD	MONROE 15
UT	39.9060	-113.430	WILSON HEALTH SPRINGS	142	61	20	null	1	DELTA	FISH SPRINGS NW 7.5
UT	41.1380	-112.175	HOOPER HOT SPRINGS	140	60	null	null	14	BRIGHAM CITY	OGDEN BAY 7.5
UT	41.3380	-112.031	UTAH HOT SPRINGS	138	59	6	null	11	BRIGHAM CITY	PLAIN CITY 7.5
UT	41.2360	-111.924	OGDEN HOT SPRING	135	57	8	null	3	OGDEN	OGDEN 7.5
UT	40.8150	-111.918	BECKS HOT SPRING	133	56	11	null	1	SALT LAKE CITY	SALT LAKE CITY NORTH 7.5
UT	38.5030	-112.849	ROOSEVELT HOT SPRINGS	133	56	51	209	12	RICHFIELD	(PINNACLE PASS 7.5)
UT	41.6590	-112.087	CRYSTAL (MADSENS) HOT SPRINGS	129	54	4	null	6	BRIGHAM CITY	HONEYVILLE 7.5
UT	41.8550	-112.158	UDY HOT SPRINGS	124	51	3	null	2	BRIGHAM CITY	RIVERSIDE 7.5

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	TC	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
WA	48.7700	-121.813	SHERMAN CRATER FUMAROLES	266	130	null	null	2	CONCRETE	(MT. BAKER 15)
WA	48.7890	-121.804	DORR FUMAROLE FIELD	194	90	null	null	1	CONCRETE	(MT. BAKER 15)
WA	46.1980	-122.197	MT ST HELENS FUMAROLES	190	88	12	null	2	HOQUIAM	(MOUNT ST. HELENS 15)
WA	46.8520	-121.758	MT RAINIER FUMAROLES	162	72	null	null	1	YAKIMA	(MT. RAINIER WEST 7.5)
WA	46.2020	-121.492	MOUNT ADAMS FUMAROLES	150	66	12	null	6	YAKIMA	(MOUNT ADAMS EAST 7.5)
WA	48.1500	-121.062	GAMMA HOT SPRINGS	140	60	null	213	5	CONCRETE	GLACIER PEAK 15
WA	47.4840	-121.391	GOLDMEYER HOT SPRINGS	127	53	8	null	3	WENATCHEE	SNOQUALMIE PASS 15
WA	45.7010	-121.728	COLLINS HOT SPRINGS	122	50	null	null	4	THE DALLES	(HOOD RIVER 15)
WA	48.9740	-119.475	HOT LAKE	122	50	null	null	1	OKANOGAN	OROVILLE 15
WA	46.7380	-121.562	OHANAPECOSH HOT SPRINGS	122	50	11	214	3	YAKIMA	PACKWOOD 15
WA	48.9060	-119.455	POISON LAKE	122	50	null	null	2	OKANOGAN	(OROVILLE 15)
WA	47.7070	-121.155	SCENIC HOT SPRINGS	122	50	7	null	2	WENATCHEE	(SCENIC 7.5)
WA	47.9690	-123.864	SOL DUC HOT SPRINGS	122	50	2	null	2	SEATTLE	BOGACHIEL PEAK 7.5
WA	45.7230	-121.927	ROCK CREEK HOT SPRINGS	H	H	null	null	3	THE DALLES	BONNEVILLE DAM 15

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	T C	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
WY	44.5440	-110.788	BLACK WARRIOR GROUP, SHELF SPRING	205	96	null	215	87	ASHTON	MADISON JUNCTION 15
WY	44.5660	-110.871	FLAT CONE SPRING, STEEP CONE	205	96	null	215	78	ASHTON	MADISON JUNCTION 15
WY	44.5710	-110.811	MORNING MIST SPRINGS	205	96	19	215	76	ASHTON	MADISON JUNCTION 15
WY	44.5630	-110.834	RIVER GROUP	205	96	18	215	81	ASHTON	MADISON JUNCTION 15
WY	44.5200	-110.828	FLOOD GROUP	203	95	26	215	97	ASHTON	MADISON JUNCTION 15
WY	44.5680	-110.805	QUAGMIRE GROUP	203	95	null	215	77	ASHTON	MADISON JUNCTION 15
WY	44.5370	-110.801	WHITE DOME GEYSER, SURPRISE POOL	203	95	22	215	90	ASHTON	MADISON JUNCTION 15
WY	44.9080	-110.393	CALCITE SPRINGS	201	94	65	215	3	ASHTON	TOWER JUNCTION 15
WY	44.5430	-110.859	FAIRY SPRINGS	201	94	20	215	89	ASHTON	MADISON JUNCTION 15
WY	44.5540	-110.812	FOUNTAIN GROUP	201	94	null	215	83	ASHTON	MADISON JUNCTION 15
WY	44.6910	-110.728	GEYSER SPRINGS GROUP	201	94	15	215	45	ASHTON	NORRIS JUNCTION 15
WY	44.7220	-110.708	null	201	94	null	215	31	ASHTON	NORRIS JUNCTION 15
WY	44.6930	-110.738	ARTISTS PAINTPOTS	199	93	14	215	44	ASHTON	NORRIS JUNCTION 15
WY	44.7330	-110.703	CISTERN SPRING	199	93	null	215	28	ASHTON	(NORRIS JUNCTION 15)
WY	44.5260	-110.835	EXCELSIOR GEYSER CRATER	199	93	25	215	95	ASHTON	MADISON JUNCTION 15
WY	44.6970	-110.724	GIBBON HILL GEYSER	199	93	13	215	42	ASHTON	NORRIS JUNCTION 15
WY	44.6900	-110.384	HOT SPRINGS ON BOG CREEK	199	93	79	215	47	ASHTON	CANYON VILLAGE 15
WY	44.7390	-110.324	JOSEPHS COAT SPRINGS	199	93	72	215	24	ASHTON	CANYON VILLAGE 15
WY	44.5660	-110.816	null	199	93	null	215	79	ASHTON	MADISON JUNCTION 15
WY	44.6790	-110.746	BERYL SPRING	198	92	16	215	50	ASHTON	NORRIS JUNCTION 15
WY	44.7610	-110.730	BIJAH SPRING	198	92	9	215	14	ASHTON	MAMMOTH 15
WY	44.7430	-110.242	HOT SPRING BASIN GROUP	198	92	75	215	21	ASHTON	PELICAN CONE 15
WY	44.5180	-110.813	HOT SPRINGS, RABBIT CREEK GROUP	198	92	26	215	98	ASHTON	MADISON JUNCTION 15
WY	44.6840	-110.753	MONUMENT GEYSER BASIN	197	92	16	215	48	ASHTON	MADISON JUNCTION 15
WY	44.5140	-110.828	RABBIT CREEK GROUP	198	92	null	215	99	ASHTON	MADISON JUNCTION

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	T C	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
										15
WY	44.7860	-110.740	SEMI-CENTENNIAL GEYSER	198	92	7	215	8	ASHTON	MAMMOTH 15
WY	44.5300	-110.297	STEAMBOAT SPRINGS	198	92	95	215	93	ASHTON	CANYON VILLAGE 15
WY	44.5440	-110.258	TURBID SPRINGS	198	92	94	215	88	ASHTON	CANYON VILLAGE 15
WY	44.7970	-110.725	AMPHITHEATER SPRINGS	196	91	7	215	7	ASHTON	MAMMOTH 15
WY	44.7560	-110.308	COFFEE POT HOT SPRINGS	196	91	73	215	15	ASHTON	TOWER JUNCTION 15
WY	44.5910	-110.321	HOT SPRINGS AT SULPHUR HILLS	196	91	89	215	72	ASHTON	CANYON VILLAGE 15
WY	44.5560	-110.832	RIVER GROUP	196	91	null	215	82	ASHTON	MADISON JUNCTION 15
WY	44.7660	-110.429	WASHBURN HOT SPRINGS	196	91	50	215	12	ASHTON	TOWER JUNCTION 15
WY	44.6810	-110.326	HOT SPRINGS ON UPPER SOUR CREEK	194	90	null	215	49	ASHTON	CANYON VILLAGE 15
WY	44.5320	-110.796	FIVE SISTERS SPRINGS	192	89	null	215	92	ASHTON	MADISON JUNCTION 15
WY	44.5320	-110.874	IMPERIAL GEYSER, SPRAY GEYSER	192	89	24	215	91	ASHTON	MADISON JUNCTION 15
WY	44.5640	-110.869	QUEENS LAUNDRY	192	89	17	215	80	ASHTON	MADISON JUNCTION 15
WY	44.6530	-110.482	SULPHUR SPRINGS	194	89	61	215	57	ASHTON	CANYON VILLAGE 15
WY	44.7020	-110.767	SYLVAN SPRINGS	192	89	12	215	40	ASHTON	MADISON JUNCTION 15
WY	44.7280	-110.701	null	192	89	null	215	29	ASHTON	NORRIS JUNCTION 15
WY	44.7690	-110.269	RAINBOW SPRINGS	190	88	null	215	11	ASHTON	TOWER JUNCTION 15
WY	44.6280	-110.433	SULPHUR CALDRON	190	88	61	215	61	ASHTON	CANYON VILLAGE 15
WY	44.7520	-110.418	HOT SPRINGS AT SEVENMILE HOLE	189	87	52	215	18	ASHTON	TOWER JUNCTION 15
WY	44.5210	-110.275	BUTTE SPRINGS	187	86	96	215	96	ASHTON	CANYON VILLAGE 15
WY	44.7330	-110.712	HORSESHOE SPRING	187	86	null	215	27	ASHTON	(NORRIS JUNCTION 15)
WY	44.6900	-110.750	null	187	86	null	215	46	ASHTON	NORRIS JUNCTION 15
WY	44.7220	-110.701	ECHINUS GEYSER	185	85	11	215	32	ASHTON	NORRIS JUNCTION 15
WY	44.6970	-110.375	HOT SPRINGS ON BOG CREEK	185	85	79	215	43	ASHTON	CANYON VILLAGE 15
WY	44.5290	-110.791	WHITE CREEK GROUP	185	85	null	215	94	ASHTON	(MADISON JUNCTION 15)
WY	44.2440	-111.022	BOUNDARY CREEK HOT SPRINGS	181	83	null	215	1	ASHTON	WARM RIVER BUTTE 15

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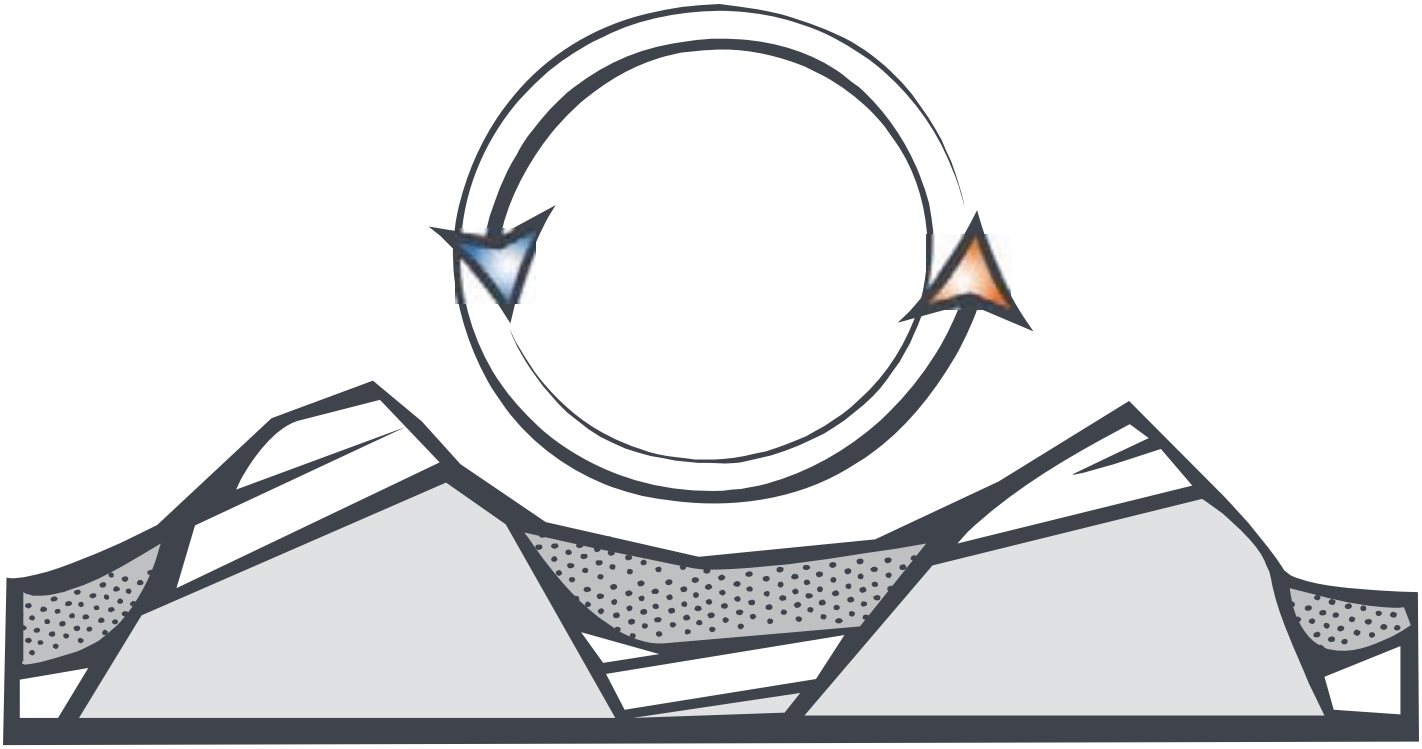
WY	44.6710	-110.290	PONUNTPA SPRINGS GROUP	180	82	83	215	53	ASHTON	CANYON VILLAGE 15
WY	44.7140	-110.475	null	167	75	null	215	35	ASHTON	CANYON VILLAGE 15
WY	44.9670	-110.708	MAMMOTH HOT SPRINGS	163	73	2	215	2	ASHTON	MAMMOTH 15
WY	43.9580	-110.696	JACKSON LAKE HOT SPRINGS	162	72	null	null	1	DRIGGS	(COLTER BAY 7.5)
WY	44.7530	-110.724	ROADSIDE SPRINGS, FRYING PAN SPRING	158	70	9	215	17	ASHTON	MAMMOTH 15
WY	44.5980	-110.236	HOT SPRINGS IN PELICAN VALLEY	156	69	null	215	70	ASHTON	PELICAN CONE 15
WY	44.7540	-110.403	SEVENMILE HOLE	154	68	null	215	16	ASHTON	(TOWER JUNCTION 15)
WY	44.7390	-110.258	HOT SPRING BASIN GROUP	153	67	75	215	25	ASHTON	CANYON VILAGE 15
WY	42.8280	-110.999	AUBURN HOT SPRINGS	144	62	103	218	1	PRESTON	null
WY	44.7810	-110.699	WHITEROCK SPRINGS	144	62	8	215	10	ASHTON	MAMMOTH 15
WY	44.7200	-110.715	null	144	62	null	215	33	ASHTON	NORRIS JUNCTION 15
WY	44.5820	-110.314	VERMILION SPRINGS	140	60	91	215	74	ASHTON	CANYON VILLAGE 15
WY	44.5880	-110.341	EBRO SPRINGS	136	58	90	215	73	ASHTON	CANYON VILLAGE 15
WY	44.5500	-110.805	FOUNTAIN PAINT POT	136	58	21	215	86	ASHTON	MADISON JUNCTION 15
WY	44.9850	-110.689	HOT RIVER	136	58	1	215	1	ASHTON	MAMMOTH 15
WY	43.6540	-108.194	THERMOPOLIS HOT SPRINGS	133	56	111	null	1	THERMOPOLIS	THERMOPOLIS 7.5
WY	44.6250	-110.433	MUD VOLCANO	131	55	61	215	62	ASHTON	CANYON VILLAGE 15
WY	42.5450	-106.725	ALCOVA HOT SPRINGS	129	54	113	null	1	CASPER	(ALCOVA 7.5)
WY	41.4500	-106.804	SARATOGA HOT SPRINGS	129	54	115	null	1	RAWLINS	SARATOGA 7.5
WY	44.7110	-110.741	CHOCOLATE POTS	124	51	null	215	36	ASHTON	NORRIS JUNCTION 15
WY	44.8420	-110.732	APOLLINARIS SPRING	H	H	null	215	4	ASHTON	MAMMOTH 15
WY	44.5530	-110.301	BEACH SPRINGS	H	H	93	215	84	ASHTON	CANYON VILLAGE 15
WY	44.7080	-110.461	FOREST SPRINGS	H	H	54	215	39	ASHTON	CANYON VILLAGE 15
WY	44.7500	-110.714	GAS VENT	H	H	null	215	20	ASHTON	MAMMOTH 15
WY	44.6120	-110.618	GAS VENT	H	H	null	215	65	ASHTON	NORRIS JUNCTION 15
WY	44.7410	-110.699	GAS VENT	H	H	null	215	23	ASHTON	NORRIS JUNCTION 15
WY	44.6010	-110.632	GAS VENT EAST OF MARY LAKE	H	H	null	215	68	ASHTON	NORRIS JUNCTION 15

State	Latitude	Longitude	"Popular" or USGS Spring Name	TF	T C	P.P. 492	Circ. 790	NOAA	AMS	USGS Quadrangle
WY	44.7150	-110.555	GAS VENTS	H	H	null	215	34	ASHTON	NORRIS JUNCTION 15
WY	44.8250	-110.675	GAS VENTS AT HORSESHOE HILL	H	H	null	215	6	ASHTON	MAMMOTH 15
WY	44.5950	-110.622	GAS VENTS SOUTHEAST OF MARY LAKE	H	H	null	215	71	ASHTON	NORRIS JUNCTION 15
WY	44.6160	-110.616	HIGHLAND HOT SPRINGS	H	H	57	215	64	ASHTON	NORRIS JUNCTION 15
WY	44.7520	-110.256	HOT SPRING	H	H	null	215	19	ASHTON	TOWER JUNCTION 15
WY	44.6420	-110.238	HOT SPRING	H	H	null	215	58	ASHTON	PELICAN CONE 15
WY	44.7660	-110.300	HOT SPRINGS	H	H	null	215	13	ASHTON	TOWER JUNCTION 15
WY	44.5720	-110.691	HOT SPRINGS	H	H	27	215	75	ASHTON	NORRIS JUNCTION 15
WY	44.6100	-110.438	HOT SPRINGS	H	H	null	215	66	ASHTON	CANYON VILLAGE 15
WY	44.6670	-110.282	HOT SPRINGS	H	H	null	215	54	ASHTON	CANYON VILLAGE 15
WY	44.6720	-110.236	HOT SPRINGS	H	H	null	215	51	ASHTON	PELICAN CONE 15
WY	44.7110	-110.468	HOT SPRINGS	H	H	null	215	37	ASHTON	CANYON VILLAGE 15
WY	44.6070	-110.617	HOT SPRINGS EAST OF MARY LAKE	H	H	59	215	67	ASHTON	NORRIS JUNCTION 15
WY	44.6170	-110.432	MUD GEYSERS	H	H	61	215	63	ASHTON	CANYON VILLAGE 15
WY	44.5510	-110.850	SPRINGS ON FAIRY CREEK	H	H	null	215	85	ASHTON	MADISON JUNCTION 15
WY	44.7810	-110.738	STEAM VENTS AT ROARING MOUNTAIN	H	H	null	215	9	ASHTON	MAMMOTH 15
WY	44.6340	-110.234	THE MUDKETTLES	H	H	87	215	59	ASHTON	PELICAN CONE 15
WY	44.6340	-110.226	THE MUSHPOTS	H	H	88	215	60	ASHTON	PELICAN CONE 15
WY	44.6560	-110.572	VIOLET SPRINGS	H	H	56	215	56	ASHTON	NORRIS JUNCTION 15



Appendix G

Ecoregion Divisions

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APPENDIX G
ECOREGION DIVISIONS

The descriptions in this appendix were adapted from the United States Forest Service "Description of Ecoregions of the United States," compiled by Roger G. Bailey in 1995 with the exception of the ecoregions unique to Alaska which were adapted from "Description of Ecological Subregions: Sections of the Conterminous United States," compiled by W. H. McNab, D. T. Cleland, J. A. Freeouf, J. E. Keys, Jr., G. J. Nowacki, and C. A. Carpenter in 2007.

POLAR DOMAIN

Arctic Division

The northern continental fringes of North America, from the Arctic Circle northward to about the 75th parallel, lie within the outer zone of control of arctic air masses. This produces the arctic climate. The average temperature of the warmest month lies between 50F (10C) and 32F (0C).

The arctic climate has a very short, cool summer and a long, severe winter (see Appendix 2, climate diagram for Barrow, Alaska). No more than 188 days per year, and sometimes as few as 55, have a mean temperature higher than 32F (0C). Annual precipitation is light, often less than 8 in (200 mm), but because potential evaporation is also very low, the climate is humid.

Vegetation on the tundra consists of grasses, sedges, lichens, and willow shrubs. As one moves south, the vegetation changes into birch-lichen woodland, and then into needleleaf forest. In some places, a distinct tree line separates forest from tundra. Koppen (1931) uses this line, which coincides approximately with the 50F (10C) isotherm of the warmest month, as a boundary between subarctic and arctic climates.

Wildlife species in arctic habitats fall into three categories: 1) resident species that remain active year-round, 2) resident species hibernating in winter such as

the polar bear, and 3) migratory species present for only a portion of the year (Lent 1986). Resident species that remain active year-round include the willow ptarmigan, common raven, snowy owl, Arctic fox, brown lemming, muskox, and caribou. Hibernating species include the Arctic ground squirrel, and hoary marmot. The great majority of the approximately 100 bird species using the arctic are migratory (Pitelka 1979).

Except for the wood frog, there are no amphibians or reptiles in the Arctic Ecoregion. Because they are cold-blooded animals, the climate is too cold for these groups. Wood frogs are unique in that they partially freeze in winter; up to one-third of the water in a wood frog's body may turn to ice for a period of several weeks (Behler 1995).

The arctic has low species diversity; arctic insect fauna, for example, is only 1 percent to 5 percent as rich in species as the insect fauna found at temperate latitudes (Bolen 1998). Wildlife populations are also constrained by the low plant productivity, and can fluctuate greatly in response to annual changes in plant productivity. Animal population peaks can markedly alter vegetation and other habitat features in some instances, leading to sharp declines in population numbers.

Insect fauna provides an important prey base for migratory shorebirds and waterfowl. To cope with the short summer and limited food supplies, migratory birds tend to nest almost immediately upon arriving on the breeding grounds, and young hatch when insects and vegetation are most abundant.

Brant and common eider are prevalent in this area. Seabirds such as the pomarine jaeger, glaucous gull, and black guillemot are characteristic breeders. The semipalmated sandpiper is a common breeder in this section as is the rare Arctic Loon. The breeding range of the rare curlew sandpiper is limited to the tundra adjacent to the coast. Waterfowl, other small birds, and small mammals are preyed upon by Arctic fox, snowy owl, gyrfalcons, peregrine falcons, and rough-legged hawks.

Suitable habitat for denning or burrowing species may be limited in areas with continuous or near-continuous permafrost. Burrowing species must select areas where the permafrost is not near the surface. The presence of deep snowdrifts is important for denning wolverines, polar bears, and brown bears. Talus slopes and cut banks are important habitat features used by denning Arctic foxes. Raptors tend to nest along river and coastal bluffs because of the generally flat, treeless character of the Arctic tundra. Pink and chum salmon are present in this Section as are king, sockeye, and silver salmon.

Soil particles in the arctic derive almost entirely from mechanical breakup of rock, with little or no chemical alteration. Inceptisols with weakly differentiated horizons are dominant. Continual freezing and thawing of the soil have

disintegrated its particles. Like the northern continental interior, the arctic has a permanently frozen sublayer of soil known as permafrost. The permafrost layer is more than 1,000 ft (300 m) thick throughout most of the region; seasonal thaw reaches only 4-24 in (10-60 cm) below the surface.

Geomorphic processes are distinctive in the arctic, resulting in a variety of curious landforms. Under a protective layer of sod, water in the soil melts in summer to produce a thick mud that sometimes flows downslope to create bulges, terraces, and lobes on hillsides. The freeze and thaw of water in the soil sorts out coarse particles, giving rise to such patterns in the ground as rings, polygons, and stripes made of stones. The coastal plains have numerous lakes of thermokarst origin, formed by melting groundwater.

Arctic Tundra Province

Land-surface form.--The north coast of Alaska is a broad, level plain that is generally less than 1,000 ft (300 m) in elevation. Rolling foothills rise near the Colville River and gain altitude southward into the Brooks Range. In summer, thousands of lakes and marshes dot the plain.

Climate.--The severe arctic climate reaches temperatures of -60F (-51C) in winter. Average annual temperature is only 10 to 20F (-12C to -6C). Due to its location in the extreme north, this province gets very different amounts of sunlight at different times of year. In summer, the sun remains above the horizon 24 hours a day for from 2 to 85 consecutive days, depending on the latitude; in winter, it can remain below the horizon 24 hours a day for as long as 67 consecutive days. All sunlight is received at oblique angles that average 41 degrees. The growing season averages only 2 weeks per year. Precipitation is very low throughout the year; average annual precipitation is only 7 in (180 mm).

Vegetation.--Permafrost limits the rooting depth of plants and forces surface water to drain by preventing it from seeping into the soil. Extensive marshes and lakes result. Cottongrass-tussock, the most widespread vegetation system in the Arctic, is associated with sedges, dwarf shrubs, lichens, mosses, dwarf birch, Labrador-tea, and cinquefoil. These highly productive systems produce 500-1,000 lb (227-454 kg) of vegetation per acre, an important source of food for caribou and waterfowl. Several forbs flower brightly in the short summer.

Soils.--The soils are wet, cold Inceptisols with weakly differentiated horizons. Soils on south slopes and low moraines are well drained and loamy, with permafrost and ice features. They are underlain by coarse outwash and till. The uplands have localized areas of poorly drained clayey soils; lowland soils are deep, wet, and silty. There is no surface water in winter and only moderate flows in summer. Supplies of ground water are very limited. The entire province is under continuous permafrost to depths of 2,000 ft (600 m) in some areas.

Fauna.--Mammals of the Arctic include brown bear, wolf, wolverine, caribou, arctic hare, mink, weasel, and lemming. Polar bear, walrus, and arctic fox are common on the ice pack and coastal areas during winter.

Shore and lake areas provide rich habitat for millions of migrating waterfowl and shore birds during the summer months. Ptarmigans, ravens, hawks, and open country owls are common. Gyrfalcons have also been seen on sea ice.

Brooks Range Tundra

Land-surface form.--The Brooks Range, a northern extension of the Rocky Mountains, reaches 600 mi (970 km) westward from Canada to the Chukchi Sea. Its rugged peaks reach elevations of 9,000 ft (2,700 m) in the east, falling to 3,000 ft (900 m) in the west. Broad U-shaped valleys, morainal topography, and braided stream channels show evidence of glaciation. A series of rolling plateaus and low mountains, the arctic foothills, borders the coastal plain to the north.

Climate.--The climate of the Brooks Range is similar to that of the arctic coastal plain, but precipitation increases at the higher altitudes and at the east end of the range. Summer temperatures reach 90 to 100F (32 to 38C), and winter temperatures drop as low as -75F (-60C). Because the province lies above the Arctic Circle, it gets several days of 24-hr sunlight in June, and several sunless days in December. Precipitation averages 7 to 15 in (180 to 390 mm), but drainage is rapid due to the area's steep slopes and the low holding capacity of its soils.

Vegetation.--In the higher alpine areas, plant cover is discontinuous over barren rock. It consists chiefly of low mats of such herbaceous and shrubby species as dwarf arctic birch, crowberry, Labrador-tea, arctic willow, resin birch, and dwarf blueberry. Areas at lower elevations may be covered by a mat of sedge and shrub that provides valuable forage for caribou. Cottongrass, bluejoint, mosses, dwarf willow, dwarf birch, Labrador-tea, and bistort are common. Regeneration is extremely slow for most species; some mosses require more than 60 years to recover from disturbance.

Soils.--The mountains are underlain by folded and faulted limestone, the foothills by various sediments. Soils are rocky and poorly developed. Inceptisols cover the lower slopes. Glacial and alluvial deposits occur in the valleys and at the base of the mountain slopes. Permafrost is continuous under the entire area.

Fauna.--The Brooks Range is an important big-game area in Alaska, supporting brown and black bear, wolf, wolverine, caribou, and Dall sheep. Smaller mammals include marmot, red and arctic fox, ground squirrel, lemming, and pika.

The Brooks Range is an important resting area for migrating waterfowl and songbirds during summer. Raptors prominent in many areas include golden eagles, marsh hawks, gyrfalcons, and snowy and other open country owls.

Bering Sea Tundra Province

Land-surface form.--The Bering Sea Tundra is a western extension of the arctic coastal plain, a broad lowland area rising gradually to the east. General topography is less than 1,000 ft (300 m) in elevation, broken in places by small mountain groups that rise 2,500-3,500 ft (800-1,100 m). Standing water is present in thousands of shallow lakes and marshes along the coast. Two large braided rivers, the lower Yukon and the Kuskokwim, flow out of the province to the southwest.

Climate.--The climate is less severe in the Bering Sea Tundra than on the arctic slope, but it also has cold winters and generally cool summers. Temperatures range from a high of 90F (32C) in summer to a low of -70F (-57C) in winter. Annual precipitation averages 17 in (430 mm).

Vegetation.--Vegetation along the wet coastal areas is chiefly sedge and cottongrass; woody plants grow on higher sites. Birch-willow-alder thickets are extensive in transition zones between beach and forest. The lower Yukon and Kuskokwim Valleys are dominated by white spruce mixed with cottonwood and balsam poplar in tall, relatively dense stands, with a dense undergrowth of thinleaf alder, willow, rose, dogwood, and various species of berry bushes.

Soils.--Coastal soils are wet, cool Inceptisols over silt, sand, and marine sediments. The lower Yukon and Kuskokwim Valley bottoms have pockets of Entisols with no soil horizons. Ground water throughout the area is limited, but some is present in the major river valleys. Surface water on the Seward Peninsula ceases to flow in winter, but further south it flows year-round. Permafrost is continuous under most of the area.

Fauna.--River bottom lands provide excellent habitat for furbearers, game birds, and moose. Upland and coastal areas support brown and black bear, wolf, wolverine, coyote, caribou, reindeer, snowshoe hare, red fox, lynx, beaver, moose, squirrels, mice, weasel, mink, and marten. Along the northern Bering Sea coast, polar bear, walrus, and arctic fox are occasionally found.

Coastal areas provide extensive and excellent habitat for migrating waterfowl and shore birds. Other bird species in the area include ospreys, falcons, grouse, ravens, golden eagles, and various hawks and owls.

SUBARCTIC DIVISION

The source region for the continental polar air masses is south of the tundra zone between lat. 50 and 70 N. The climate type here shows very great seasonal range in temperature; winters are severe, and the region's small

amounts of annual precipitation are concentrated in the 3 warm months. This cold, snowy forest climate, referred to in this volume as the boreal subarctic type, is classified as E in the Koppen-Trewartha system. This climate is moist all year, with cool, short summers (see Appendix 2, climate diagram for Fort Yukon, Alaska). Only 1 month of the year has an average temperature above 50F (10C).

Winter is the dominant season of the boreal subarctic climate. Because average monthly temperatures are subfreezing for 6 to 7 consecutive months, all moisture in the soil and subsoil freezes solidly to depths of many feet. Summer warmth is insufficient to thaw more than a few surface feet, so permafrost prevails under large areas. Seasonal thaw penetrates from 2 to 14 ft (0.6 to 4 m), depending on latitude, aspect, and kind of ground. Despite low temperatures and long winters, the valleys of interior Alaska were not glaciated during the Pleistocene, probably because of insufficient precipitation.

The subarctic climate zone coincides with a great belt of needleleaf forest, often referred to as boreal forest, and with the open lichen woodland known as tayga. Most trees are small, with less value as lumber than as pulpwood.

Boreal forests are structurally more complex than tundra, and thus support a greater diversity of wildlife species. These forests provide habitat for large mammals, such as grizzly bear, black bear, wolf, moose, and wolverine; small mammals, such as red fox, American beaver, American marten, and weasels; birds, such as spruce and ruffed grouse, owls, and raven; and the amphibian, wood frog. (Veg PEIS CH 3) Cliffs along the Yukon and Porcupine Rivers provide habitat for several raptor species: osprey, gyrfalcon, hawks, and the endangered American peregrine falcon. Rich fish resources support bald eagles and osprey on the coastline. (http://wetlandsfws.er.usgs.gov/status_trends/Classification_Documents/Baileys_Ecoregions.pdf)

Many species have unique adaptations to survive in subarctic forests. Herbivores typically graze on herbaceous and shrubby vegetation during the summer, but shift to a high fiber diet of conifer needles and woody shrub browse during winter. White-winged crossbills are an example of a species that have adapted to the abundant cone seeds in boreal forests. These birds move in large flocks when cone supplies are abundant, but are nomadic when cone supplies are limited. White-winged crossbills also breed opportunistically, when cone supplies are most abundant. The boreal forests also provide a rich source of lichen, a food-source that comprises 60-80 percent of the winter diet for barren-ground caribou.

There are fewer wildlife species are found in bogs of the subarctic ecoregion than in upland forests, given the lack of diversity in flora. The high water table of bogs also discourages burrowing species. (Veg PEIS CH 3)

The arctic needleleaf forest grows on Inceptisols with pockets of wet, organic Histosols. These light gray soils are wet, strongly leached, and acid; they form a very distinct layer beneath a topsoil layer of humus and forest litter. Agricultural potential is poor, due to the natural infertility of soils and the prevalence of swamps and lakes left by departing ice sheets. In some places, ice scoured rock surfaces bare, entirely stripping off the overburden. Elsewhere rock basins were formed and stream courses dammed, creating countless lakes.

Yukon Intermontane Tayga Province

Land-surface form.--A series of broad valleys, dissected uplands, and lowland basins covered with alluvial deposits extends across interior Alaska between the Brooks and Alaska Ranges. Four major rivers, the Yukon, Tanana, Koyukuk, and upper Kuskokwim, provide the area's outstanding hydrologic features. All four form wide valleys, with extensively braided channels; in some areas, the valleys contain hundreds of small lakes and marshes. Elevations are generally less than 2,000 ft (600 m).

Climate.--The semiarid climate has extreme temperatures. Summers are short and hot, with temperatures up to 100F (38C); winters are long and severe, with temperatures as low as -75F (-60C). Average annual precipitation is only 17 in (430 mm). Temperature inversions, frequent in upland areas in winter, result in warmer temperatures on lower slopes than in bottom lands.

Vegetation.--The major river bottoms support dense white spruce-cottonwood-poplar forests on floodplains and southfacing slopes up to about 1,000 ft (300 m). The undergrowth is dense shrubbery formed by green and thinleaf alder, willow, dogwood, and berries. The outer valley edges support evergreen and coniferous forests, often with pure stands of black spruce. The undergrowth consists of willow, dwarf birch, crowberry, fern, blueberry, lichens, and mosses. Upland areas are generally covered by a rather dense white spruce-birch-aspen-poplar forest. Pure stands of white spruce grow near streams. Typical undergrowth includes willow, alder, fern, berries, grasses, and mosses. Root systems are shallow. Water balance is likely the factor limiting growth in most of these areas because of the hot, dry summer climate. Old river terraces, ponds, and sloughs contain scattered but extensive bogs where the vegetation is chiefly sphagnum and other mosses, sedges, bog rosemary, and Labrador-tea. Marginal areas may support willow and alder.

Soils.--River bottom and lower slope soils are generally deep, well-drained Inceptisols over sands, silts, and gravels that are only slightly weathered. Permafrost is discontinuous in major river valleys. Soils on northfacing slopes are shallow and poorly developed, with continuous permafrost. Upland soils that support spruce-hardwood forests are well-drained, shallow Inceptisols over continuous permafrost. Bog soils are Histosols.

Fauna.--The spruce-hardwood forests provide excellent habitat for furbearers and other mammals. Brush zones and immature forests recovering from fires furnish especially good browse for moose. Common game animals in addition to moose include black and brown bear, wolf, wolverine, and caribou. Smaller mammals include lynx, red fox, beaver, mink, muskrat, weasel, river otter, marten, red and northern flying squirrel, and deer mouse.

Woodland game birds find plentiful habitat. Upland birds include northern hawk-owl, spruce grouse, and boreal chickadee.

Upper Yukon Tayga Province

Land-surface form.--This province is mostly a flat plains and rounded low mountains. The plains consist of marshy lake-dotted flats rising from 300 ft (90 m) in altitude in the west to 600-900 ft (180-270 m) in the north and east. The mountains rise to 4,000 ft (600-1,200 m). The province is made up of outwash fans and floodplains of the Chandalar, Christian, Sheenjek, and Upper Yukon Rivers. Rolling silt- and gravel-covered marginal terraces with sharp escarpments 150-600 ft (50-180 m) high rise above the flats, sloping gradually upward to altitudes of about 1,500 ft (460 m) at the base of surrounding uplands and mountains.

Climate.--The climate is the extreme continental boreal type, with its large annual temperature range, severely cold winters, and short, hot summers. The average daily minimum temperature of the coldest month is -29F (-33C). At Fort Yukon, more than 130 days per year have a minimum temperature of 0F (-18C) or below. The record low at Fort Yukon is -78F (-61C), and the record high is 100F (38C). The growing season is less than 3 months. The region is semiarid, with an average annual precipitation of about 7 in (179 mm), with a summer maximum. Snowfall averages 45 in (1,150 mm) per year.

Vegetation.-- The vegetation pattern in the area is complex. Bottom land spruce-aspen-birch grow on the better drained alluvial sites. Alder and willow form thickets on newly exposed alluvial sites subject to periodic flooding. Forests of white spruce, paper birch, and quaking aspen cover most lower slopes in the south and southfacing slopes in the north. Black spruce forest vegetation grows at higher elevations, on all northfacing slopes in the south, on all but steep southfacing slopes in the north, and on lower slopes with impeded soil drainage throughout the area. Above the black spruce forest, the vegetation is alpine meadow characterized by sedges on poorly drained sites and by low-growing shrubs on drier sites.

Soils.--Principal soils are wet Inceptisols, mostly in flats and low areas. Lower parts of the floodplains are poorly drained and covered with peat, whereas river terraces are better drained.

Fauna.--The fauna of the Yukon Flats Province are similar to those in other tayga regions. But this province provides what may be the most productive arctic habitat for avian wildlife on the continent. Predominant waterfowl species that breed in the region include the lesser scaup, pintail, scoter, and wigeon. The area supports 15-20 percent of remaining canvasbacks. Arctic, red-throated, and common loons, horned and red-necked grebes, and sandhill cranes are also common. Cliffs along the Yukon and Porcupine Rivers support several raptor species, including osprey, gyrfalcon, Swainson's hawk, and the endangered American peregrine falcon.

Alaska Range Taiga

Land-surface form--The Alaska Range is a continuation of the Pacific Coast Mountains extending in an arc across the northern Pacific. The towering, glaciated peaks of the Wrangell Mountains and of the Alaska Range--which includes Mt. McKinley at 20,320 ft (6,194 m)--typify the ruggedness of the area. The only major waterways are the Susitna and upper Copper Rivers.

Climate.--The Alaska Range and the Wrangell Mountains have a transitional climate of severe winters and hot, dry summers. Temperatures range from 90F to -70F (32C to -57C). Precipitation averages only 16 in (410 mm) annually.

Vegetation.--Vertical vegetational zonation characterizes the Alaska Range and Wrangell Mountains, beginning with dense bottom-land stands of white spruce and cottonwood on the floodplains and low terraces of the Copper and Susitna Rivers. Above the terraces, poorly drained areas up to 1,000 ft (300 m) support stands of black spruce. Upland spruce-hardwood forests of white spruce, birch, aspen, and poplar, with an undergrowth of moss, fern, grass, and berry, extend to timberline at about 2,500-3,500 ft (800-1,100 m). Tundra systems of low shrubs and herbaceous plants form discontinuous mats among the rocks and rubble above timberline. White mountain-avens may cover entire ridges in the Alaska Range, associated with moss campion, black oxytrope, arctic sandwort, lichens, grasses, and sedges. These tundra systems stop short of the permanent ice caps on the highest peaks.

Soils.--Bottom-land and terrace soils of the Copper and Susitna Rivers are stratified, well-drained Entisols without pedogenic horizons. Upland hardwood forest soils are mostly shallow, well-drained Inceptisols. Permafrost is continuous on northfacing slopes, discontinuous on southfacing ones. Soils that support the moister tundra areas range from wet Inceptisols to Histosols. Alpine Inceptisols are generally shallow and poorly developed, with discontinuous or continuous permafrost.

Fauna.--The Alaska Range supports large big-game populations of moose, Dall sheep, black and brown bear, wolf, caribou, and wolverine. Smaller mammals include beaver, red fox, lynx, otter, marten, squirrels, and weasel. Golden eagles, ptarmigan, ravens, and sharp-shinned hawks inhabit the uplands. Near

timberline in Lake Clark National Park, Alaska Range. (Photo: National Park Service.)

HUMID TEMPERATE DOMAIN

Warm Continental Division

South of the subarctic climate lies the humid warm-summer continental climate. Located squarely between the source regions of polar continental air masses to the north and maritime air masses to the south, it is subject to strong seasonal contrasts in temperature as these air masses push back and forth across the land.

It has a cold snowy winter climate with a warm. The climate has 4 to 7 months when temperatures exceed 50F (10C), with no dry season. The average temperature during the coldest month is below 32F (0C). The warm summer has an average temperature during its hottest month that does not exceed 72F (22C). Precipitation is ample all year, but is substantially greater during the summer.

Needleleaf and mixed needleleaf-deciduous forest grows throughout the colder northern parts of the humid continental climate zone, extending into the mountain regions north of Cook Inlet.

Alaska Mixed Forest Province

Land-surface form.--This province is a moraine- and outwash-mantled lowland that rises from sea level to an altitude of 2,000 ft (600 m). Drained by the Nushagak and other large rivers that flow into Bristol Bay, the lowland is dotted with morainal and thaw lakes. The Copper River lowland is also part of the province. It is a broad basin of rolling to hilly moraines and nearly level alluvial plains on the site of a Pleistocene glacial lake.

Climate.--This province has a marine phase of the tundra climate, with cold winters and cool, short summers. Although the climate is subarctic, it is less severe than the interior of Alaska, because much of the region is sheltered by the Alaska Range to the north. Proximity to the Gulf of Alaska makes the climate transitional to the marine climates to the south. Average annual temperatures range from 32 to 39F (0 to 4C), with a winter average of about 5F (-15C) and summer maximums of about 64F (18C). Average annual precipitation ranges from 10 to 18 in (260 to 460 mm). Annual snowfall averages from 4 to 10 in (100 to 260 mm).

Vegetation.-- Throughout the Cook Inlet lowlands, lowland spruce-hardwood forests are abundant. Bottom land spruce-poplar forest adjoins the larger river drainages, along with thickets of alder and willow. Wet tundra communities exist along the Cook Inlet coastline. The Copper River lowland is characterized by black spruce forest interspersed with large areas of brushy tundra. White

spruce forests occur on southfacing gravelly moraines, and cottonwood-tall bush communities are common on large floodplains.

Soil.--Dominant soils are Inceptisols. Most soils are formed in ash deposits of various thickness, underlain by gravelly glacial till, outwash deposits, or silty alluvium. Coastal plain soils are formed in gravelly alluvium, cinders, or weathered rock blanketed by thick sedge peat. Spodosols are the principal upland soils in the Cook Inlet. Permafrost is sporadic or absent.

Fauna.-- The diversity of habitats in this province supports a large variety of species. Muskrats and red foxes abound, moose flourish in lowland areas, and Dall sheep are frequently seen in the uplands. Black bear populations are dense throughout the region. Trumpeter swans nest here, and tundra swans are present during migration. King, sockeye, and silver salmon are common or abundant. Brown bears are common mammals, partly because of large salmon runs in this area.

Bristol Bay provides staging and migration habitat for large numbers of waterfowl. Ospreys occur more frequently in this province than in any other part of Alaska. Blackpoll warblers are common breeders in conifer stands in the north.

Cold Oceanic Division

The Cold Oceanic division includes much of the Alaska Peninsula and all of the Aleutian Islands. The islands that chiefly make up this province are mountainous, rising steeply from the sea. The Islands and the Alaska peninsula experience a maritime climate. Precipitation varies widely, from 20 to 82 inches. Generally, larger islands receive more precipitation than smaller ones, and coastal areas more than inland areas. Temperatures range from average lows of 20°F to -4°F in winter to average highs of 50°F to 55°F in summer

Trees are absent from the division and vegetation consists of low shrubs of willow, birch, and alder interspersed with lichen, and grass communities. At lower elevations, there is a luxuriant growth of tall grasses, flowering plants, and ferns, with thickets of low willows in some places. A little higher up, several types of heath cover vast areas. The boreal forest and coastal rainforest are slowly encroaching from the east on the area of this province. This is explained by the assumption that the distribution of the vegetation is not yet adjusted to the climatic conditions produced by retreat of the last continental glaciers Alpine tundra is found on mountainsides.

The division supports many seabird colonies of extraordinary size and global importance. The Pribilof Islands, for example, provide breeding habitat for approximately 3 million seabirds including virtually all of the world's 250,000 red-legged kittiwakes. Many of the islands also support endemic species,

including the Pribilof Island shrew and the Aleutian shield fern, the only federally-listed endangered plant in Alaska.

The division has most soils form of volcanic ash or cinders over basaltic rock, and dominant soil types are Typic Haplocryands and Typic Vitricryands. Higher elevations often are covered in bare rock and basaltic rubble.

Aleutian Meadow Province
Aleutian Islands, Alaska Peninsula, West Kodiak Island 22,200 mi2 (57,500 km2)

Land-surface form.--The islands that chiefly make up this province are mountainous, rising steeply from the sea. They contain more than 75 volcanoes, about half of which are know to have erupted during the last 200 years. Altitudes of the volcanoes decrease southwestward from 7,500 ft (2,300 m) at Mount Katmai on the Alaska Peninsula to 6,000 ft (1,800 m) on the Aleutian Islands. Not much of the land on the islands or on the peninsula is level. Steep slopes prevail all the way to water's edge, and shores are rocky and craggy. The Alaska Peninsula has intensely glaciated mountains indented with fjords that are bordered by cliffs. Several large lakes are on the peninsula.

Climate.--The climate is similar to that on the arctic coastal plain, except it is a marine phase (described above for the Bering Tundra [Southern] Province). Winters are less severe than those on the coastal plain, with temperature ranges of 18 to 27F (10 to 15C), as compared to a 54F (30C) range on the coastal plain. The climate is characterized by fog and rain, with the amount of precipitation varying little from month to month. Annual precipitation varies from 21 in (530 mm) to more than 78 in (2,000 mm). In general, smaller islands receive less precipitation than larger islands. Winds are often severe on the islands. Pacific Ocean water moving northward through the straits between the islands produces complex mixing with Bering Sea water, including upwelling. The Pribilof Islands in the Bering Sea are about at the southern limit of the arctic ice pack in winter.

Vegetation.--Trees are absent from the Aleutian Province, although there are a few shrubs, chiefly dwarf willows. At lower elevations, there is a luxuriant growth of tall grasses, flowering plants, and ferns, with thickets of low willows in some places. A little higher up, several types of heath cover vast areas. The boreal forest and coastal rainforest are slowly encroaching from the east on the area of this province. This is explained by the assumption that the distribution of the vegetation is not yet adjusted to the climatic conditions produced by retreat of the last continental glaciers.

Soils.--About 30 percent of the area consists of high mountains without soil cover. Dominant soils are Inceptisols formed from volcanic ash or pumice, with large components of pyroclastic materials. Permafrost is generally absent.

Fauna.--The Aleutian Islands support no land mammals larger than foxes. Marine mammals such as seals, sea lions, and sea otters are abundant, using the islands for hauling out and as rookeries.

Bald eagles and hawks are prevalant predators, feeding on the millions of sea birds that use the islands and rocks as rookeries.

Marine Division

Situated on the Pacific coast between latitudes 40 and 60 N. is a zone that receives abundant rainfall from maritime polar air masses and has a rather narrow range of temperatures because it borders on the ocean. The average temperature of the warmest month is below 72F (22C), but at least 4 months per year have an average temperature of 50F (10C). The average temperature during the coldest month of the year is above 32F (0C). Precipitation is abundant throughout the year, but is markedly reduced during summer. Although total rainfall is not great by tropical standards, the cooler air temperatures here reduce evaporation and produce a very damp, humid climate with much cloud cover. Mild winters and relatively cool summers are typical. Coastal mountain ranges influence precipitation markedly in these middle latitudes. The mountainous coasts of British Columbia and Alaska annually receive 60 to 80 in (1,530 to 2,040 mm) of precipitation and more. Heavy precipitation greatly contributed to the development of fiords along the coast: heavy snows during the glacial period fed vigorous valley glaciers that descended to the sea, scouring deep troughs that reach at their lower ends below sea level.

Natural vegetation in the Marine Division is needleleaf forest. In the coastal ranges of the Pacific Northwest, Douglas-fir, redcedar, and spruce grow to magnificent heights, forming some of the densest of all coniferous forests with some of the world's largest trees.

The Marine Ecoregion is dominated by evergreen and, to a lesser extent, deciduous forests located along the Pacific Coast. Temperate forests are among the most productive habitats in the world and, due to routine subjection to disturbances that increase variability in the environment, they provide habitat for a diversity of wildlife, including mule deer, bobcat, mountain lion, black bear and grey fox.

In general evergreen trees support less wildlife than deciduous, as they are less palatable. Conifers do possess characteristics that are critical to the survival of many wildlife species, providing critical winter cover for elk, deer and Spruce grouse. Grey squirrels are common among the oak trees of deciduous groves.

Since this ecoregion is characterized by abundant rainfall, there is an abundance of moisture on the forest floor, as well as in ponds and streams, to support a diversity of amphibians. All frogs and toads in this region lay their eggs in water. Most salamanders lay their eggs in or near water, while others lay their eggs on

land under logs, in rock outcrops, or both. Many of these amphibians spend a portion or most of their lives out of water, living under moist logs, dead wood, or forest litter, or in burrows or root or rock crevasses.

Few reptiles are found in this ecoregion. The alligator lizard is the only widely distributed species found in forested habitats, and the painted turtle and western pond turtle are the only turtles common in the area. The most common snake is the northwestern garter snake.

Birds have adapted to exploit the different layers of vegetation in the forest. Cavities in snags provide shelter and nesting sites for woodpeckers, owls, and other cavity-using wildlife, while dead and dying bark often harbors large numbers of insect prey for birds. Ruffed grouse, winter wren, American robin, spotted towhee, and dark-eyed junco are often found near the forest floor or in shrubs. Woodpeckers and brown creepers are seen moving up and down the trunks of trees in search of insects. Nuthatches and chickadees exploit the cone seeds, while warblers and kinglets glean insects from the upper deciduous forest canopy. Shrews, mice and moles are fossorial and also exploit the vegetation types and strata of the forest, while rabbits and hares see shelter in dense vegetation near forest edges

A number of species rely on old-growth forests for most or all of their life requisites. Old-growth forests in the Marine Ecoregion generally consist of conifer trees with a diameter of more than 3 feet at the base of the tree, and that are more than 200 years old (Bolen 1998). These forests also contain a multilayered canopy and numerous snags and logs. Vaux's swifts depend on large, hollow snags for nesting and roosting habitat. Marbled murrelets use the stout branches of old-growth trees for nest platforms. Northern spotted owl nest in tree cavities and feed on northern flying squirrels. Banana slugs, Pacific giant salamander, Olympic salamander, and Oregon slender salamander are other species that prefer the rotting logs and moist soil conditions found in old-growth habitats.

Soils are strongly leached, acid Inceptisols and Ultisols. Due to the region's cool temperatures, bacterial activity is slower than in the warm tropics, so vegetative matter is not consumed and forms a heavy surface deposit. Organic acids from decomposing vegetation react with soil compounds, removing such bases as calcium, sodium, and potassium.

Pacific Lowland Mixed Forest Province

Land-surface form.--The Pacific Lowland Mixed Forest occupies a north-south depression between the Coast Ranges and the Cascade Mountains. Elevations range from sea level to 1,500 ft (460 m). The Willamette Valley has nearly level to gently sloping floodplains bordered by dissected high terraces and hills. The Puget Sound Valley is a moderately dissected tableland covered by

glacial till, glacial outwash, and lacustrine deposits. This province includes isolated hills and low mountains.

Climate.--Because this province is close to the Pacific Ocean, its climate is generally mild throughout the year. Annual temperatures average 48 to 55F (9 to 13C). The moderate rainfall reaches its maximum in winter; summer has a slight moisture deficit. Average annual rainfall ranges from 15 to 60 in (380 to 1,530 mm); but in much of the area, the range is from 30 to 45 in (760 to 1,150 mm). Coastal mountains are responsible for the drier and less muted climate. Fog partially compensates for the summer drought.

Vegetation.--Before cultivation, dense coniferous forest dominated the vegetation here. Principal trees are western redcedar, western hemlock, and Douglas-fir. In interior valleys, the coniferous forest is less dense than along the coast and often contains deciduous trees, such as big-leaf maple, Oregon ash, and black cottonwood. There are prairies that support open stands of oaks or are broken by groves of Douglas-fir and other trees; principal indicator species are Oregon white oak and Pacific madrone. Poorly drained sites with swamp or bog communities are abundant.

Soils.--Alfisols, Inceptisols, and Ultisols are the principal soil orders. Inceptisols dominate in Puget Sound Valley.

Fauna.--The fauna are closely related to those of the surrounding Cascade Province (described below). Mule deer is the most common large mammal. Chief mammalian predators are the mountain lion and bobcat. The western gray squirrel lives in oak trees, and the bushytail wood rat builds nests on shrub-covered stream margins and at forest edges. Isolated thickets are inhabited by brush rabbit and gray fox.

Ruffed grouse inhabit the same scattered thickets. The dusky Canada goose winters exclusively in the Willamette Valley in Oregon. The periodically abundant acorn crop attracts flocks of band-tailed pigeons, acorn woodpeckers, and mountain quail.

The dry terrain is ideal for reptiles, including the northern Pacific rattlesnake, the only poisonous snake in the Pacific Northwest.

Cascade Mixed Forest--Coniferous Forest--Alpine Meadow Province

Land-surface form.--The Cascade Province covers a series of steep, rugged mountains bordered in places by a narrow coastal plain. Mountains along the coast rise 5,000 ft (1,500 m) above sea level, with a local relief of 1,000-3,000 ft (300-900 m). The interior Cascade Range has mountains 8,000-9,000 ft (2,400-2,700 m) in altitude, dominated every 5-85 mi (8-135 km) by a volcano of much higher elevation. Mt. Rainier, for example, rises more than 14,000 ft (4,300 m)

above sea level. Some parts of the province, especially its northern portion and the Cascade Range, have been glaciated.

Climate.--Because this province borders on the Pacific Ocean, its climate is characterized by generally mild temperatures averaging 35 to 50F (2 to 10C) throughout the year. Rainfall is heavy, 30 to 150 in (770 to 3,800 mm) per year, with a maximum in winter. Humidity is always high, producing an extremely favorable precipitation/evaporation ratio. The southern part of this province is winter-wet with no snow; fog partially compensates for the summer drought. As one moves to the north, the summer dry season shortens, and the proportion of precipitation falling as snow increases. On high mountains, all precipitation may be snow, which reaches depths of 50 to 65 ft (15 to 20 m). East slopes are much drier than west slopes, accumulating less than 20 in (511 mm) of precipitation per year.

Vegetation.--The Cascade Province is primarily montane, but it ranges from sea level to altitudes above 5,000 ft (1,500 m). At the lowest elevations, there is a dense conifer forest of Douglas-fir, western redcedar, western hemlock, grand fir, silver fir, Sitka spruce, and Alaska-cedar. Numerous species of shrubs grow exceptionally well in this forest and around its margins. In many places, this vegetation is practically impenetrable.

Although Douglas-fir is the most abundant tree at lower elevations in the region, it is not part of the climax forest. Western hemlock and several other species of fir are more tolerant of shade than Douglas-fir, and in mature forest stands, Douglas-fir cannot regenerate. On the western and southern slopes of the Olympic Mountains in Washington, hemlock is eventually displaced by the more shade-tolerant silver fir.

In the humid conifer forests of southwestern Oregon, Alaska-cedar is replaced by silver fir and redwood. In the fog belt along the coast of northwestern California, redwood is the characteristic tree. Douglas-fir and other conifers associate with it to form perhaps the densest of all coniferous forests, with the world's largest trees. Some redwoods attain heights of more than 325 ft (99 m) and girths of more than 65 ft (19.8 m).

A xerophytic forest of ponderosa pine grows along the dry eastern slopes of the Cascades, descending to 500 ft (150 m) along the eastern foot of the range at the Columbia River. This is typically open forest mixed with grass and shrubs. It occurs throughout the Southwest, the Sierra Nevada, the Rocky Mountains, and the Black Hills.

The high, snowcapped mountains of the Cascades have a well-marked subalpine forest belt that reaches into British Columbia. Important trees are mountain hemlock, subalpine fir, whitebark pine, and Alaska-cedar. To the north, the subalpine forest becomes fragmentary or disappears completely.

All but the highest peaks are covered by forest. In the Cascade Mountains of Oregon, timberline varies from 7,700 to 10,000 ft (2,350 to 3,050 m). Above timberline, there is an alpine zone with rich communities of shrubs and herbs. Perpetual snow is confined to small patches.

Riparian forests in the Pacific Northwest are an exception to the general rule that conifers dominate in the region. Along the region's many rivers and streams, needleleaf trees are replaced by broadleaf species such as black cottonwood and red alder. This kind of forest occurs from southern Alaska south through Washington, Oregon, Idaho, and western Montana, continuing into northern California and the Sierra Nevada.

Soils.--Andisols are extensive where underlain by volcanic ash. Moist Inceptisols are found west of the Cascades; dry soils predominate in the rain shadow east of the mountains.

Fauna.--Common large mammals include elk, deer, mountain lion, bobcat, and black bear. Small mammals include mice, Douglas squirrels, martens, Townsend chipmunks, red tree voles, and bushytail wood rats.

The more common birds are the winter wren, Townsend's warbler, chestnut-backed chickadee, red-breasted nuthatch, gray jay, and Steller's jay. The most important game birds are blue and ruffed grouse; there are hawks and owls in the northwestern part of the province. Spotted owl and marbled murrelet depend on remaining old-growth forests.

Among the many species of amphibians that live in this region's moist, cool forests are the Pacific treefrog and the Pacific giant salamander. Reptiles include the northern alligator lizard and rubber boa.

The many swift-flowing rivers of the region are high in dissolved oxygen and generally unpolluted, making them ideal habitats for various salmon and trout species.

Pacific Coastal Icefields

Land-surface form.--The Coast Mountains rise precipitously from the sea to altitudes of about 9,000 ft (2,700 m), cut by an intricate network of deep, narrow fiords. Farther north, in the rugged St. Elias, Chugach, and Kenai Mountains, elevations range from sea level to more than 16,000 ft (4,900 m). Mount Logan (19,850 ft [6,050 m]) and Mount St. Elias (18,008 ft [5,490 m]) are the second and forth highest peaks on the continent of North America. Icefields and glaciers cover the higher parts of the mountains, forming some of the most extensive valley glacier systems in North America.

Climate.--The marine climate is the same as in Oregon and Washington, except that it has cool summers. Less than 4 months each year have average

temperatures higher than 50F (10C). Despite the many glaciers, the climate is surprisingly mild, with average winter temperatures of about 32F (0C) and minimum temperatures of 0F (18C). Summer temperatures average in the 50's (10-15C), with highs in the 90's (32-37C). The growing season lasts 4 months or more. Precipitation is heavy, generally averaging more than 80 in (2,040 mm) annually, with some places getting more than 150 in (3,830 mm). Inland, the climate grows increasingly severe, partly because of rising distance from the ocean, but chiefly due to higher altitude. Topography and high precipitation form so much ice in the mountains that glaciers extend down to sea level despite mild temperatures. Above 3,000 ft (900 m), there is perennial ice, and above 8,000 ft (2,400 m), even summer storms are usually accompanied by snow.

Vegetation.--The most important trees in the thick forest that covers the lower elevations of this province are Alaska-cedar, western hemlock, mountain hemlock, Sitka spruce, several species of willow, and black cottonwood. Several kinds of shrubs also grow in the forest, often forming a fringe on its margins. In many places, the dense vegetation is practically impenetrable.

The timberline is at low elevations, and much of the mountainous area above it is covered with nearly bare rocks, snowfields, and glaciers. Wherever soil has accumulated, however, there are grasses, herbs, and low shrubs. The timberline varies greatly in elevation from place to place, depending on slope exposure and other factors. Near Prince William Sound, for example, the timberline is usually between 1,000 and 2,000 ft (300 and 600 m), but sometimes it drops as low as 500 ft (150 m).

Soils.--Icefields and bare rock or rubble make up about 70 percent of the area. The dominant soils are cool, moist Inceptisols.

Fauna.--Due to the glacial character of the region, Sitka deer do not range into the area, nor do many of the large animals of the interior. The only important large mammals are brown and black bears and mountain goats. The principal small mammals are red squirrels, voles, and shrews. Birds include some arctic types of water birds, such as murrelets and puffins. Land birds include sooty grouse, white-tailed ptarmigan, and Steller's jay. There are no reptiles or amphibians.

Pacific Gulf Coastal Forest Province

Land-surface form.--The Alexander Archipelago, with its hundreds of islands formed by the partly submerged western foothills of the Coast Range, makes up most of this province. The larger islands have mountains 3,000-5,000 ft (900-1,500 m) high, with slopes covered by dense forest where they are not too steep. Long, narrow bays carved into the mountains by glaciers create extremely irregular coastlines. Northward, at Prince Willam Sound and Kodiak

Island, the foothills are mixed with coastal lowlands consisting of alluvial fans, uplifted estuaries, morainal deposits, dunes, and river deltas and terraces.

Climate.--Though similar to that of the Pacific Coastal Mountains Province, the climate here is milder due to the region's generally lower elevation. At Sitka, Alaska, average monthly temperatures for January and August are approximately 28F and 50F (2C and 10C), respectively, for an annual temperature range of only 22F (8C). Precipitation, which averages 96 in (2,450 mm) per year, reaches a maximum in autumn.

Vegetation.--A coastal rainforest of Sitka spruce and western hemlock provides the dominant vegetation. In poorly drained areas, a wetland vegetation of sphagnum moss, sedges, and willows fosters peatland development. Alder, cottonwood, and birch are found in low-lying areas and along major river channels.

Soils.--The dominant soils are Spodosols.

Fauna.--A characteristic large mammal is the Sitka black-tailed deer. Other mammals include the brown bear, black bear, wolf, red squirrel, and moose. The mountain goat is common on mainland mountain heights, but not on the islands. Sea otters and Steller's sea lions are common throughout Prince William Sound.

A conspicuous and characteristic bird is the Alaska bald eagle. A small sea bird, the marbled murrelet, nests in the tall trees of old-growth forests. Water birds are well represented, including loons and ducks, and there are many gulls and other shore birds. Common land birds include the red-breasted sapsucker, Pacific-slope flycatcher, and golden-crowned kinglet, and both the red and white-winged crossbills. The entire population of dusky Canada geese nests within this province. Fish are abundant in the waters, including several species of salmon.

260 Mediterranean Division

Situated on the Pacific coast between latitudes 30 and 45 N. is a zone subject to alternate wet and dry seasons, the transition zone between the dry west coast desert and the wet west coast.

The division has a temperate rainy climate with the dry, hot summers. The combination of wet winters with dry summers is unique among climate types and produces a distinctive natural vegetation of hardleaved evergreen trees and shrubs called sclerophyll forest. Various forms of sclerophyll woodland and scrub are also typical. Trees and shrubs must withstand the severe summer drought--2 to 4 rainless months--and severe evaporation.

The vegetation of the Mediterranean Ecoregion is dominated by grassland, shrubland, and forestland habitats. Many shrub (chaparral) and forest/woodland

plant species have thick, hard, evergreen leaves. The number of wildlife species using shrub habitats is limited by the lack of trees in shrublands. However, wildlife species diversity can also be limited in evergreen woodlands due to the paucity of shrubs in these communities, as shrubs are often unable to compete with trees for the limited moisture.

Because of their tough, leathery texture, the leaves of vegetation in chaparral communities are resistant to wilting, and thus provide cover for wildlife even during the frequent droughts typical of the region. Wildlife found in chaparral tend to be species that nest on the ground or in shrubs, such as ground- and shrub-nesting birds and rodents, or that prey upon ground- and shrub-dwelling species, including coyote, striped skunk, and bobcat.

Although this ecoregion supports a diverse vertebrate fauna, including numerous species of reptiles and rodents, only a limited number of species are closely tied to the chaparral. These include the mountain quail, California thrasher, wrentit, brush rabbit, California mouse, and dusky-footed woodrat.

Mountain quail favor slopes covered with chaparral. They feed on acorn mast, fruits, and seeds in the fall, leafy foods during winter, and bulbs in the spring and summer. Thrashers and wrentits find good food and cover in the chaparral, and are more often seen than heard in the dense vegetation. The brush rabbit does not use burrows regularly like most other species of rabbits, perhaps because of the dense chaparral cover. Woodrats construct stick dens that are also used by the California mouse. Since homes are constructed of sticks, woodrats are vulnerable to fires in chaparral communities.

Chaparral communities are adapted to fire, and wildlife respond by retreating to burrows, hiding in rock crevices, or escaping from the area. After a fire, seed-eating birds, such as mourning doves, move into the area to feed on seeds exposed by fire. Mule deer seek out the temporary community of herbaceous plants that develop during the first year or two after the fire. Many of these plants produce bright flowers that attract nectar-feeding insects and birds.

Deciduous and evergreen woodlands provide vegetation structure and complexity that benefits a variety of wildlife species. The habitat often occurs in a mosaic-like pattern of conifer stands intermixed with deciduous tree stands. The shrub and herbaceous strata are often poorly developed in these woodlands. Mature woodlands are important to cavity nesting birds, and oak mast crops are an important food source for birds and mammals, such as scrub and Steller's jays, acorn woodpecker, wild turkey, mountain quail, California ground squirrel, western gray squirrel, black bear, and mule deer (Anderson 1988). Amphibians that reside in the forest detritus layers include Mount Lyell salamander, ensatina, and relictual slender salamander.

Oak woodlands serve as important wildlife habitat, supporting over 300 vertebrate species, many of which are special status species such as the California spotted owl and willow flycatcher. Oak trees provide nesting sites for both canopy- and cavity-nesting birds, and the acorns they produce are an autumn food source relied upon by many bird and mammal species.

Annual and perennial grasslands are found in central and coastal California. Annual grassland habitats consist largely of non-native annuals that have displaced native perennials (Kie 1988). Habitat structure and wildlife abundance are dependent on a mix of plant species at a site. Sites with western brackenfern exhibit a taller, more diverse structure than sites with shorter grasses. Many wildlife species use grassland habitats, but some require special habitat features, such as cliffs, caves, ponds, or shrubby areas for breeding, resting, and escape cover.

Soils of this Mediterranean climate are not susceptible to simple classification. Alfisols and Mollisols typical of semiarid climates are generally found.

California Coastal Chaparral Forest Shrub Province

Land-surface form.--This province includes the discontinuous coastal plains, low mountains, and interior valleys adjacent to the Pacific Ocean from San Francisco to San Diego. Elevations range from sea level to 2,400 ft (730 m).

Climate.--The climate is characterized by hot, dry summers and rainy, mild winters. Annual temperatures average 50 to 65F (10 to 18C). Annual precipitation ranges from 10 to 50 in (260 to 1,280 mm), with a pronounced summer drought. This coastal province has a more moderate climate than the interior and receives some moisture from fog in summer. Fire is common, usually set by lightning during the summer dry season.

Vegetation.--Plant communities are well marked in this province. Several tree species are endemic to the region, including the Monterey cypress, Torrey pine, Monterey pine, and Bishop pine. The coastal plains and larger valleys have sagebrush and grassland communities. A riparian forest containing many broadleaf species grows along streams. On the hills and lower mountains, there is sclerophyll forest consisting of low trees with small, leathery leaves that can withstand the lack of summer precipitation. Live oak or white oak woodland is found here. On steep hill and mountain slopes too dry to support oak woodland or oak forest, much of the vegetation is scrub or "dwarf forest" know as chaparral, which varies in composition with elevation and exposure. It consists of chamise and various manzanitas that are adapted to periodic occurrence of fire. Exposed coastal areas support desertlike shrub communities called coastal scrub, dominated by coyote bush, California sagebrush, and bush lupine. Toward southern California, sages become abundant within coastal scrub communities.

Most of the coastal plains and interior valleys have been converted to urban use or irrigated agriculture. Citrus, grapes, avocados, nuts (such as almonds and walnuts), and deciduous fruits are grown extensively. Irrigated alluvial soils are also highly productive of vegetable crops. Bluegum eucalyptus and other species imported from Australia are abundant along roadsides and much of the coastline as well as farther inland.

Soils.--The soils of this region are mostly Alfisols and Mollisols. They are high in bases and quite fertile when soil water is adequate.

Fauna.--The brushy rabbit is common, as is the opossum, North America's only marsupial. Several species of seals and sea lions live along the California coast, and sea otters often float among kelp, feeding on sea urchins. The blue whale, the world's largest animal species, is found in California's coastal waters.

Coastal California is a major migration route for both water and land birds. From midsummer through winter and spring, thousands of shore birds, ducks, and geese inhabit coastal estuaries, lagoons, and mudflats. Other birds include the lesser goldfinch and golden-crowned sparrow.

California Dry Steppe Province

Land-surface form.--This province lies within the Central Valley of California--a flat alluvial plain between the Sierra Nevada and the Coast Ranges. Elevations range from sea level to 500 ft (150 m). This area has broad, nearly level valleys bordered by sloping alluvial fans, slightly dissected terraces and the lower foothills of the surrounding uplands. Large undrained basins lie in the south.

Climate.--Annual temperatures in this climate average 60 to 67F (16 to 19C), but can fall as low as 55F (13C) in the south. Precipitation is largely limited to winter rainfall, which peaks in December, January, and February. Except near the coast, summers are hot and the winters mild--often foggy, with little or no snow. Annual rainfall ranges from approximately 6 in (150 mm) in the upper San Joaquin Valley to nearly 30 in (760 mm) along the coast. Potential evaporation during the warmest months is often much greater than the precipitation. Low rainfall and small streamflow result in water scarcity in many areas.

Vegetation.--Evidence indicates that the Central Valley of California was once dominated by natural grasses that the plow, fire, and grazing have eliminated except in a few remaining stands. These stands suggest that the dominants were bunch grasses on lands similar in appearance to mixed prairie. Apparently, needlegrass was the principal species except near the coast. Today, introduced annual grasses, including various species of avens, brome, fescue, and barley, occupy most of the remaining grassland areas.

The rivers flow through alkaline flats where greasewood, picklewood, salt grass, and shadscale provide the chief cover. Tule marshes border the lower reaches of the San Joaquin and Sacramento Rivers.

Soils.--The soils of this region are mostly Entisols and Alfisols. The Entisols are usually at the lower elevations and the Alfisols at slightly higher elevations, away from the valley floor. A small area of Aridisols occurs in the more arid southern portions of the San Joaquin Valley.

Fauna.--Intensive agricultural development has changed the fauna of the annual grasslands. Larger species, such as the California grizzly bear, wolf, and pronghorn antelope, have been eliminated or pushed up into the hills. Common mammals include the Beechy ground squirrel, cottontail, blacktail jackrabbit, California mouse, and kangaroo rats. Several subspecies of mule deer live in brushy areas. Other species, such as the coyote and bobcat, live in adjacent woodlands, occasionally entering from them. The San Joaquin kit fox is classified as an endangered species.

Common birds include the mourning dove, horned lark, western meadowlark, western kingbird, mockingbird, loggerhead shrike, house finch, lesser goldfinch, red-shafted flicker, and scrub jay. The roadrunner feeds on reptiles and insects. The California quail is numerous in areas where brush or rock outcrops provide cover. Avian predators include the golden eagle, red-tailed hawk, and Cooper's hawk.

Several species of snakes and lizards are present; rattlesnakes are important predators on rodents.

California Coastal Steppe, Mixed Forest, and Redwood Forest Province

Land-surface form.--Much of this province is composed of low mountains, but in places there is a narrow coastal plain and gently sloping marine terraces. A few broad valleys extend inland through the mountains. Confined to the coast, this region extends no farther inland than 35 mi (56 km), remaining at elevations below 3,000 ft (900 m).

Climate.--Characterized by a cool-summer subtype of the Mediterranean dry-summer subtropical climate, this province is confined to coasts washed by cool currents. The annual temperature cycle is very weak, reflecting the powerful influence of the cold California sea current with its cool marine air layer. Cool summers are typical, and winter temperatures are much milder than those of inland locations at similar latitudes. Annual temperatures average 50 to 55F (10 to 13C). All months are above freezing. Rainfall drops to nearly zero for 2 consecutive summer months, but rises to substantial amounts in the rainy winter season. Annual rainfall ranges from 40 to 100 in (1,020 to 2,550 mm). Heavy fogs are common along the coast in summer. This region has a greater mean number of days with dense fogs than any other place in the United States.

Vegetation.--The redwood is characteristic of the fog belt on seaward slopes of coastal northwestern California. Associated with it are Douglas-fir and other conifers such as hemlock and cedar. The redwood forest is a hygrophyllic type of warm-temperate forest. Redwoods, which attain a height of 330 ft (100 m), are taller than the giant sequoia (big tree), which grows only in the Sierra Nevada of California. But redwood trunks remain relatively slender. Although redwoods live 500 years on average, they can reach up to 1,800 years of age. By comparison, 4,000 annual rings have been counted in the trunks of giant sequoia.

Redwood forests typically have a well-developed understory, usually dominated by large and colorful Pacific rhododendrons and western azaleas. Other shrubs, especially salal and California huckleberry, are usually present. Many ferns and flowers grow in the cool shade, such as western sword fern and redwood sorrel.

Headlands tend to be dry, and their outer ends are covered with fescue-oatgrass grasslands. Along the coast in a narrow, patchy belt lies pine-cypress forest. Inland, the southfacing mountain slopes are covered by mixed forest, including tanoak, coast live oak, madrone, and Douglas-fir. Oaks in the area of coastal forest tend to form distinct patches of oak woodland.

Soils.--The dominant soils are Ultisols under forest and Mollisols under grasslands.

Fauna.--Mule deer are common, and the Roosevelt subspecies of elk can be seen in Redwood National Park. Mammals include both Douglas and western gray squirrels, as well as two chipmunk species.

Birds include Anna's hummingbird and Wilson's warbler. The spotted owl can be found in both old-growth and second-growth redwood forest, along with great horned owls, western screech-owls, and northern pygmy-owls. A variety of shore birds and waterfowl occur in the coastal part of the province. Species of concern include marbled murrelet and northern spotted owl.

Salamanders, such as the Pacific giant salamander, are numerous in the cool, moist litter of the redwoods, especially near streams and rivers. The banana slug is also found here. Streams and rivers are used by anadromous fish.

Sierran Steppe--Mixed Forest--Coniferous Forest--Alpine Meadow Province

Land-surface form.--This province covers the southernmost portion of the Cascade Mountains, the northern Coast Range, the Klamath Mountains, and the Sierra Nevada. Most of the area is covered with steeply sloping to precipitous mountains crossed by many valleys with steep gradients. The long west slope of the Sierra Nevada rises gradually from 2,000 ft (600 m) to more than 14,000 ft

(4,300 m); the east slope drops abruptly to the floor of the Great Basin, about 4,000 ft (1,200 m). Much of this region has been glaciated.

Climate.--Temperatures average 35 to 52F (2 to 11C), but fall with rising elevation. The base of the west slope receives only about 10 to 15 in (250 to 380 mm) of rainfall per year and has a long, unbroken dry summer season. At higher elevations, the dry summer season shortens and precipitation rises to as much as 70 in (1,790 mm), with a larger portion falling as snow. Prevailing west winds influence climatic conditions for the whole region. East slopes are much drier than west slopes (see Appendix 2, climate diagram for Tahoe, California). Winter precipitation makes up 80 to 85 percent of the total; at high elevations, it is mostly snow. The greatest total precipitation reported is on slopes between 3,000 and 7,000 ft (900 and 2,100 m), which support the luxuriant mixed conifer forests of the montane zone. The subalpine zone coincides with the altitude of greatest snowfall, where precipitation is 40 to 50 in (1,020 to 1,280 mm) per year.

Vegetation.--Vegetation zones are exceptionally well marked. The lower slopes and foothills, from about 1,500 to 4,000 ft (460 to 1,200 m), are covered by coniferous and shrub associations. On higher slopes, digger pine and blue oak dominate, forming typical open or woodland stands. Most of the low hills are covered by close-growing evergreen scrub, or chaparral, in which buckbrush and manzanita predominate. Several oaks are common associates.

The montane zone lies between about 2,000 and 6,000 ft (600 and 1,800 m) in the Cascades, 4,000 and 7,000 ft (1,200 and 2,100 m) in the Central Sierras, and 5,000 and 8,000 ft (1,500 and 2,400 m) or more in the south. The most important trees are ponderosa pine, Jeffrey pine, Douglas-fir, sugar pine, white fir, red fir, and incense cedar; but several other conifers are also present. The giant sequoia (big tree) is one of the most spectacular species, but it grows only in a few groves on the western slope. Dense chaparral communities of manzanita, buckbrush, and buckthorn may appear after fire, sometimes persisting for years. Within the Sierran rain shadow, on the dry eastern slopes, Jeffrey pine replaces ponderosa pine. At lower elevations, pine forests are replaced by sagebrush-pinyon forest, part of the Intermountain Desert Province.

The subalpine zone begins at from 6,500 ft to 9,500 ft (1,980 m to 2,900 m), depending on latitude and exposure, and extends upslope about 1,000 ft (300 m). Mountain hemlock, California red fir, lodgepole pine, western white pine, and whitebark pine are important. Conditions are severe, and timberline varies from about 7,000 ft (2,100 m) in the north to 10,000 ft (3,000 m) in the south. Lodgepole pine is said to have climax characteristics near the upper limits of this zone. The alpine zone covers the treeless areas above timberline.

Soils.--Ultisols are extensive on mountain slopes where air is humid; dry Alfisols predominate at lower elevations. Entisols occupy the narrow floodplains and alluvial fans of the valleys.

Fauna.--Common large mammals include mule deer, mountain lion, coyote, and black bear. Smaller mammals include golden-mantled squirrel, bushytail wood rat, flying squirrel, red fox, fisher, yellow-haired porcupine, long-eared chipmunk, and Trowbridge's shrew.

Common birds are mountain quail, Cassin's finch, Hammond's flycatcher, Lincoln's sparrow, Audubon's warbler, pine siskin, Oregon junco, blue goose, Williamson's sapsucker, and mountain chickadee. Birds of prey include the western screech-owl, Cooper's hawk, northern pygmy-owl, and great gray owl. The California mountain kingsnake also lives here. The bark beetles Ips emarginatus and I. integer infest ponderosa and lodgepole pine.

California Coastal Range Open Woodland--Shrub--Coniferous Forest--Meadow Province

Land-surface form.--This province occupies the central part of the California Coast Ranges and the mountains of southern California. The Coast Ranges are gently to steeply sloping low mountains underlain by shale, sandstone, and igneous and volcanic rocks. Elevations range from 500 to 2,500 ft (150 to 800 m); some peaks rise to 5,000 ft (1,500 m). Stream valleys are narrow and widely spaced. The mountains of southern California are steeply sloping to precipitous; high mountains have unstable slopes and sharp crests; valleys are narrow. Elevations range from 2,000 to 8,000 ft (600 to 2,400 m); some peaks reach 12,000 ft (3,700 m).

Climate.--The climate is characterized by hot, dry summers and rainy, mild winters. Temperatures average 53 to 65F (12 to 18C) in the Coast Range, but are only 32 to 60F (0 to 16C) in the mountains of southern California, always falling with rising elevation. Precipitation, which ranges from 12 to 40 in (310 to 1,020 mm) per year, is evenly distributed through fall, winter, and spring, and increases with elevation. Most of this is rain; the little snow that falls in winter melts quickly. Frost and short periods of freezing weather occur occasionally in winter. Coastal areas have a more moderate climate than the interior and receive some moisture from fog in summer.

Vegetation.--The montane vegetation of this region consists of species with thick, hard evergreen leaves. One climax association, dominated by trees, is called sclerophyll forest. The other, called chaparral, is a shrub climax. These two associations appear in alternating patches in almost every part of the region, but chaparral occupies the greater area. The forest consistently appears on northfacing slopes and on wetter sites; chaparral occupies southfacing slopes and drier sites.

The most important evergreen trees of the sclerophyll forest are California live oak, canyon live oak, interior live oak, tanoak, California laurel, Pacific madrone, golden chinkapin, and Pacific bayberry. Several deciduous trees, shrubs, and herb associates are also characteristic.

The chaparral community of fire-adapted shrubs extends over a wide area with a diversity of habitats. It includes at least 40 species of evergreen shrubs with varying degrees of dominance and importance. Some are so dense that they practically eliminate understory vegetation; other types support a highly productive understory. The most important species are chamise and manzanita. Other common species are Christmasberry, California scrub oak, mountain mahogany, and many species of ceanothus. At higher elevations and near the ocean, chaparral is often interspersed with, or alternates with, coniferous forests.

The interior valleys have sagebrush and grassland communities. A riparian forest with many broadleaf species grows along streams.

Soils.--The pattern of Alfisols, Entisols, and Mollisols in this region is complex. Mollisols are usually found along the coast; Alfisols occur in the north; and the south consists mostly of Entisols.

Fauna.--Mule deer are the most important large mammals. Other large mammals include the coyote, mountain lion, California bobcat, gray fox, wood rat, and spotted and striped skunks. Small mammals peculiar to chaparral include the Merriam chipmunk, California mouse, and five-toed kangaroo rat.

The most common birds seen in the dry summer season are wrentit, common bushtit, and rufous-sided towhee. In October, white-and-golden-crowned sparrows, several races of fox sparrows, hermit thrushes, ruby-crowned kinglets, and Audubon's warblers are present. The California condor is classified as an endangered species.

Reptiles, including the coast horned lizard and gopher snake, are numerous in all vegetation types. Amphibians appear to be scarce, except for the Pacific treefrog.

DRY DOMAIN

Tropical/ Subtropical Steppe Division

Tropical steppes border the tropical deserts on both the north and south, and in places on the east as well. Locally because of altitude, plateaus and high plains within what would otherwise be desert have a semiarid steppe climate. Steppes on the poleward fringes of the tropical deserts grade into the Mediterranean climate in many places. In the United States, they are cut off from the

Mediterranean climate by coastal mountains that allow tropical deserts to extend farther north.

The division has a hot semiarid climate where potential evaporation exceeds precipitation, and where all months have temperatures above 32F (0C--see Appendix 2, climate diagram for Abilene, Texas).

Steppes typically are grasslands of short grasses and other herbs, and with locally developed shrub- and woodland. On the Colorado Plateau, for example, there is pinyon-juniper woodland. To the east, in Texas, the grasslands grade into savanna woodland or semideserts composed of xerophytic shrubs and trees, and the climate becomes semiarid-subtropical. Cactus plants are present in some places. These areas are able to support limited grazing, but are not generally moist enough for crop cultivation without irrigation. Soils are commonly Mollisols and Aridisols, containing some humus.

The Temperate Steppe Ecoregion is comprised of prairie grasslands, evergreen and deciduous forests, and sagebrush and chaparral shrublands. Prairie grasslands occur in an environment with irregularities in weather patterns, including wet and dry spells, which occur often enough to impose severe stresses on wildlife. Drought years can cause rapid declines in some species, especially birds, as the abundance and quality of vegetation is markedly decreased.

Many grassland species live in burrows, including burrowing owls, prairie dogs, ground squirrels, pocket gophers, black-footed ferrets, and American badgers. Burrows provide a more stable microclimate during hot summers and cold winters, and shelter from predators and grassland fires. Animals that do not utilize burrows have adapted to speed in order to escape predators, including the swift fox and pronghorn. Even quail and grouse often run instead of flying to escape predation, staying close to the ground and using the vegetation as cover.

Grassland animals tend to occur in large social groups and tend to be more social than their forestland counterparts. Prairie dogs live in large, highly organized social units, while their eastern woodland counterpart, the woodchuck, rarely interacts with its own species. Flocking species are also more prevalent in grasslands than in forestlands. Socialization enables the members of a flock to more readily detect predators, but also to convey other information, such as mating status, which is difficult to ascertain in open grassland where sound is muffled and perches are few. Raptors are also more common in grasslands than other habitats, as open spaces favor animals with good vision and provide an abundance of prey items.

Compared with other habitats, grasslands tend to have low bird species diversity and abundance as they are structurally simple and less complex than other habitat types, and thus provide birds with few niches to exploit. Bird

species tend to differentiate themselves based on the cover and height of the grassland vegetation, with the horned lark and burrowing owl selecting areas with low, scattered vegetation, and the savanna sparrow and bobolink selecting high, dense herbaceous cover.

Deer, elk, and pronghorn are found in the intermountain grasslands, which can not support Temperate Steppe species that require a supply of green grass year-round. Ground squirrel diversity is especially high in the intermountain grasslands, with 19 of the 22 species of ground squirrels in North America found in this region.

Evergreen and deciduous forests are found at higher elevations and along streams and other aquatic areas. Aspen is an important component of these forests. American beaver use aspen limbs and foliage for food and to build dams and lodges. Snowshoe hare feed on aspen twigs and bark during winter, and aspen buds are important in the winter diet of ruffed grouse. American badger, ground squirrels, and other burrowing animals are common in this habitat.

Colorado Plateau Semidesert Province

Land-surface form.--The Colorado Plateau Province consists of tablelands with moderate to considerable relief in Arizona, New Mexico, and Utah. Elevations of the plateau tops range from 5,000 to 7,000 ft (1,500 to 2,100 m), with local relief ranging from 500 to more than 3,000 ft (150 to 900 m) in some of the deeper canyons that dissect the plateaus (such as the Grand Canyon of the Colorado River). In some areas, volcanic mountains rise 1,000 to 3,000 ft (300 to 900 m) above the plateau surface. Stream valleys are narrow and widely spaced. The Colorado River, which crosses the northern part of the province, is the region's only large stream. Many other streams flow year-round, but the volume of water fluctuates considerably.

Climate.--Due to the region's generally high altitude, the climate is characterized by cold winters. Summer days are usually hot, but nights are cool; accordingly, the diurnal variation in temperature is considerable. Annual average temperatures are 40 to 55F (4 to 13C), decreasing with rising elevation. Average annual precipitation is about 20 in (510 mm), except on the higher mountains; some parts of the province receive less than 10 in (260 mm). Summer rains are thunderstorms, with ordinary rains arriving in winter. Thus, this province differs from the Intermountain Semidesert Province, which generally lacks summer rains.

Vegetation.--Vegetational zones are conspicuous but lack uniformity. In the lowest zone, there are arid grasslands, but the shortgrass sod seldom covers the ground completely, leaving many bare areas. Xeric shrubs often grow in open stands among the grasses, and sagebrush is dominant over extensive areas. A profusion of annuals and perennials blooms during the summer rainy season. At low elevations in the south, several kinds of cactus and yucca are common.

Cottonwoods and, more rarely, other trees grow along some of the permanent streams.

The woodland zone is the most extensive, dominated by open stands of two-needle pinyon pine and several species of juniper, often termed a pygmy forest. Between the trees the ground is sparsely covered by grama, other grasses, herbs, and various shrubs, such as big sagebrush and alderleaf cercocarpus.

The montane zone extends over considerable areas on the high plateaus and mountains, but it is much smaller in area than the pinyon-juniper zone. Vegetation in the montane zone varies considerably from area to area. In the south, especially in Arizona, ponderosa pine is the dominant forest tree. Douglas-fir is associated with ponderosa pine or else grows in more sheltered locations or at higher elevations. In Utah, by contrast, lodgepole pine and aspen are dominant.

The subalpine zone is characterized by abundance of Engelmann spruce and subalpine fir. On San Francisco Mountain in northern Arizona, the spruce is often associated with bristlecone pine. Because only a few isolated mountains rise above timberline, the alpine zone is not extensive.

South of the Mogollon Rim in Arizona, toward the American Desert, lies a foothill forest. The principal trees are Mexican pinyon, alligator juniper, and various species of oak. Forests of ponderosa pine and common Douglas-fir carpet moist canyons and northfacing slopes. Pointleaf manzanita is a common evergreen shrub.

Soils.--Entisols occur along the floodplains of major streams. Aridisols cover plateau tops, older terraces, and alluvial fans. Badlands of rough broken land are extensive in the mountains and on plateaus.

Fauna.--Major mammals are the mule deer, mountain lion, coyote, and bobcat; elk are locally important. Pronghorn antelope are the primary large mammal in the arid grasslands. Smaller species include the blacktail jackrabbit, Colorado chipmunk, rock squirrel, wood rat, white-footed mouse, cliff chipmunk, cottontail, porcupine, and gray fox. The ringtail cat and spotted skunk occur rarely.

The most abundant resident birds are the bushtit, pinyon jay, plain titmouse, black-chinned hummingbird, Woodhouse's jay, red-tailed hawk, golden eagle, red-shafted flicker, and rock wren. Summer residents include the chipping sparrow, nighthawk, black-throated gray warbler, northern cliff swallow, lark sparrow, and mourning dove. Common winter residents are the pink-sided junco, Shufeldt's junco, gray-headed junco, red-backed junco, Rocky Mountain nuthatch, mountain bluebird, robin, and Steller's jay. Turkeys are locally

abundant during winter. Reptiles include the horned lizard, collared lizard, and rattlesnake.

Southwest Plateau and Plains Dry Steppe and Shrub Province

Land-surface form.--This is a region of flat to rolling plains and plateaus occasionally dissected by canyons at the western end of the Gulf Coastal Plain and the southern end of the Great Plains. The Stake Plains of Texas are included in this province. Elevations range from sea level to 3,600 ft (1,100 m) on the Edwards Plateau and to 6,500 ft (1,980 m) near the Rocky Mountain Piedmont. A mesa-and-butte landscape is characteristic of certain parts.

Climate.--The climate is semiarid. Summers are long and hot, and winters are short and mild. Annual temperatures average 60 to 70F (16 to 21C). The frost-free season ranges from about 130 to considerably more than 300 days. Precipitation, which falls mostly during the growing season, is about 30 in (770 mm) in the eastern part of the province and decreases to 10 to 15 in (255 to 380 mm) in the western part. Annual evaporation is 71 to 79 in (1,800 to 2,000 mm). From May to October, potential evaporation is about twice the precipitation.

Vegetation.--This province is characterized by arid grasslands in which shrubs and low trees grow singly or in bunches. On the plains of northwestern Texas and eastern New Mexico, xerophytic grasses (blue grama and buffalo grass) are the characteristic vegetation. However, in much of this area, mesquite (Prosopis) grows in open stands among the grasses. On the Edwards Plateau, oak and juniper are often mixed with grasses and mesquite, and on steep rocky slopes these trees may form closed stands. Due to low rainfall, they rarely grow higher than 20 ft (6.1 m). The most characteristic tree is Ashe juniper. Over much of the Plateau, the characteristic vegetation is grass, especially prairie three-awn (needlegrass); trees and shrubs are present only in very open stands. On slopes leading down to the Rio Grande, the ceniza shrub dominates. Live oak forest is found along the Gulf Coast. A unique semiarid forest consisting of small trees and shrubs with Mexican affinities occupies the Rio Grande delta. The endangered sabal palm is native here.

Soils.--Soils in this region are varied, but the different orders are well correlated with the different plant communities. The mesquite-live oak savanna, for example, is the only Entisol area in the region. Soils of the mesquite-buffalograss and juniper-oak savannas are almost entirely Mollisols; an island of Alfisols within the area corresponds to the boundaries of the mesquite-oak savanna. In the mesquite-acacia savanna, Mollisols, Alfisols, and Vertisols occur. On sandy soils in the Staked Plains of Texas, a thick growth of low shin oak practically excludes every other type of plant.

Fauna.--The northern limit of distribution of several mammals coincides generally with the northern boundary of this province. The Mexican ground

squirrel and gray fox live to the south of this boundary, but not to the north. Whitetail deer are abundant, and armadillo are present. The fox squirrel is hunted in wooded areas along streams. Chief furbearers are the ringtail and raccoon. The Edwards Plateau contains several scattered limestone caverns that support huge populations of Mexican freetail bats.

The threatened golden-cheeked warbler and black-capped vireo inhabit northwestern areas where the Ashe juniper is present. Wild turkey, mourning dove, scaled quail, and bobwhite are common game birds, and several species of hawks and owls are present.

Arizona-New Mexico Mountains Semidesert--Open Woodland--Coniferous Forest--Alpine Meadow Province

Land-surface form.--This area consists mostly of steep foothills and mountains, but includes some deeply dissected high plateaus. Elevations range from 4,500 to 10,000 ft (1,370 to 3,000 m), with some mountain peaks reaching as high as 12,600 ft (3,840 m). In many areas, the relief is higher than 3,000 ft (900 m). Isolated volcanic peaks rise to considerable heights in the northwest.

Climate.--Climate varies considerably with altitude. Average annual temperature is about 55F (13C) in the lower foothills and 40F (4C) on the upper mountain slopes. Average annual precipitation ranges from 10 to 35 in (260 to 890 mm), increasing with rising elevation. During late spring, there is a moisture deficit until the arrival of summer rains, which appear as thunderstorms. Rains also come in early autumn and winter. In the mountains, most precipitation is snow.

Vegetation.--Vegetational zones resemble those of the Rocky Mountains (described below), but occur at higher elevations. The foothill zone, which reaches as high as 7,000 ft (2,100 m), is characterized by mixed grasses, chaparral brush, oak-juniper woodland, and pinyon-juniper woodland. At about 7,000 ft (2,100 m), open forests of ponderosa pine are found, although pinyon and juniper occupy southfacing slopes. In Arizona, the pine forests of this zone are strongly infused with Mexican species, including Chihuahuan and Apache pine. Pine forest is replaced at about 8,000 ft (2,400 m) on northfacing slopes (a little higher elsewhere) by Douglas-fir. Aspen is common in this zone, and limber pine grows in places that are rockier and drier.

At about 9,000 ft (2,700 m), the Douglas-fir zone merges into a zone of Engelmann spruce and corkbark fir. Limber pines and bristlecone pines grow in the rockier places. An alpine belt covers relatively small areas above 11,000 ft (3,400 m).

Soils.--Detailed information about orders of soils is lacking for much of this area. The Four Corners region is composed mostly of Entisols. Alfisols and

Inceptisols dominate upland areas. Stony land and rock outcrops occupy large areas on the mountains and in the foothills.

Fauna.--The most common large mammal is the mule deer. Mammalian predators include mountain lions, coyotes, and bobcats. Small mammals are the deer mouse, longtail weasel, porcupine, golden-mantled ground squirrel, Colorado chipmunk, red squirrel, wood rat, pocket gopher, longtail vole, Kaibab (Abert) squirrel, and cottontail.

Some of the more common birds are the northern pygmy-owl, olive warbler, red-faced warbler, hepatic tanager, mountain bluebird, pygmy nuthatch, white-breasted nuthatch, Mexican junco, Steller's jay, red-shafted flicker and the Rocky Mountain sapsucker. Goshawks and red-tailed hawks are present. The only widely found reptile is the short-horned lizard.

Tropical/ Subtropical Desert Division

South of the Arizona-New Mexico Mountains are the continental desert climates, which have not only extreme aridity, but also extremely high air and soil temperatures. Direct sun radiation is very strong, as is outgoing radiation at night, causing extreme variations between day and night temperatures and a rare nocturnal frost. Annual precipitation is less than 8 in (200 mm), and less than 4 in (100 mm) in extreme deserts (see Appendix 2, climate diagram for Brawley, California). These areas have climates that Trewartha (1968) calls BWh.

The region is characterized by dry-desert vegetation, a class of xerophytic plants that are widely dispersed and provide negligible ground cover. In dry periods, visible vegetation is limited to small hard-leaved or spiny shrubs, cacti, or hard grasses. Many species of small annuals may be present, but they appear only after the rare but heavy rains have saturated the soil.

In the Mojave-Sonoran Deserts (American Desert), plants are often so large that some places have a near-woodland appearance. Well known are the treelike saguaro cactus, the prickly pear cactus, the ocotillo, creosote bush, and smoke tree. But much of the desert of the Southwestern United States is in fact scrub, thorn scrub, savanna, or steppe grassland. Parts of this region have no visible plants; they are made up of shifting sand dunes or almost sterile salt flats.

The Subtropical Desert Ecoregion is composed of the Mohave, Sonoran, and Chihuahuan deserts. In contrast to the cooler deserts of the Temperate Desert Ecoregion, the hotter deserts of the Subtropical Desert Ecoregion tend to have a more diverse flora and fauna. The northern limits of many species common in Mexico are found in this ecoregion, such as brown-crested flycatcher, vermilion flycatcher, black-tailed gnatcatcher, hooded skunk, pocketed free-tail bat, coatimundi, and jaguar. The Sonoran Desert is the most floristically diverse of the three deserts, and as a result, has the greatest diversity of wildlife. The

desert tortoise, which is federally listed as a threatened species (in the Mojave Desert only), is found in this ecoregion. Long-lived and once common, desert tortoises have suffered population declines due to adverse impacts associated with human activities. The Sonoran pronghorn is classed as an endangered species; few of these animals are left in southern Arizona. The mashed bobwhite quail is also an endangered species. Large ungulates are mostly absent from this ecoregion. Pronghorn antelope and mule deer are the most widely distributed large game animals.

Wildlife species in the Subtropical Desert have evolved numerous means to deal with water scarcity and other rigors of the hot desert. Presence of standing water in winter and new herbaceous growth in spring provide water and forage for most wildlife. During summer and fall, some species, such as the desert kangaroo rat and other rodents, derive water from the seeds in their diet. However, collared peccaries and many desert rodents can avoid or digest cactus spines and obtain water from the plants' succulent tissues.

Black-throated sparrows secrete highly-concentrated urine and dry feces, and thus need little drinking water. In contrast, most other desert-living bird species show few adaptations for coping with water scarcity and simply fly to water sources to meet their needs. Reptiles and small mammals are active mostly at night and retreat to cool burrows, or seek shelter under vegetation or in rock outcrops to avoid the midday sun and reduce water loss.

Salt balance is an important physiological function in desert animals. Chuckwallas are able to excrete salt from their nostrils by sneezing, without losing much water. Many other lizard species, including Desert Iguanas, also have salt glands for excreting salt.

The structure of live vegetation is probably the most important habitat feature in these deserts. Cacti provide breeding and housing habitats for bats and birds, including elf owl, cactus wren, Gila woodpecker and gilded flicker. Lizards use cacti and shrubs for feeding and breeding and climb creosotebush to escape hot ground temperatures during the day. Small mammals such as the blacktailed jackrabbit, desert cottontail, kangaroo rat, wood rat, toads and reptiles utilize the root systems of the creosote bush and other shrubs as protection for burrow openings and to hide from predators such as coyote, bobcat, golden eagle, great horned owl, red-tailed hawk, and ferruginous hawk.

A dominant pedogenic process is salinization, which produces areas of salt crust where only salt-loving (halophytic) plants can survive. Calcification is conspicuous on well-drained uplands, where encrustations and deposits of calcium carbonate (caliche) are common. Humus is lacking and soils are mostly Aridisols and dry Entisols.

Chihuahuan Desert Province

Land-surface form.--This province is mostly desert. Practically the only permanent streams are a few large rivers that originate in humid provinces. The Rio Grande and the Pecos Rivers and a few of their larger tributaries are the only perennial streams. The area has undulating plains with elevations near 4,000 ft (1,200 m), from which somewhat isolated mountains rise 2,000 to 5,000 ft (600 to 1,500 m). Washes, dry most of the year, fill with water following rains. Basins with no outlets drain into shallow playa lakes that dry up during rainless periods. Small whirlwinds constantly play over these dry playas when they are heated by summer sun. Extensive dunes of silica sand cover parts of the province. In a few places there are dunes of gypsum sand, the most notable being the White Sands near Alamogordo in southern New Mexico. In scattered areas, small beds and isolated buttes of blackish lava occur.

Climate.--Summers are long and hot. Winters are short, but may include brief periods when temperatures fall below freezing. Average annual temperatures range from 50 to 65F (10 to 18C). The climate is distinctly arid; spring and early summer are extremely dry. Mean annual precipitation at El Paso, Texas, is 8.65 in (221 mm). In July, summer rains usually begin, torrential storms that are mostly local and continue through October. The northern part of the province also receives winter rains, which are more gentle and widespread.

Vegetation.--A number of shrubs, most of them thorny, are typical of the Chihuahuan Desert. They frequently grow in open stands, but sometimes form low, closed thickets. In many places, they are associated with short grass, such as grama. Extensive arid grasslands cover most of the high plains of the province. On deep soils, honey mesquite is often the dominant plant. Cacti are also abundant, particularly prickly pears, but they are smaller in size and fewer in number of species than in the Sonoran Desert. The desert is characterized by yuccas, so much so that one has been adopted as the state flower of New Mexico. A few cottonwoods and other trees grow beside the widely separated rivers. Creosote bush, which covers great areas in characteristic open stands, is especially common on gravel fans. Though creosote bush is the most abundant plant cover of the province, other species like lechuguilla are also abundant. Another distinctive plant is candelilla, or wax plant. On rocky slopes, the ocotillo is conspicuous. Juniper and pinyons, limited to rocky outcrops, are prominent around the Stockton Plateau in western Texas.

Some isolated mountains in the Chihuahuan Province rise high enough to carry a belt of oak and juniper woodland. On a few of the highest mountains, there are pines among the oaks, in some places forming nearly pure stands. Douglas-fir and white fir occupy a few sheltered upper slopes in the Santa Catalina Mountains.

Soils.--In the western and northern portions of this province, the soils are primarily Aridisols. Both Aridisols and Entisols are present in the south.

Fauna.--Pronghorn antelope and mule deer are the most widely distributed large game animals. Whitetail deer inhabit parts of Texas. The collared peccary or javelina is common in the southern part of the region. The blacktail jackrabbit, desert cottontail, kangaroo rat, wood rat, and numerous smaller rodents compete with domestic and wild herbivores for available forage. Mammalian predators include the coyote and bobcat.

The black-throated sparrow is one of the most abundant birds of the province. Greater roadrunner, curve-billed thrasher, and Chihuahuan raven are also common. Scaled quail and Gambel's quail occupy most of the area, and bobwhite populations reach into its eastern portion. Raptors include the golden eagle, great horned owl, red-tailed hawk, ferruginous hawk, and the rare zone-tailed hawk.

The many reptiles include the common chuckwalla, Texas horned lizard, desert spiny lizard, and various species of rattlesnakes.

American Semidesert and Desert Province

Land-surface form.--The American Desert includes the Mojave, Colorado, and Sonoran Deserts. Its topography is characterized by extensive plains, most gently undulating, from which isolated low mountains and buttes rise abruptly. Elevations range from 280 ft (85 m) below sea level to 4,000 ft (1,200 m) in valleys and basins, with some mountain ranges reaching as high as 11,000 ft (3,400 m). The mountains are rocky and rise abruptly from their outwash aprons and alluvial faces. There are areas of interior drainage, such as the Salton Trough, but a large part of the province drains to the sea through underground seepage or through washes that are dry most of the year. The Colorado River, which crosses the eastern part of the province, is the only sizable stream.

Climate.--Summers are long and hot; the highest temperature ever measured in the United States was 134F (57C) in 1913 at Death Valley. The average annual temperature is 60 to 75F (15 to 24C). Though winters are moderate, the entire province is subject to occasional frosts. In winter the rains are widespread and usually gentle, but in summer they are usually thunderstorms. In the Colorado and Mojave Deserts of southeastern California, there are virtually no summer rains. No part of the province has regular rains, and a year or more may pass without measurable rainfall, especially in the region's western part. Average annual precipitation is 2 to 10 in (50 to 250 mm) in the valleys, but may reach 25 in (610 mm) on mountain slopes. The evaporation rate in summer is very high.

Vegetation.--Vegetation is usually very sparse, with bare ground between individual plants. Cacti and thorny shrubs are conspicuous, but many thornless shrubs and herbs are also present. On the Sonoran Desert plains, the most widely distributed plant is the creosote bush, which covers extensive areas in nearly pure stands. On some parts of the plains the arborescent cacti (cholla)

are also common. Mesquite is less widespread and grows only along washes and watercourses.

At the base of the mountains, on the gentle rocky slopes called bajadas, the vegetation is dominated by paloverde, ocotillo, and saguaro, but bitterbrush is also a common shrub. Vegetation below 3,000 ft (900 m) in the Mojave Desert is mostly creosote bush and various Atriplex (saltbush) species. The desert mountains are exceptionally barren, and many are almost devoid of vegetation.

Along the higher northern edge of the province is a belt where the Joshua tree is prominent. At a still higher level is a belt of junipers and pinyons.

Interior basins characterized by ephemeral shallow playa lakes are a conspicuous feature of the Mojave Desert. Soils near these playas contain alkali in quantities varying with distance from the lake, resulting in a zonation of several species of vegetation according to their tolerance for salts.

Soils.--Gravel or bare rock covers the ground near the bases of some mountains, and much bare rock is exposed on the mountains because the heavy, violent desert rainstorms allow little soil to accumulate on the steep slopes. Entisols occur on the older alluvial fans and terraces and in the better-drained basins. Aridisols dominate throughout the rest of the province.

Fauna.--Large ungulates are almost absent from the desert. Desert mule deer and peccary live chiefly in the paloverde-cactus shrub community. The Sonoran pronghorn antelope is classified as an endangered species; few are left in southern Arizona. Carnivores, including the desert kit fox and coyote, are small and usually nocturnal. The western spotted skunk is common. Nocturnal burrowers, particularly kangaroo rats and pocket mice, dominate. Merriam kangaroo rat is closely associated with creosote bush. Other important species are the longtail pocket mouse and antelope ground squirrel.

Many desert birds are very selective in their type of habitat. Greasewood may furnish a permanent residence for the loggerhead shrike. Areas where tall cacti are plentiful furnish homes for many birds, including the Gila woodpecker, elf owl, and purple marten. Gambel's quail, the cactus wren, and the roadrunner are common in the southern part of the region. The masked bobwhite quail is an endangered species that has been reintroduced.

Reptiles include numerous species of snakes and lizards, such as the Gila monster, the only poisonous lizard in the United States. The desert tortoise is becoming increasingly rare and is everywhere protected.

Endemic species, common in the Mojave Desert, include five species of desert pupfish living in highly saline lakes in Death Valley.

Temperate Steppe Division

Temperate steppes are areas with a semiarid continental climatic regime in which, despite maximum summer rainfall, evaporation usually exceeds precipitation. There is a cool climate with at least one month of average temperatures below 32F (0C). Winters are cold and dry, summers warm to hot. The vegetation is steppe, sometimes called shortgrass prairie, and semidesert. Typical steppe vegetation consists of numerous species of short grasses that usually grow in sparsely distributed bunches. Scattered shrubs and low trees sometimes grow in the steppe; all gradations of cover are present, from semidesert to woodland. Because ground cover is generally sparse, much soil is exposed. Many species of grasses and other herbs occur. Buffalo grass is typical of the American steppe; other typical plants are the sunflower and locoweed.

The semidesert cover is a xerophytic shrub vegetation accompanied by a poorly developed herbaceous layer. Trees are generally absent. An example of semidesert cover is the sagebrush vegetation of the middle and southern Rocky Mountain region and the Colorado Plateau.

In this climatic regime, the dominant pedogenic process is calcification, with salinization on poorly drained sites. Soils contain a large excess of precipitated calcium carbonate and are very rich in bases. Mollisols are typical in steppe lands. The soils of the semidesert shrub are Aridisols with little organic content, pedogenic and (occasionally) clay horizons, and (in some places) accumulations of various salts. Humus content is small because the vegetation is so sparse.

Great Plains- Palouse Dry Steppe Province

Land-surface form.--This region is characterized by rolling plains and tablelands of moderate relief in a broad belt that slopes gradually eastward from an altitude of 5,500 ft (1,520 m) near the foot of the Rocky Mountains to 2,500 ft (760 m) in the Central States. The plains are notably flat, but there are occasional valleys, canyons, and buttes. In the northern section, badlands and isolated mountains break the continuity of the plains. The Palouse region occupies a series of loess-covered basalt tablelands with moderate to high relief, ranging in altitude from 1,200 to 6,000 ft (370 to 1,800 m).

Climate.--This region lies in the rain shadow east of the Cascade Range and the Rocky Mountains. The climate of the Great Plains grasslands is a semiarid continental regime. The average annual temperature is 45F (7C) throughout most of the region, but can reach as high as 60F (16C) in the south. Winters are cold and dry, and summers are warm to hot. The frost-free season ranges from fewer than 100 days in the north to more than 200 days in Oklahoma. Precipitation ranges from 10 in (260 mm) in the north to more than 25 in (640 mm) in the south, with maximum rainfall in summer. Evaporation usually exceeds precipitation, and the total supply of moisture is low. When precipitation does occur, it is often in the form of hail or blizzards, and tornadoes and dust storms are frequent.

The climate of the Palouse grassland east of the Cascades is similar to that of the Great Plains grasslands east of the Rockies, except for the timing of precipitation: on the Palouse dry steppe, there is a winter maximum.

Vegetation.--Steppe, sometimes called shortgrass prairie, is a formation class of short grasses usually bunched and sparsely distributed. The steppe in this province is dry, with 6-7 arid months per year. The Great Plains grasslands east of the Rockies have scattered trees and shrubs, such as sagebrush and rabbitbrush, and support all gradations of cover, from semidesert to woodland. Because ground cover is scarce, much soil is exposed.

Many species of grasses and herbs grow in this province. A typical grass is buffalo grass; sunflower and locoweed are typical plants. Other grasses include grama, wheatgrass, and needlegrass. Many wildflower species bloom in spring and summer. The blazingstar and white prickly poppy are usually abundant. The alien Russian-thistle, also know as tumbleweed, is sometimes abundant.

Except for the presence of shrubs, the Palouse grassland resembles the Great Plains shortgrass prairie. The dominant species, however, are distinctive. They include bluebunch wheatgrass, fescue, and bluegrass.

Soil.--In this climatic regime, the dominant pedogenic process is calcification; salinization is dominant on poorly drained sites. Soils contain a large excess of precipitated calcium carbonate and are rich in bases. Mollisols are typical. Humus content is small because vegetation is sparse.

Fauna.--Large herds of buffalo migrated with the seasons across the steppe plains. Now the pronghorn antelope is probably the most abundant large mammal, but mule deer and whitetail deer are common where brush cover is available along stream courses. The whitetail jackrabbit occupies the northern part of the province, with the blacktail jackrabbit in the area south of Nebraska. The desert cottontail is widespread. The lagomorphs, prairie dogs, and several other small rodents are preyed upon by the coyote and several other mammalian and avian predators; one, the blackfooted ferret, is classified as an endangered species. The thirteen-lined ground squirrel is common here; both prairie dogs and ground squirrels are preyed upon by badgers. The Washington and Columbia ground squirrels inhabit large areas of the Palouse grassland.

The lesser prairie chicken, once abundant, is now classified as threatened. Sage grouse, greater prairie chickens, and sharp-tailed grouse are present in the area. Among the many smaller birds are the horned lark, lark bunting, and western meadowlark. Two bird species are unique to the shortgrass prairies east of the Rockies, the mountain plover and McCown's longspur. Mountain plovers, which resemble killdeer, live in small flocks often seen feeding in freshly plowed fields. Construction of stock ponds has created an important "duck factory" in the northern Great Plains.

Southern Rocky Mountain Steppe--Open Woodland--Coniferous Forest--Alpine Meadow Province

Land-surface form.--The Rocky Mountains are rugged glaciated mountains as high as 14,000 ft (4,300 m). Local relief is between 3,000 ft (900 m) and 7,000 ft (2,100 m). Several sections have intermontane depressions ("parks") with floors less than 6,000 ft (1,800 m) in altitude. Many high-elevation plateaus composed of dissected, horizontally layered rocks lie in Wyoming and Utah.

Climate.--The climate is a temperate semiarid steppe regime with average annual temperatures ranging from 35 to 45F (2 to 7C) in most of the region, but reaching 50F (10C) in the lower valleys. Climate is influenced by the prevailing west winds and the general north-south orientation of the mountain ranges. East slopes are much drier than west slopes; individual mountain ranges have similar east-west slope differences regionwide. Winter precipitation varies considerably with altitude (see Appendix 2, climate diagram for Pikes Peak, Colorado). Total precipitation is moderate, but greater than on the plains to the east and west. In the highest mountains, a considerable part of annual precipitation is snow, although permanent snowfields and glaciers cover only relatively small areas. Bases of these mountains receive only 10 to 20 in (260 to 510 mm) of rainfall per year. At higher elevations, annual precipitation increases to 40 in (1,020 mm), and average temperatures fall.

Vegetation.--A striking feature of the region is its pronounced vegetational zonation, controlled by a combination of altitude, latitude, direction of prevailing winds, and slope exposure. Generally, the various zones are at higher altitudes in the southern part of the province than in the northern, and they extend downward on eastfacing and northfacing slopes and in narrow ravines and valleys subject to cold air drainage. The uppermost (alpine) zone is characterized by alpine tundra and the absence of trees. Directly below it is the subalpine zone, dominated in most places by Engelmann spruce and subalpine fir. Below this area lies the montane zone, characterized by ponderosa pine and Douglas-fir, which frequently alternate--ponderosa pine dominates on lower, drier, more exposed slopes, and Douglas-fir is predominant in higher, moister, more sheltered areas.

After fire in the subalpine zone and in the upper part of the montane zone, the original forest trees are usually replaced by aspen or lodgepole pine.

Grass, often mixed with sagebrush, regularly covers the ground in open ponderosa pine forests and some treeless areas. These treeless openings are usually small, and they often alternate (depending on slope exposure) with ponderosa pine forest. At the lower edge of the montane zone, they may open onto the adjacent grass and sagebrush belt.

Below the montane belt is the foothill (woodland) zone. Dry rocky slopes in this zone often have a growth of shrubs in which mountain-mahogany and several

kinds of scrub oak are conspicuous. Along the border of the Colorado Plateau Province, ponderosa pine and pinyon-juniper associations frequently alternate, depending on slope exposure.

Unforested parks are a conspicuous feature of this province. Many are dominated by grasses, but some are covered largely by sagebrush and other shrubs, such as antelope bitterbrush.

Soils.--In the Rocky Mountains, soil orders occur in zones corresponding to vegetation, ranging from Mollisols and Alfisols in the montane zone to Aridisols in the foothill zone. In addition, because of steep slopes and recent glaciation, there are areas of Inceptisols.

Fauna.--Common large mammals include elk, deer, bighorn sheep, mountain lion, bobcat, beaver, porcupine, and black bear. Grizzly bear and moose inhabit the province's northern portions. Small mammals include mice, squirrels, martens, chipmunks, mountain cottontails, and bushytail woodrats.

Common birds include the mountain bluebird, chestnut-backed chickadee, red-breasted nuthatch, ruby-crowned kinglet, pygmy nuthatch, gray jay, Steller's jay, and Clark's nutcracker. Rosy finches are found in the high snowfields. Blue and ruffed grouse are the most common upland game birds. Hawks and owls inhabit most of the region.

Middle Rocky Mountain Steppe--Coniferous Forest--Alpine Meadow Province

Land-surface form.--Most of central Idaho and the Salmon River Mountains are formed by granitic intrusions that collectively make up the Idaho Batholith, with altitudes ranging from 3,000 to 7,000 ft (900 to 2,130 m). The batholith is deeply dissected, with a relief greater than 3,000 ft, and its granite is heavily weathered over large areas. East of the batholith is a basin-and-range area consisting of mountains, alluvial fans at their bases, and floodplains along the streams draining the valleys. To the west lie the Blue Mountains, which seldom exceed 8,000 ft (2,400 m) but have at least one peak 10,000 ft (3,050 m) high. The Snake River crosses the province at the bottom of Hells Canyon, which is deeper than the Grand Canyon. Many of the region's higher reaches have been glaciated.

Climate.--Despite the northerly latitudes and high altitudes of this region, its climates are surprisingly mild due to their proximity to the Pacific Ocean. Mean monthly temperatures at Canyon City, Oregon (near John Day), range from just above freezing to 68F (20C). In the mountain valleys of Montana, January temperatures average as much as 10F (6C) higher and summer temperatures 5 to 10F (3 to 6C) lower than on the Great Plains just to the east. The average length of the growing season is about the same as on the Great Plains, roughly 120 days. Temperature and snowfall, of course, vary greatly with altitude. Winds

are from the west, with much of their moisture precipitated where they cross the Pacific ranges. Consequently, most of this portion of the Rocky Mountains is semiarid. Valleys get less than 20 in (510 mm) of precipitation each year; up to 30 in (770 mm) falls in the mountains, mostly as snow.

Vegetation.--Altitudinal zones are evident. Below the subalpine zone, Douglas-fir is the climax dominant, with grand fir as an associate west of the continental divide, chiefly on westfacing slopes. Lodgepole pines and grasses grow principally in the basins and ranges in the eastern and southeastern part of the province. Below the Douglas-fir belt, ponderosa pine is dominant to the west of the continental divide, constituting a xerophytic forest. The lower slopes of the mountains and the basal plain are dominated by sagebrush semidesert or steppe.

Due to aridity, forests directly east of the Bitterroot Mountains are usually restricted to northern and eastern slopes. Although south- and westfacing slopes receive comparable precipitation, they are hotter and evaporation is higher. Consequently, they support few trees and are covered by shrubs and grasses.

Soils.--Soils of the fans and valley floors, most of which lie below 2,000 ft (600 m), are Mollisols. These soils support sagebrush and grass. Above 2,000 ft, under coniferous forest, the soils are Alfisols. Areas recently glaciated or with steep slopes have Inceptisols.

Fauna.--Fauna in the Middle Rocky Mountain Province are like those elsewhere in the Rockies to the north and south. However, parts of the province are filled with mountain ranges that are isolated by stretches of arid territory. Each such range usually contains a group of species peculiar to the region, and some of these species may be found only in a single range.

Northern Rocky Mountain Forest-Steppe--Coniferous Forest--Alpine Meadow Province

Land-surface form.--The Northern Rocky Mountain Province consists of high, rugged mountains rising to more than 9,000 ft (2,700 m), with a local relief in excess of 3,000 ft (900 m). Most of the region has been glaciated. In the several Rocky Mountain trenches, there are flat or nearly flat valleys, some of which are several miles wide.

Climate.--Severe winters are usual. The average temperature of the coldest month is below 32F (0C), and the average temperature of the warmest month is below 72F (22C). Summer days are often hot and nights cool. Precipitation averages 20 to 40 in (510 to 1,020 mm) per year and is concentrated in fall, winter, and spring. Summers are usually dry, because westerly air masses draw the dry climate of the Pacific coast across the area. As a result, there is a distinct climatic gradient from north to south and east to west. Snowfall in

winter is heavy, but permanent snowfields and glaciers cover only rather small areas.

Vegetation.--Mixed evergreen-deciduous forest predominates; Douglas-fir forest and cedar-hemlock-Douglas-fir forest are the two major types.

Well-marked life belts are a striking feature of the province. In the uppermost (alpine) belt, trees are absent. The subalpine belt is dominated in most places by Engelmann spruce and subalpine fir. In the Bitterroot Range, mountain hemlock is said to be the climax tree of the subalpine belt. Western redcedar and western hemlock are characteristic of the montane belt. Associated trees include Douglas-fir (found throughout the region), along with western white pine, western larch, grand fir, and western ponderosa pine (found in the south). In these forests, areas that have been burned or cut are invaded first by larch, a deciduous conifer. White pine may crowd out the larch, then be replaced by hemlock, redcedar, and lowland white fir. Depending on latitude, the lower part of the montane belt may be interspersed with grass and sagebrush.

Soils.--Soils are mostly cool, moist Inceptisols. A variety of igneous, sedimentary, and metamorphic rocks form the mountain masses. But compared to other parts of the Rocky Mountains, the shallowness and stoniness of soils play a relatively minor role in forest distribution. In the foothills of the Rockies and to the south of the glacial border, the loess and volcanic ash deposited on the slopes have helped to form excellent soils.

Fauna.--Large mammals in this province include black bear, deer, elk, mountain goat, mountain lion, and bobcat. Smaller mammals include Columbia ground squirrel, flying squirrel, marten, redtail chipmunk, and bushytail woodrat.

Some familiar birds are hawks, jays, chestnut-backed chickadees, red-breasted nuthatches, and great gray owls. Blue and ruffed grouse are the most common game birds.

Temperate Desert Division

Temperate deserts of continental regions have low rainfall and strong temperature contrasts between summer and winter. In the intermountain region of the Western United States between the Pacific coast and Rocky Mountains, the temperate desert has characteristics of a sagebrush semidesert, with a very pronounced drought season and a short humid season. Most precipitation falls in winter, despite a peak in May, climate diagram for Salt Lake City, Utah). Aridity increases markedly in the rain shadow of the Pacific mountain ranges. Even at intermediate elevations, winters are long and cold, with temperatures falling below 32F (0C).

These deserts differ from those at lower latitudes chiefly in their far greater annual temperature range and much lower winter temperatures. Unlike the dry

climates of the tropics, dry climates in the middle latitudes receive part of their precipitation as snow.

Temperate desert climates support the sparse xerophytic shrub vegetation typical of semidesert. One example is the sagebrush vegetation of the Great Basin and northern Colorado Plateau. Recently, semidesert shrub vegetation seems to have invaded wide areas of the Western United States that were formerly steppe grasslands, due to overgrazing and trampling by livestock. Soils of the temperate desert are Aridisols low in humus and high in calcium carbonate. Poorly drained areas develop saline soils, and dry lake beds are covered with salt deposits.

Northern, cooler desert regions, such as the Great Basin Desert, support far fewer wildlife species than southern, warmer deserts found in the Subtropical Desert Division due to a shorter growing season which results in lower plant productivity and a lower diversity and abundance of animal prey. Thermal regimes in northern deserts also limit the activity of wildlife, especially cold-blooded animals such as amphibians and reptiles, to short periods each year.

The Great Basin Desert, which is the largest desert in North America, is characterized by sagebrush and saltbush. This desert supports large populations of pronghorn antelope, and also provides critical habitat for sage-grouse species that use sagebrush for food and cover.

Similarly to the SubTropical Desert division, wildlife of the Temperate Desert has adapted to survive under extreme environmental conditions, including low, erratic rainfall, and highly variable temperatures. Spadefoot toads have a special appendage on their hind foot that allows them to burrow into the soil to avoid daytime heat, and breeding activities are timed to occur during periods with summer thunderstorms. Many small mammals are able to survive on metabolically-produced water and secret hyper-concentrated urea. Despite these adaptations, riparian areas are especially important in the desert. For example, of the 148 species of breeding birds in the Great Basin Desert, 131 are dependent upon riparian areas for all or part of their life requisites.

Reptiles such as the common garter snake, western rattlesnake and sagebrush lizard are found among the talus slopes, cliffs and rock outcroppings, which provide thermal and escape cover, nesting and feeding habitat. Bats use caves and rock outcroppings as root and nursery sites. Deep, rugged cliffs are used by desert bighorn sheep for lambing, escape, and thermal cover. Raptors, including golden eagles and several species of hawks use cliffs and rock outcrops as nest and perch sites. The canyon walls of Snake River provide habitat for one of the highest densities of raptors in the world.

Due to the conversion of lands to agricultural and urban uses, species associated with native perennial bunchgrass communities, including the Columbian sharp-

tailed grouse, kit fox, and Idaho ground squirrel, have declined in numbers more than other species' groups in the region. These species rely on grassland vegetation for plant and insect forage, nesting and brood-rearing habitat, and hiding cover.

Intermountain Semidesert and Desert Province

Land-surface form.--The Intermountain Desert Province covers the physiographic section called the Great Basin and the northern Colorado Plateau in Utah. Much of this area is made up of separate interior basins; only a small part of it drains to the sea. The lower parts of many basins have heavy accumulations of alkaline and saline salts. Streams are rare and few are permanent. Many mountains rise steeply from the semiarid, sagebrush-covered plains. These mountains are generally well covered by vegetation, and their upper elevations usually bear sparse conifer forests.

Climate.--Summers are hot, but winters are only moderately cold. The average annual temperature ranges from 40 to 55F (4 to 13C). Spring comes early, except at higher elevations. Annual precipitation averages only 5 to 20 in (130 to 490 mm), often falling as winter snow. Almost no rain falls during the summer months except in the mountains.

Vegetation.--Sagebrush dominates at lower elevations. Other important plants in the sagebrush belt are antelope bitterbrush, shadscale, fourwing saltbush, rubber rabbitbrush, spiny hopsage, horsebrush, and short-statured Gambel oak. All these shrubs tolerate alkali to varying degrees, essential to their survival on the poorly drained soils widespread in the region. On soils with the highest concentrations of salt, even these shrubs are unable to grow; they are replaced by plant communities dominated by greasewood or saltgrass.

Although sagebrush now dominates this zone, it may not represent climax growth, but rather a disclimax produced by overgrazing. In plots protected from fire, grasses typical of the Palouse grassland or mixed-grass steppe gradually become dominant.

Above the sagebrush belt lies a woodland zone dominated by pinyon pine and juniper, similar to the pinyon-juniper woodland of the Colorado Plateau.

In the montane belt above the woodland zone, ponderosa pine generally occupies the lower and more exposed slopes and Douglas-fir the higher and more sheltered ones. In the subalpine belt, the characteristic trees are subalpine fir and Engelmann spruce. Only a few mountains rise high enough to support an alpine belt.

Soils.--Aridisols dominate all basin and lowland areas; forest soils are found at higher elevations. Narrow bands of Entisols lie in stream floodplains and rocky

landscapes. Salt flats and playas without soils are extensive in the lower parts of basins with interior drainage.

Fauna.--Few large mammals live in this province, but mule deer, mountain lion, bobcat, and badger occasionally venture into it. Sagebrush provides ideal habitat for pronghorn antelope and whitetail prairie dog. The most common species are such small mammals as ground squirrels, jackrabbits, kangaroo mice, wood rats, and kit foxes. In the lower life belts, some ground squirrels--especially the Belding and Townsend ground squirrels--become dormant during the hot, dry summer.

Bird species range from the burrowing owl to such specialized species as sage sparrow and sage thrasher, both found only in sagebrush habitat. Raptors include the American kestrel and golden eagle, along with the ferruginous hawk and various other species of western hawks. In early spring, groups of sage grouse engage in elaborate courtship displays.

Intermountain Semidesert Province

Land-surface form.--This province covers the plains and tablelands of the Columbia-Snake River Plateaus and Wyoming Basin. The plateaus include most of the Northwest's lava fields. Lying at about 3,000 ft (900 m), the plateaus are surrounded by lavas that have been folded or faulted into ridges. To the south, the plateaus grade into the basins and ranges of the Intermountain Desert Province. The Wyoming Basin consists of plains at elevations of 6,000-8,000 ft (1,800-2,400 m) broken by isolated hills and low mountains 1,000-2,000 ft (300-600 m) higher. In the south, broad intermountain basins and isolated small mountain ranges merge into a dissected plateau. Sloping alluvial fans at the edges of the basins merge into flat plains in the center. Badlands are typical of the dissected areas along the region's outer edges.

Climate.--The climate of the plateaus is semiarid and cool, with an average annual temperature of about 50F (10C). Average annual precipitation ranges from less than 10 in (260 mm) in the west (in the rain shadow of the Cascade Range) to 20 in (510 mm) in the east. Precipitation is fairly evenly distributed throughout the year, except during the summer months, when there is little rain.

The higher overall elevation of the Wyoming Basin gives it slightly lower average temperatures and precipitation than on the plateaus. Winters are cold, and summers are short and hot. Average annual temperatures range from 40 to 52F (4 to 11C), and the average growing season has fewer than 100 days in the south and 140 days in the north and east. Average annual precipitation ranges from 5 to 14 in (130 to 360 mm), and is fairly evenly distributed throughout the year.

Vegetation.--The chief vegetation, sometimes called sagebrush steppe, is made up of sagebrush or shadscale mixed with short grasses. Moist alkaline flats support alkali-tolerant greasewood. Along streams in and near the mountains where the water is good, valley bottoms are lined with willows and sedges, which give way to greasewood and other alkali-tolerant plants as one moves away from the mountains. Lands in the Columbia River Basin with more than 10 in (260 mm) of rainfall per year have an open cover of bunchgrass, and are excellent for raising wheat. A woodland of western juniper covers parts of central Oregon that get little rain.

Soils.--This province has extensive alluvial deposits in the floodplains of streams and in the fans at the foot of mountains. Dry lake beds are numerous, and there are extensive eolian deposits, including both dune sand and loess. In the Columbia River Basin, loess deposits are up to 150 ft (46 m) thick, and soils developed from them are correspondingly complex. Aridisols dominate all basin and lowland areas; Mollisols are found at higher elevations.

Soils in the Wyoming Basin are alkaline Aridisols. Subsoils contain a layer enriched with lime and/or gypsum, which may develop into a caliche hardpan. Because the basin is semiarid and weathering is therefore slight, soil texture and composition are governed by parent materials. Entisols are found in the Bighorn basin.

Fauna.--Because of its wilderness character, this region supports a great variety of wildlife species. In winter, seasonal changes force many birds and mammals to move from the mountains into the sagebrush semidesert, where they find suitable habitat alongside the area's permanent residents.

Major mammals are coyote, pronghorn antelope, mountain lion, and bobcat. Smaller species include Wyoming ground squirrel, whitetail prairie dog, deer mouse, whitetail jackrabbit, and porcupine. During severe winters, elk and mule deer move into the desert. Moose are locally important in the dense willow thickets along the desert watercourses of eastern Idaho and western Wyoming.

This region is an important breeding and resting ground for migrating waterfowl. Mallards, pintails, green-winged teal, and gadwalls are most common. Canada geese are locally important. Sage grouse are the most abundant upland game bird. The numerous raptors here include Swainson's hawk, ferruginous hawk, rough-legged hawk, red-tailed hawk, marsh hawk, prairie falcon, great horned owl, and burrowing owl.

Reptiles include sagebrush lizard, horned lizard, and prairie rattlesnake.

Nevada-Utah Mountains Semidesert--Coniferous Forest--Alpine Meadow Province

Land-surface form.--This province covers the highest areas of the Great Basin and Colorado Plateau, including valleys that are 5,000 ft (1,500 m) in elevation. Although some valleys are closed, none contain perennial lakes. Streams are rare and few are permanent. Many linear mountain ranges rise steeply from the semiarid plains, reaching altitudes up to 13,000 ft (3,960 m). They are composed mostly of folded and faulted sedimentary rocks block faulted to produce basins and ranges. To the east, on the Colorado Plateau, the mountains are formed from high-elevation plateaus composed of dissected, horizontally layered rocks.

Climate.--This region has a high-altitude variation of the temperate desert climate, with a very pronounced drought season and a short humid season. Most precipitation falls in winter, despite a peak in August (see Appendix 2, climate diagram for Panguitch, Utah). Winters are long, and climate varies considerably with altitude. Average annual temperatures range from about 38F (3C) 50F (10C) in the valleys to 50F (10C) 38F (3C) on upper mountain slopes. Average annual precipitation ranges from 5 to 8 in (130 to 200 mm) in the valleys to 25 to 35 in (640 to 890 mm) at higher elevations. A considerable portion of winter precipitation is snow, and summer afternoon thunderstorms are common on the Colorado Plateau.

Vegetation.--Sagebrush dominates at lower elevations. Other important plants in the sagebrush belt are shadscale, fourwing saltbush, rubber rabbitbrush, spiny hopsage, and horsebrush. All tolerate alkali to varying degrees, essential to their survival on the poorly drained soils widespread in the region. Where salt concentrations are very high, even these shrubs are unable to grow; they are replaced by plant communities dominated by greasewood or saltgrass.

The woodland belt above the sagebrush zone is similar to the corresponding belt on the Colorado Plateau, with juniper and pinyon occupying lower mountain slopes. The belt is frequently interrupted as mountains give way to plains.

In the montane zone above the woodland belt, ponderosa pine generally occupies the lower and more exposed slopes and Douglas-fir the higher and more sheltered ones. Typical species of the subalpine belt are alpine fir and Engelmann spruce. Great Basin bristlecone pine, with some individuals more than 1,000 years old, occupies widely scattered peaks. Only a few mountains in this province rise high enough to support an alpine meadow belt.

Soils.--Aridisols dominate all basin and lowland areas; Mollisols and Alfisols are found at higher elevations in the mountains. Salt flats and playas without soil are extensive in the Great Basin.

Fauna.--Sagebrush shrublands provide ideal habitat for pronghorn antelope and whitetail prairie dog. Golden-mantled squirrels inhabit the region's ponderosa pine forests, and snowshoe hares along with red squirrels are found throughout the spruce-fir forests of Utah.

The sagebrush shrublands contain many species of birds, ranging from burrowing owls to such specialized species as sage sparrow and sage thrasher, both found in no other type of habitat. Various raptors prey on jackrabbits, including the American kestrel, ferruginous hawk, and golden eagle. The pinyon jay is typical of the pinyon-juniper forest, which also supports the plain titmouse and black-throated gray warbler, along with flocks of bushtits. Ponderosa pine forests contain the Steller's jay and dark-eyed junco. Many reptiles can be found; collared lizards are common.

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Appendix H

Federally Listed Species

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Scientific Name	Common Name	Listing Status[a]	State in which Species could Occur	Designated Critical Habitat	Recovery Plan
Plants					
Abronia alpina	Ramshaw Meadows sandverbena	C	CA	N	N
Acanthomintha ilicifolia	San Diego thornmint	T	CA	N	N
Acanthomintha obovata duttonii	San Mateo thornmint	E	CA	N	Y
Allium munzii	Munz's onion	E	CA	N	N
Alopecurus aequalis var. sonomensis	Sonoma alopecurus	E	CA	N	N
Ambrosia pumila	San Diego ambrosia	E	CA	N	N
Amsinckia grandiflora	Large-flowered fiddleneck	E	CA	Y	Y
Amsonia kearneyana	Kearney's blue-star	E	AZ	N	Y
Arabis mcdonaldiana	McDonald's rock-cress	E	CA	N	Y
Arctomecon humilis	Dwarf bear-poppy	E	UT	N	Y
Arctostaphylos glandulosa crassifolia	Del Mar manzanita	E	CA	N	N
Arctostaphylos hookeri var. ravenii	Presidio manzanita	E	CA	N	Y
Arctostaphylos morroensis	Morro manzanita	T	CA	N	Y
Arctostaphylos myrtifolia	Ione manzanita	T	CA	N	N
Arctostaphylos pallida	Pallid manzanita	T	CA	N	Y
Arenaria paludicola	Marsh sandwort	E	CA	N	Y
Arenaria ursina	Bear Valley sandwort	T	CA	N	N
Argemone pleiacantha pinnatisecta	Sacramento prickly poppy	E	NM	N	Y
Artemisia campestris var. wormskioldii	Northern wormwood	C	OR, WA	N	N
Asclepias welshii	Welsh's milkweed	T	AZ, UT	Y	Y
Astragalus albens	Cushenbury milk-vetch	E	CA	Y	Y
Astragalus ampullarioides	Shivwits milk-vetch	E	UT	Y	Y
Astragalus applegatei	Applegate's milk-vetch	E	OR	N	Y
Astragalus brauntonii	Braunton's milk-vetch	E	CA	Y	Y
Astragalus clarianus	Clara Hunt's milk-vetch	E	CA	N	N
Astragalus cremnophylax var. cremnophylax	Sentry milk-vetch	E	AZ	N	Y
Astragalus desereticus	Deseret milk-vetch	T	UT	N	N
Astragalus holmgreniorum	Holmgren milk-vetch	E	AZ, UT	Y	Y
Astragalus humillimus	Mancos milk-vetch	E	CO, NM	N	Y
Astragalus jaegerianus	Lane Mountain milk-vetch	E	CA	Y	N
Astragalus lentiginosus var. coachellae	Coachella valley milk-vetch	E	CA	Y	N
Astragalus lentiginosus var. piscinensis	Fish Slough milk-vetch	T	CA	N	Y
Astragalus magdalenae var. peirsonii	Peirson's milk-vetch	T	CA	Y	N
Astragalus montii	Heliotrope milk-vetch	T	UT	N	Y
Astragalus osterhoutii	Osterhout milk-vetch	E	CO	N	Y
Astragalus phoenix	Ash Meadows milk-vetch	T	NV	Y	Y
Astragalus pycnostachyus var. lanosissimus	Ventura Marsh milk-vetch	E	CA	Y	N
Astragalus tener var. titi	Coastal dunes milk-vetch	E	CA	N	Y
Astragalus tortipes	Sleeping Ute milk-vetch	C	CO	N	N
Astragalus tricarinatus	Triple-ribbed milk-vetch	E	CA	N	N
Atriplex coronata var. notatior	San Jacinto Valley crownscale	E	CA	N	N
Baccharis vanessae	Encinitas baccharis	T	CA	N	N
Berberis nevinii	Nevin's barberry	E	CA	N	N
Blennosperma bakeri	Sonoma sunshine	E	CA	N	N
Brodiaea filifolia	Thread-leaved brodiaea	T	CA	Y	Y
Brodiaea pallida	Chinese Camp brodiaea	T	CA	N	N
Calochortus persistens	Siskiyou mariposa lily	C	CA	N	N

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Calochortus tiburonensis	Tiburon mariposa lily	T	CA	N	Y
Calyptridium pulchellum	Mariposa pussypaws	T	CA	N	N
Calystegia stebbinsii	Stebbins' morning-glory	E	CA	N	Y
Camissonia benitensis	San Benito eveningprimrose	T	CA	N	Y
Carex albida	White sedge	E	CA	N	N
Carex specuicola	Navajo sedge	T	AZ, UT	Y	Y
Castilleja affinis neglecta	Tiburon paintbrush	E	CA	N	Y
Castilleja campestris succulenta	Fleshy owl's-clover	T	CA	Y	Y
Castilleja christii	Christ's paintbrush	C	ID	N	N
Castilleja cinerea	Ash-grey paintbrush	T	CA	N	N
Castilleja levisecta	Golden paintbrush	T	WA	N	Y
Castilleja mollis	Soft-leaved paintbrush	E	CA	N	Y
Caulanthus californicus	California jewelflower	E	CA	N	Y
Ceanothus ferrisae	Coyote ceanothus	E	CA	N	Y
Ceanothus ophiochilus	Vail Lake ceanothus	T	CA	N	N
Ceanothus roderickii	Pine Hill ceanothus	E	CA	N	Y
Centaurium namophilum	Spring-loving centaury	T	CA, NV	Y	Y
Chamaesyce hooveri	Hoover's spurge	T	CA	Y	N
Chlorogalum purpureum	Purple amole	T	CA	Y	N
Chorizanthe howellii	Howell's spineflower	E	CA	N	Y
Chorizanthe orcuttiana	Orcutt's spineflower	E	CA	N	N
Chorizanthe parryi var. fernandina	San Fernando Valley spineflower	C	CA	N	N
Chorizanthe pungens var. hartwegiana	Ben Lomond spineflower	E	CA	N	Y
Chorizanthe pungens var. pungens	Monterey spineflower	T	CA	Y	Y
Chorizanthe robusta	Robust spineflower	E	CA	Y	Y
Chorizanthe valida	Sonoma spineflower	E	CA	N	Y
Cirsium fontinale var. fontinale	Fountain thistle	E	CA	N	Y
Cirsium fontinale var. obispoense	Chorro Creek bog thistle	E	CA	N	Y
Cirsium hydrophilum var. hydrophilum	Suisun thistle	E	CA	Y	N
Cirsium loncholepis	La Graciosa thistle	E	CA	Y	N
Cirsium vinaceum	Sacramento Mountains thistle	T	NM	N	Y
Clarkia franciscana	Presidio clarkia	E	CA	N	Y
Clarkia imbricata	Vine Hill clarkia	E	CA	N	N
Clarkia speciosa immaculata	Pismo clarkia	E	CA	N	Y
Clarkia springvillensis	Springville clarkia	T	CA	N	N
Cordylanthus maritimus maritimus	Salt marsh bird's-beak	E	CA	N	Y
Cordylanthus mollis mollis	Soft bird's-beak	E	CA	Y	Y
Cordylanthus palmatus	Palmate-bracted bird's beak	E	CA	N	Y
Cordylanthus tenuis capillaris	Pennell's bird's-beak	E	CA	N	Y
Coryphantha robbinsorum	Cochise pincushion cactus	T	AZ	N	Y
Coryphantha scheeri var. robustispina	Pima pineapple cactus	E	AZ	N	N
Coryphantha sneedii var. leei	Lee pincushion cactus	T	NM	N	Y
Coryphantha sneedii var. sneedii	Sneed pincushion cactus	E	NM	N	Y
Cupressus abramsiana	Santa Cruz cypress	E	CA	N	Y
Cupressus goveniana goveniana	Gowen cypress	T	CA	N	Y
Cycladenia jonesii	Jones cycladenia	T	AZ, UT	N	Y
Deinandra conjugens	Otay tarplant	T	CA	Y	Y
Deinandra increscens villosa	Gaviota tarplant	E	CA	Y	N
Delphinium bakeri	Baker's larkspur	E	CA	Y	N

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Delphinium luteum	Yellow larkspur	E	CA	Y	N
Dodecahema leptoceras	Slender-horned spineflower	E	CA	N	N
Dudleya abramsii parva	Conejo dudleya	T	CA	N	Y
Dudleya cymosa. marcescens	Marcescent dudleya	T	CA	N	Y
Dudleya cymosa. ovatifolia	Santa Monica Mountains dudleyea	T	CA	N	Y
Dudleya setchellii	Santa Clara Valley dudleya	E	CA	N	Y
Dudleya stolonifera	Laguna Beach liveforever	T	CA	N	N
Dudleya verityi	Verity's dudleya	T	CA	N	Y
Echinocactus horizonthalonius var. nicholii	Nichol's Turk's head cactus	E	AZ	N	Y
Echinocereus fendleri var. kuenzleri	Kuenzler hedgehog cactus	E	NM	N	Y
Echinocereus triglochidiatus var. arizonicus	Arizona hedgehog cactus	E	AZ	N	Y
Echinomastus erectocentrus var. acunensis	Acuna cactus	C	AZ	N	N
Enceliopsis nudicaulis var. corrugata	Ash Meadows sunray	T	NV	Y	N
Eremalche kernensis	Kern mallow	E	CA	N	Y
Eriastrum densifolium sanctorum	Santa Ana river woolly-star	E	CA	N	N
Erigeron decumbens var. decumbens	Willamette daisy	E	OR	N	N
Erigeron lemmonii	Lemmon fleabane	C	AZ	N	N
Erigeron maguirei	Maguire daisy	T	UT	N	Y
Erigeron parishii	Parish's daisy	Y	CA	Y	Y
Erigeron rhizomatus	Zuni fleabane	Y	AZ, NM	N	Y
Eriodictyon altissimum	Indian Knob Mountain balm	E	CA	N	Y
Eriodictyon capitatum	Lompoc yerba santa	E	CA	Y	N
Eriogonum apricum	Ione buckwheat	E	CA	N	N
Eriogonum codium	Umtanum desert buckwheat	C	WA	N	N
Eriogonum corymbosum car. Nilesii	Las Vegas buckwheat	C	NV	N	N
Eriogonum diatomaceum	Churchill Narrows buckwheat	C	NV	N	N
Eriogonum gypsophilum	Gypsum wild-buckwheat	T	NM	Y	Y
Eriogonum kelloggii	Red Mountain buckwheat	C	CA	N	N
Eriogonum kennedyi var. austromontanum	Southern mountain wildbuckwheat	T	CA	N	N
Eriogonum ovalifolium var. vineum	Cushenbury buckwheat	E	CA	Y	Y
Eriogonum ovalifolium var. williamsiae	Steamboat buckwheat	E	NV	N	Y
Eriogonum pelinophilum	Clay-loving wild-buckwheat	E	CO	Y	Y
Eriophyllum latilobum	San Mateo woolly sunflower	E	CA	N	Y
Eryngium aristulatum var. parishii	San Diego button-celery	E	CA	N	Y
Eryngium constancei	Loch Lomond coyote thistle	E	CA	N	Y
Erysimum capitatum var. angustatum	Contra Costa wallflower	E	CA	Y	Y
Erysimum menziesii	Menzies' wallflower	E	CA	N	Y
Erysimum teretifolium	Ben Lomond wallflower	E	CA	N	Y
Eutrema penlandii	Penland alpine fen mustard	T	CO	N	N
Fremontodendron californicum decumbens	Pine Hill flannelbush	E	CA	N	Y
Fremontodendron mexicanum	Mexican flannelbush	E	CA	N	N
Fritillaria gentneri	Gentner's fritillary	E	OR	N	Y
Galium californicum sierrae	El Dorado bedstraw	E	CA	N	Y
Gaura neomexicana var. coloradensis	Colorado butterfly plant	T	CO, WY	V	N
Gilia tenuiflora arenaria	Monterey gilia	E	CA	N	Y
Gilia tenuiflora hoffmannii	Hoffmann's slenderflowered gilia	E	CA	N	Y
Grindelia fraxino-pratensis	Ash Meadows gumplant	T	CA,NV	Y	Y
Hackelia venusta	Showy stickseed	E	WA	N	Y
Hazardia orcuttii	Orcutt's hazardia	C	CA	N	N

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Hedeoma todsenii	Todsen's pennyroyal	E	NM	Y	Y
Helianthus paradoxus	Pecos sunflower	T	NM	N	Y
Hesperolinon congestum	Marin dwarf-flax	T	CA	N	Y
Holocarpha macradenia	Santa Cruz tarplant	T	CA	Y	N
Howellia aquatilis	Water howellia	T	CA, ID, MT, OR, WA	N	Y
Ipomopsis polyantha	Pagosa skyrocket	C	CO	N	N
Ipomopsis sancti-spiritus	Holy Ghost ipomopsis	E	NM	N	Y
Ivesia kingii var. eremica	Ash Meadows ivesia	T	NV	Y	Y
Ivesia webberi	Webber ivesia	C	CA, NV	N	N
Lasthenia burkei	Burke's goldfields	E	CA	N	N
Lasthenia conjugens	Contra Costa goldfields	E	CA	Y	Y
Layia carnosa	Beach layia	E	CA	N	Y
Lepidium barnebyanum	Barneby ridge-cress	E	UT	N	Y
Lesquerella congesta	Dudley Bluffs bladderpod	T	CO	N	N
Lesquerella kingii bernardina	San Bernardino Mountains bladderpod	E	CA	Y	Y
Lesquerella tumulosa	Kodachrome bladderpod	E	UT	N	Y
Lessingia germanorum	San Francisco lessingia	E	CA	N	Y
Lilaeopsis schaffneriana var. recurva	Huachuca water-umbel	E	AZ	Y	N
Lilium occidentale	Western lily	E	CA, OR	N	Y
Lilium pardalinum pitkinense	Pitkin marsh lily	E	CA	N	Y
Limnanthes floccosa californica	Butte County meadowfoam	E	CA	Y	Y
Limnanthes floccosa grandiflora	Large-flowered woolly meadowfoam	E	OR	N	Y
Limnanthes vinculans	Sebastopol meadowfoam	E	CA	N	Y
Lomatium bradshawii	Bradshaw's desert-parsley	E	OR, WA	N	Y
Lomatium cookii	Cook's lomatium	E	OR	N	Y
Lupinus nipomensis	Nipomo Mesa lupine	E	CA	N	N
Lupinus sulphureus kincaidii	Kincaid's lupine	T	OR, WA	N	N
Lupinus tidestromii	Clover lupine	E	CA	N	Y
Mentzelia leucophylla	Ash Meadows blazingstar	T	NV	Y	Y
Mirabilis macfarlanei	Macfarlane's four-o'clock	T	ID, OR	N	Y
Monardella linoides viminea	Willowy monardella	E	CA	N	N
Monolopia congdonii	San Joaquin wooly-threads	E	CA	N	Y
Navarretia fossalis	Spreading navarretia	T	CA	N	Y
Navarretia leucocephala pauciflora	Few-flowered navarretia	E	CA	N	Y
Navarretia leucocephala plieantha	Many-flowered navarretia	E	CA	N	Y
Neostapfia colusana	Colusa grass	T	CA	Y	Y
Nitrophila mohavensis	Amargosa niterwort	E	CA, NV	Y	Y
Oenothera avita eurekensis	Eureka Valley eveningprimrose	E	CA	N	Y
Oenothera deltoides howellii	Antioch Dunes eveningprimrose	E	CA	Y	Y
Opuntia treleasei	Bakersfield cactus	E	CA	N	Y
Orcuttia californica	California orcutt grass	E	CA	N	Y
Orcuttia inaequalis	San Joaquin orcutt grass	T	CA	Y	Y
Orcuttia pilosa	Hairy orcutt grass	E	CA	Y	Y
Orcuttia tenuis	Slender orcutt grass	T	CA	Y	Y
Orcuttia viscida	Sacramento orcutt grass	E	CA	Y	Y
Oxytheca parishii var. goodmaniana	Cushenbury oxytheca	E	CA	Y	Y
Parvisedum leiocarpum	Lake County stonecrop	E	CA	N	Y

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Pediocactus bradyi	Brady pincushion cactus	E	AZ	N	Y
Pediocactus despainii	San Rafael cactus	E	UT	N	Y
Pediocactus knowltonii	Knowlton cactus	E	CO, NM	N	Y
Pediocactus peeblesianus peeblesianus	Peebles Navajo cactus	E	AZ	N	Y
Pediocactus peeblesianus fickeiseniae	Fickeisen plains cactus	C	AZ	N	N
Pediocactus sileri	Siler pincushion cactus	T	AZ, UT	N	Y
Pediocactus winkleri	Winkler cactus	T	UT	N	Y
Penstemon debilis	Parachute beardtongue	C	CO	N	N
Penstemon penlandii	Penland beardtongue	E	CO	N	Y
Penstemon scariosus albifluvis	White River beardtongue	C	CO, UT	N	N
Pentachaeta bellidiflora	White-rayed pentachaeta	E	CA	N	Y
Pentachaeta lyonii	Lyon's pentachaeta	E	CA	Y	Y
Phacelia argillacea	Clay phacelia	E	UT	N	Y
Phacelia formosula	North Park phacelia	E	CO	N	Y
Phacelia stellaris	Brand's phacelia	C	CA	N	N
Phacelia submutica	Debeque phacelia	E	CO	N	N
Phlox hirsuta	Yreka phlox	E	CA	N	Y
Physaria obcordata	Dudley Bluffs twinpod	T	CO	N	Y
Physaria tuplashensis	White Bluffs bladderpod	C	WA	N	N
Piperia yadonii	Yadon's piperia	E	CA	N	Y
Plagiobothrys hirtus	Rough popcornflower	E	OR	N	Y
Plagiobothrys strictus	Calistoga allocarya	E	CA	N	N
Poa atropurpurea	San Bernardino bluegrass	E	CA	N	N
Poa napensis	Napa bluegrass	E	CA	N	N
Pogogyne abramsii	San Diego mesa-mint	E	CA	N	Y
Pogogyne nudiuscula	Otay mesa-mint	E	CA	N	Y
Polygonum hickmanii	Scotts Valley polygonum	E	CA	Y	N
Polystichum aleuticum	Aleutian shield fern	E	AK	N	Y
Potentilla basaltica	Soldier Meadows cinquefoil	C	NV	N	N
Potentilla hickmanii	Hickman's potentilla	E	CA	N	Y
Primula maguirei	Maguire primrose	T	UT	N	Y
Pseudobahia bahiifolia	Hartweg's golden sunburst	E	CA	N	N
Pseudobahia peirsonii	San Joaquin adobe sunburst	T	CA	N	N
Purshia subintegra	Arizona cliff-rose	E	AZ	N	Y
Ranunculus aestivalis	Autumn buttercup	E	UT	N	Y
Rorippa gambellii	Gambel's watercress	E	CA	N	Y
Rorippa subumbellata	Tahoe yellow cress	C	CA, NV	N	N
Schoenocrambe argillacea	Clay reed-mustard	T	UT	N	Y
Schoenocrambe barnebyi	Barneby reed-mustard	E	UT	N	Y
Schoenocrambe suffrutescens	Shrubby reed-mustard	E	Y	N	Y
Sclerocactus glaucus	Uinta Basin hookless cactus	T	CO, UT	N	Y
Sclerocactus mesae-verdae	Mesa Verde cactus	T	CO,UT	N	Y
Sclerocactus wrightiae	Wright fishhook cactus	E	UT	N	Y
Sedum eastwoodiae	Red Mountain stonecrop	C	CA	N	N
Senecio franciscanus	San Francisco Peaks groundsel	T	AZ	Y	Y
Senecio layneae	Layne's butterweed	T	CA	N	Y
Sidalcea keckii	Keck's checker-mallow	E	CA	Y	N
Sidalcea nelsoniana	Nelson's checker-mallow	T	OR, WA	N	Y
Sidalcea oregana valida	Kenwood marsh checkermallow	E	CA	N	N

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Sidalcea oregana var. calva	Wenatchee Mountains checker-mallow	E	WA	Y	Y
Sidalcea pedata	Pedate checker-mallow	E	CA	N	Y
Silene spaldingii	Spalding's catchfly	T	ID, MT, OR, WA	N	Y
Spiranthes delitescens	Canelo hills ladies'-tresses	E	AZ	N	N
Spiranthes diluvialis	Ute ladies'-tresses	T	CO, ID, MT, NV, UT, WA, WY	N	Y
Stephanomeria malheurensis	Malheur wire-lettuce	E	OR	Y	Y
Streptanthus albidus albidus	Metcalf Canyon jewelflower	E	CA	N	Y
Streptanthus niger	Tiburon jewelflower	E	CA	N	Y
Suaeda californica	California seablite	E	CA	N	N
Swallenia alexandrae	Eureka dune grass	E	CA	N	Y
Taraxacum californicum	California taraxacum	E	CA	N	N
Thelypodium howellii spectabilis	Howell's spectacular thelypody	T	OR	N	Y
Thelypodium stenopetalum	Slender-petaled mustard	E	CA	N	Y
Thlaspi californicum	Kneeland Prairie pennycress	E	CA	Y	Y
Townsendia aprica	Last chance townsendia	T	UT	N	Y
Trichostema austromontanum compactum	Hidden Lake bluecurls	T	CA	N	N
Trifolium amoenum	Showy Indian clover	E	CA	N	N
Trifolium trichocalyx	Monterey clover	E	CA	N	Y
Tuctoria greenei	Greene's tuctoria	E	CA	Y	Y
Tuctoria mucronata	Solano grass	E	CA	Y	Y
Verbena californica	Red Hills vervain	T	CA	N	N
Verbesina dissita	Big-leaved crownbeard	T	CA	N	N
Yermo xanthocephalus	Desert yellowhead	T	WY	Y	N
Invertebrates					
Ambrysus amargosus	Ash Meadows naucorid	T	NV	Y	Y
Ambrysus funebris	Nevares Spring naucorid bug	C	CA	N	N
Apodemia mormo langei	Lange's metalmark butterfly	E	CA	N	Y
Assiminea pecos	Pecos assiminea snail	E	NM	Y	N
Boloria acrocnema	Uncompahgre fritillary butterfly	E	CO	N	Y
Branchinecta conservatio	Conservancy fairy shrimp	E	CA	Y	Y
Branchinecta longiantenna	Longhorn fairy shrimp	E	CA	Y	Y
Branchinecta lynchi	Vernal pool fairy shrimp	T	CA, OR	Y	Y
Branchinecta sandiegonensis	San Diego fairy shrimp	E	CA	Y	Y
Callophrys mossii bayensis	San Bruno elfin butterfly	E	CA	N	Y
Cicindela limbata albissima	Coral pink sand dunes tiger beetle	C	UT	N	N
Cicindela ohlone	Ohlone tiger beetle	E	CA	N	N
Desmocerus californicus dimorphus	Valley elderberry longhorn beetle	T	CA	Y	Y
Elaphrus viridis	Delta green ground beetle	T	CA	Y	Y
Euphilotes battoides allyni	El Segundo blue butterfly	E	CA	N	Y
Euphilotes enoptes smithi	Smith's blue butterfly	E	CA	N	Y
Euphydryas editha bayensis	Bay checkerspot butterfly	T	CA	Y	Y
Euphydryas editha quino	Quino checkerspot butterfly	E	CA	Y	Y
Euphydryas editha taylori	Taylor's checkerspot	C	OR, WA	N	N

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Euproserpinus euterpe	Kern primrose sphinx moth	T	CA	N	Y
Gammarus desperatus	Noel's amphipod	E	NM	N	N
Glaucopsyche lygdamus palosverdesensis	Palos Verdes blue butterfly	E	CA	Y	Y
Haliotis sorenseni	White abalone	E	CA	N	N
Helminthoglypta walkeriana	Morro shoulderband snail	E	CA	Y	Y
Hesperia leonardus montana	Pawnee montane skipper	T	CO	N	Y
Heterelmis stephani	Stephan's riffle beetle	C	AZ	N	N
Icaricia icarioides fenderi	Fender's blue butterfly	E	OR	N	N
Icaricia icarioides missionensis	Mission blue butterfly	E	CA	N	Y
Juturnia kosteri	Koster's springsnail	E	NM	N	N
Lanx sp.	Banbury springs limpet	E	ID	N	Y
Lepidurus packardi	Vernal pool tadpole shrimp	E	CA	Y	Y
Lycaeides argyrognomon lotis	Lotis blue butterfly	E	CA	N	Y
Oreohelix peripherica wasatchensis	Ogden mountainsnail	C	UT	N	N
Oxyloma haydeni kanabensis	Kanab ambersnail	E	AZ, UT	N	Y
Pacifastacus fortis	Shasta crayfish	E	CA	N	Y
Physa natricina	Snake River physa snail	E	ID	N	Y
Polites mardon	Mardon skipper	C	CA, OR, WA	N	N
Polyphylla barbata	Mount Hermon june beetle	E	CA	N	Y
Popenaias popei	Texas hornshell	C	NM	N	N
Pseudocopaeodes eunus obscurus	Carson wandering skipper	E	CA, NV	N	Y
Pyrgulopsis bernardina	San Bernardino springsnail	C	AZ	N	N
Pyrgulopsis bruneauensis	Bruneau hot springsnail	E	ID	N	Y
Pyrgulopsis chupaderae	Chupadera springsnail	C	NM	N	N
Pyrgulopsis gilae	Gila springsnail	C	NM	N	N
Pyrgulopsis idahoensis	Idaho springsnail	E	ID	N	Y
Pyrgulopsis morrisoni	Page springsnail	C	AZ	N	N
Pyrgulopsis neomexicana	Socorro springsnail	E	NM	N	Y
Pyrgulopsis roswellensis	Roswell springsnail	E	NM	N	N
Pyrgulopsis thermalis	New Mexico springsnail	C	NM	N	N
Pyrgulopsis thompsoni	Huachuca springsnail	C	AZ	N	N
Pyrgulopsis trivialis	Three Forks springsnail	C	AZ	N	N
Pyrgus ruralis lagunae	Laguna Mountains skipper	E	CA	Y	N
Rhaphiomidas terminatus abdominalis	Delhi sands flower-loving fly	E	CA	N	Y
Speyeria callippe callippe	Callippe silverspot butterfly	E	CA	N	N
Speyeria zerene behrensii	Behren's silverspot butterfly	E	CA	N	Y
Speyeria zerene hippolyta	Oregon silverspot butterfly	T	CA, OR, WA	Y	Y
Speyeria zerene myrtleae	El Segundo blue butterfly	E	CA	N	Y
Stagnicola bonnevillensis	Bonneville pondsnail	C	UT	N	N
Streptocephalus woottoni	Riverside fairy shrimp	E	CA	Y	Y
Syncaris pacifica	California freshwater shrimp	E	CA	N	Y
Taylorconcha serpenticola	Bliss rapids snail	T	ID	N	Y
Thermosphaeroma thermophilus	Socorro isopod	E	NM	N	Y
Trimerotropis infantilis	Zayante band-winged grasshopper	E	CA	Y	Y
Tryonia alamosae	Alamosa springsnail	E	NM	N	Y
Valvata utahensis	Utah valvata snail	E	ID	N	Y

Scientific Name	Common Name	Listing Status[a]	State in which Species could Occur	Designated Critical Habitat	Recovery Plan
Fish					
Acipenser transmontanus	White sturgeon	E	ID, MT	Y	Y
Catostomus discobolus yarrowi	Zuni bluehead sucker	C	AZ, NM	N	N
Catostomus microps	Modoc sucker	E	CA	Y	Y
Catostomus santaanae	Santa Ana sucker	T	CA	Y	N
Catostomus warnerensis	Warner sucker	E	OR	Y	Y
Chasmistes brevirostris	Shortnose sucker	E	CA, OR	N	Y
Chasmistes cujus	Cui-ui	E	NV	N	Y
Chasmistes liorus	June sucker	E	UT	Y	Y
Crenichthys baileyi baileyi	White River springfish	E	NV	Y	Y
Crenichthys baileyi grandis	Hiko White River springfish	E	NV	Y	Y
Crenichthys nevadae	Railroad Valley springfish	T	NV	Y	Y
Cyprinella formosa	Beautiful shiner	T	AZ, NM	Y	Y
Cyprinodon diabolis	Devils Hole pupfish	E	NV	Y	Y
Cyprinodon macularius	Desert pupfish	E	AZ, CA	Y	Y
Cyprinodon nevadensis mionectes	Ash Meadows amargosa pupfish	E	NV	Y	Y
Cyprinodon nevadensis pectoralis	Warm Springs pupfish	E	NV	N	Y
Cyprinodon radiosus	Owens pupfish	E	CA	N	Y
Deltistes luxatus	Lost River sucker	E	CA, OR	N	Y
Empetrichthys latos	Pahrump poolfish	E	NV	N	Y
Eremichthys acros	Desert dace	T	NV	Y	Y
Etheostoma cragini	Arkansas darter	C	CO	N	N
Eucyclogobius newberryi	Tidewater goby	E	CA	Y	Y
Gambusia nobilis	Pecos gambusia	E	NM	N	Y
Gasterosteus aculeatus williamsoni	Unarmored threespine stickleback	E	CA	N	Y
Gila bicolor mohavensis	Mohave tui chub	E	CA	N	Y
Gila bicolor snyderi	Owens tui chub	E	CA	Y	Y
Gila bicolor ssp.	Hutton tui chub	T	OR	N	Y
Gila boraxobius	Borax Lake chub	E	OR	Y	Y
Gila cypha	Humpback chub	E	AZ, CO, UT, WY	Y	Y
Gila ditaenia	Sonora chub	T	AZ	Y	Y
Gila elegans	Bonytail chub	E	AZ, CA, CO, NV, UT, WY	Y	Y
Gila intermedia	Gila chub	E	AZ, NM	Y	N
Gila nigra	Headwater chub	C	AZ, NM	N	N
Gila nigrescens	Chihuahua chub	T	NM	N	Y
Gila purpurea	Yaqui chub	E	AZ	Y	Y
Gila robusta jordani	Pahranagat roundtail chub	E	NV	N	Y
Gila seminuda	Virgin River chub	E	AZ, NV, UT	Y	Y
Hybognathus amarus	Rio Grande silvery minnow	E	NM	Y	Y
Hypomesus transpacificus	Delta smelt	T	CA	Y	Y
Ictalurus pricei	Yaqui catfish	T	AZ	Y	Y
Lepidomeda albivallis	White River spinedace	E	NV	Y	Y
Lepidomeda mollispinis pratensis	Big Spring spinedace	T	NV	Y	Y
Lepidomeda vittata	Little Colorado spinedace	T	AZ	Y	Y
Meda fulgida	Spikedace	T	AZ, NM	Y	Y
Moapa coriacea	Moapa dace	E	NV	Y	Y

Scientific Name	Common Name	Listing Status[a]	State in which Species could Occur	Designated Critical Habitat	Recovery Plan
Notropis girardi	Arkansas River shiner	T	NM	Y	N
Notropis simus pecosensis	Pecos bluntnose shiner	T	NM	Y	Y
Oncorhynchus aguabonita whitei	Little Kern golden trout	T	CA	Y	Y
Oncorhynchus apache	Apache trout	T	AZ	N	Y
Oncorhynchus clarkii henshawi	Lahontan cutthroat trout	T	CA, NV, OR, UT	N	Y
Oncorhynchus clarkii seleniris	Paiute cutthroat trout	T	CA	N	Y
Oncorhynchus clarkii stomias	Greenback cutthroat trout	T	CO	N	Y
Oncorhynchus gilae	Gila trout	T	AZ, NM	N	Y
Oncorhynchus keta	Chum salmon[b]	T	OR	Y	N
Oncorhynchus kisutch	Coho salmon[b]	PT, T[c], E[c]	CA, OR, WA	Y	N
Oncorhynchus mykiss	Steelhead[b]	T[c], E[c]	CA, ID, OR, WA	Y	N
Oncorhynchus nerka	Sockeye salmon[b]	E	ID, WA	Y	N
Oncorhynchus tshawytscha	Chinook salmon[b]	T[c], E[c]	CA, OR, WA	Y	N
Oregonichthys crameri	Oregon chub	E	OR	N	Y
Plagopterus argentissimus	Woundfin	E	AZ, UT	Y	Y
Poeciliopsis occidentalis	Gila topminnow	E	AZ, NM	N	Y
Ptychocheilus lucius	Colorado pikeminnow	E	AZ, CA, CO, NM, NV, UT, WY	Y	Y
Rhinichthys osculus lethoporus	Independence Valley speckled dace	E	NV	N	Y
Rhinichthys osculus nevadensis	Ash Meadows speckled dace	E	NV	Y	Y
Rhinichthys osculus oligoporus	Clover Valley speckled dace	E	NV	N	Y
Rhinichthys osculus ssp.	Foskett speckled dace	T	OR	N	Y
Rhinichthys osculus thermalis	Kendall Warm Springs dace	E	WY	N	Y
Salvelinus confluentus	Bull trout	T	ID, MT, NV, OR, WA	Y	Y
Scaphirhynchus albus	Pallid sturgeon	E	MT	N	Y
Thymallus arcticus	Fluvial Arctic grayling	C	MT, WY	N	N
Tiaroga cobitis	Loach minnow	T	AZ, NM	Y	Y
Xyrauchen texanus	Razorback sucker	E	AZ, CA, CO, NM, NV, UT, WY	Y	Y
Amphibians					
Ambystoma californiense	California tiger salamander	T[c], E[c]	CA	T	N
Ambystoma tigrinum stebbinsi	Sonora tiger salamander	E	AZ	Y	Y
Batrachoseps aridus	Desert slender salamander	E	CA	N	Y
Bufo baxteri	Wyoming toad	E	WY	N	Y
Bufo californicus	Arroyo toad	E	CA	Y	Y
Bufo canorus	Yosemite toad	C	CA	N	N
Rana aurora draytonii	California red-legged frog	T	CA	Y	Y
Rana chiricahuensis	Chiricahua leopard frog	T	AZ, NM	N	Y
Rana luteiventris	Columbia Spotted frog	C	NV	N	N

Scientific Name	Common Name	Listing Status[a]	State in which Species could Occur	Designated Critical Habitat	Recovery Plan
Rana muscosa	Mountain yellow-legged frog	E[c], C[c]	CA, NV	Y	N
Rana onca	Relict leopard frog	C	AZ, NV, UT	N	N
Rana pretiosa	Oregon spotted frog	C	CA, OR, WA	N	N
Hyla wrightorum	Arizona treefrog[b]	C	AZ	N	N
Reptiles					
Crotalus willardi obscurus	New Mexican ridge-nosed rattlesnake	T	AZ, NM	Y	Y
Gambelia silus	Blunt-nosed leopard lizard	E	CA	N	Y
Gopherus agassizii	Desert tortoise	T	AZ, CA, NV, UT	Y	Y
Kinosternon sonoriense longifemorale	Sonoyta mud turtle	C	AZ	N	N
Masticophis lateralis euryxanthus	Alameda whipsnake	T	CA	Y	Y
Sceloporus arenicolus	Sand dune lizard	C	NM	N	N
Thamnophis gigas	Giant garter snake	T	CA	N	Y
Thamnophis sirtalis tetrataenia	San Francisco garter snake	E	CA	N	Y
Uma inornata	Coachella Valley fringe-toed lizard	T	CA	Y	Y
Mammals					
Antilocapra americana sonoriensis	Sonoran pronghorn	E	AZ	N	N
Aplodontia rufa nigra	Point Arena mountain beaver	E	CA	N	N
Brachylagus idahoensis	Pygmy rabbit	E	OR, WA	N	N
Canis lupus	Gray wolf	E	AZ, CO, ID, MT, NM, NV, OR, UT, WA, WY	Y	Y
Cynomys parvidens	Utah prairie dog	T	UT	N	Y
Dipodomys heermanni morroensis	Morro Bay kangaroo rat	E	CA	Y	Y
Dipodomys ingens	Giant kangaroo rat	E	CA	N	Y
Dipodomys merriami parvus	San Bernardino Merriam's kangaroo rat	E	CA	Y	N
Dipodomys nitratoides exilis	Fresno kangaroo rat	E	CA	Y	Y
Dipodomys nitratoides nitratoides	Tipton kangaroo rat	E	CA	B	Y
Dipodomys stephensi	Stephens' kangaroo rat	E	CA	N	Y
Herpailurus yagouaroundi tolteca	Sinaloan jaguarundi	E	AZ	N	Y
Leopardus pardalis	Ocelot	E	AZ	N	Y
Leptonycteris curasoae yerbabuenae	Lesser long-nosed bat	E	AZ, NM	N	Y
Leptonycteris nivalis	Mexican long-nosed bat	E	NM	N	Y
Lynx canadensis	Canada lynx	T	AK, CO, ID, OR, UT, WA, WY	Y	N
Martes pennanti	West coast fisher	C	CA, OR, WA	N	Y
Microtus californicus scirpensis	Amargosa vole	E	CA	N	Y
Microtus mexicanus hualpaiensis	Hualapai Mexican vole	E	AZ	N	Y

Scientific Name	Common Name	Listing Status[a]	State in which Species could Occur	Designated Critical Habitat	Recovery Plan
Mustela nigripes	Black-footed ferret	E	AZ, CO, MT, UT, WY	N	Y
Neotoma fuscipes riparia	Riparian woodrat	E	CA	N	Y
Odocoileus virginianus leucurus	Columbian white-tailed deer	E	OR, WA	N	Y
Ovis canadensis	Peninsular bighorn sheep	E	CA	Y	Y
Ovis canadensis californiana	Sierra Nevada bighorn sheep	E	CA	N	Y
Panthera onca	Jaguar	E	AZ, NM	N	Y
Perognathus longimembris pacificus	Pacific pocket mouse	E	CA	N	Y
Rangifer tarandus caribou	Woodland caribou	E	ID, WA	N	Y
Reithrodontomys raviventris	Salt marsh harvest mouse	E	CA	N	Y
Sorex ornatus relictus	Buena Vista Lake ornate shrew	E	CA	Y	Y
Spermophilus brunneus brunneus	Northern Idaho ground squirrel	T	ID	N	Y
Spermophilus brunneus endemicus	Southern Idaho ground squirrel	C	ID	N	N
Spermophilus tereticaudus chlorus	Palm Springs round-tailed ground squirrel	C	CA	N	N
Spermophilus washingtoni	Washington ground squirrel	C	OR, WA	N	N
Sylvilagus bachmani riparius	Riparian brush rabbit	E	CA	N	Y
Tamiasciurus hudsonicus grahamensis	Mount Graham red squirrel	E	AZ	Y	Y
Thomomys mazama glacialis	Roy Prairie pocket gopher	C	WA	N	N
Thomomys mazama louiei	Louie's western pocket gopher	C	WA	N	N
Thomomys mazama melanops	Olympic pocket gopher	C	WA	N	N
Thomomys mazama pugetensis	Olympia pocket gopher	C	WA	N	N
Thomomys mazama couchi	Shelton pocket gopher	C	WA	N	N
Thomomys mazama tacomensis	Tacoma western pocket gopher	C	WA	N	N
Thomomys mazama tumuli	Tenino pocket gopher	C	WA	N	N
Thomomys mazama yelmensis	Yelm pocket gopher	C	WA	N	N
Ursus arctos horribilis	Grizzly bear	T[d]	ID, MT, NM, NV, OR, UT, WA, WY	N	Y
Vulpes macrotis mutica	San Joaquin kit fox	E	CA	N	Y
Zapus hudsonius preblei	Preble's meadow jumping mouse	T	CO, WY	Y	N
Zapus hudsonius luteus	New Mexico meadow jumping mouse	C	AZ, NM	N	N
Birds					
Brachyramphus brevirostris	Kittlitz's murrelet	C	AK	N	N
Brachyramphus marmoratus	Marbled murrelet	T	CA, OR, WA	Y	Y
Centrocercus urophasianus	Greater sage-grouse	C	OR, WA	N	N
Charadrius alexandrinus nivosus	Western snowy plover	T	CA, OR, WA	Y	Y
Charadrius melodus	Piping plover	T	CO, MT	Y	Y

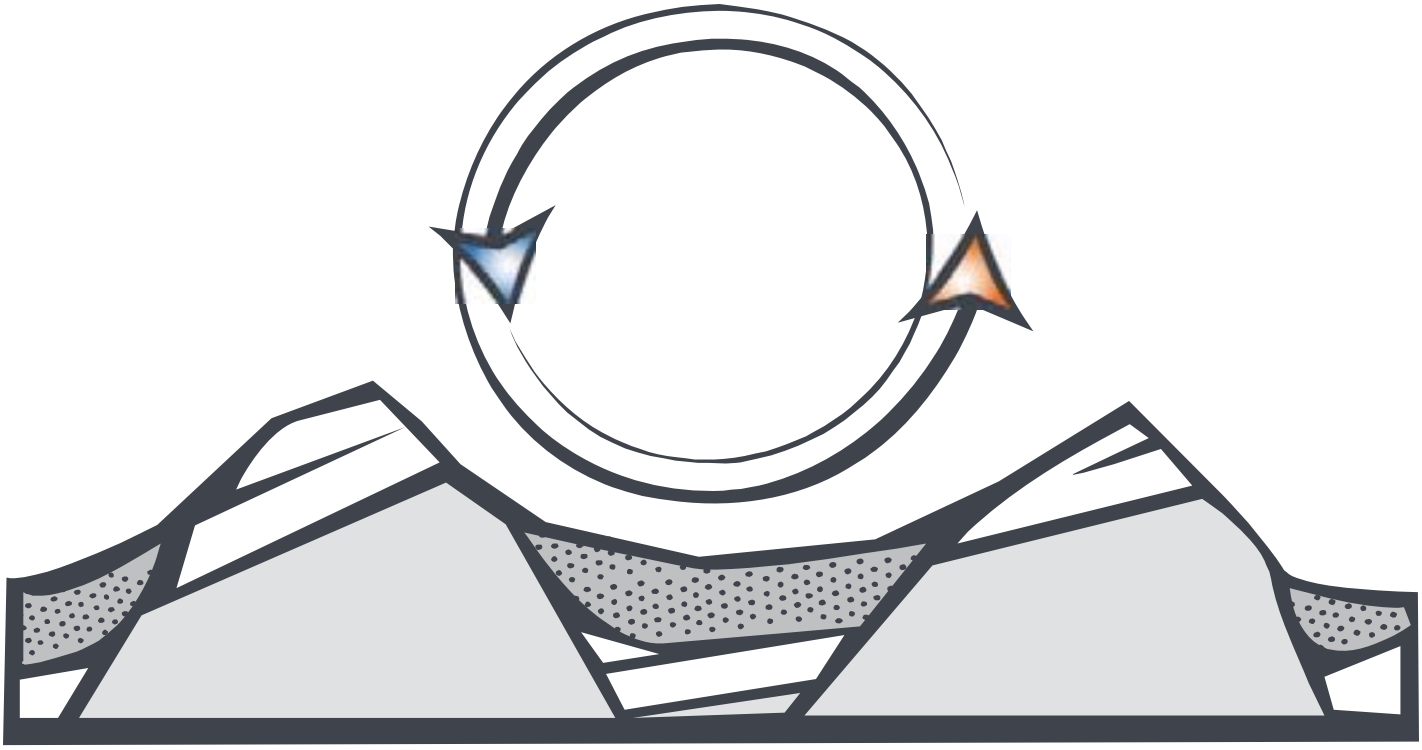
Scientific Name	Common Name	Listing Status[a]	State in which Species could Occur	Designated Critical Habitat	Recovery Plan
Coccyzus americanus	Western yellow-billed cuckoo	C	AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY	N	N
Colinus virginianus ridgwayi	Masked bobwhite	E	AZ	N	Y
Empidonax traillii extimus	Southwestern willow flycatcher	E	AZ, CA, CO, NM, UT	Y	Y
Eremophila alpestris strigata	Streaked horned lark	C	OR, WA	N	N
Falco femoralis septentrionalis	Northern Aplomado falcon	E	NM	N	Y
Grus americana	Whooping crane	E	CO, MT	Y	Y
Gymnogyps californianus	California condor	E	AZ, CA, UT	Y	Y
Numenius borealis	Eskimo curlew	E	AK, MT, NM, NV, OR, UT, WA, WY	N	N
Phoebastria (=Diomedea) albatrus)	Short-tailed albatross	E	AK	N	Y
Pipilo crissalis eremophilus	Inyo California towhee	T	CA	Y	Y
Polioptila californica californica	Coastal California gnatcatcher	T	CA	Y	N
Rallus longirostris levipes	Light-footed clapper rail	E	CA	N	Y
Rallus longirostris obsoletus	California clapper rail	E	CA	N	Y
Rallus longirostris yumanensis	Yuma clapper rail	E	AZ, CA	N	Y
Polysticta stelleri	Steller's Eiderb	T[c]	AK	Y	Y
Somateria fischeri	Spectacled Eider	T	AK	Y	Y
Sterna antillarum	Interior least tern	E	CO, MT, NM	N	Y
Sterna antillarum browni	California least tern	E	CA	N	Y
Strix occidentalis caurina	Northern spotted owl	T	CA, OR, WA	Y	Y
Strix occidentalis lucida	Mexican spotted owl	T	AZ, CO, NM, UT	Y	Y
Synthliboramphus hypoleucus	Xantus's murrelet	C	CA	N	N
Tympanuchus pallidicinctus	Lesser prairie-chicken	C	CO, NM	N	N
Vireo bellii pusillus	Least Bell's vireo	E	CA	Y	Y

[a] C = candidate for listing, E = listed as endangered, PT = proposed for listing as threatened, T = listed as threatened.

[b] Includes one or more "evolutionarily significant units" that spawn in different river basins or at different times of year and that have been assigned separate listing status.

[c] More than one listing category indicates that the species has different status in different states.

[d] Grizzley bears in the Yellowstone District Population Segment in Idaho, Montana, and Wyoming are considered recovered and have been delisted.



Appendix I

Cultural resource Regional Ethnohistory

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APPENDIX I
CULTURAL RESOURCE REGIONAL ETHNOHISTORY

Cultural resources are past and present expressions of human culture and history in the physical environment and include prehistoric and historic archaeological sites, structures, natural features, and biota which are considered important to a culture, subculture, or community. Cultural resources also include aspects of the physical environment that are a part of traditional lifeways and practices, and are associated with community values and institutions. These traditional cultural resources are addressed in a separate chapter on ethnographic resources and tribal trust assets (Chapter 3.15). Cultural resources addressed here include the physical remains of prehistoric and historic cultures and activities, such as archaeological sites, historic trails, and boom towns. Historic properties are a subset of these kinds of cultural resources that meet specific eligibility criteria found at 36 CFR 60.4 for listing on the National Register of Historic Places (NRHP).

In this chapter, cultural resources have been organized into prehistoric and historic resources. Further, they are discussed according to established culture regions: Alaska, Northwest Coast, Plateau, Great Basin, Great Plains, California, and Southwest. These are regions where there is continuity across the landscape in cultural adaptations and traditions. Although these regions are most appropriately applied to prehistoric populations, historic period resources are also organized by these culture regions for the ease of discussion. Prehistoric resources refer to any material remains, structures, and items used or modified by people before Euro-Americans established a presence in the region. Historic resources include material remains and the landscape alterations that have occurred since the arrival of Euro-Americans.

Discussions of prehistory within each region are focused on chronological periods that have been established based on the prehistoric archaeology of the

region. It should be noted that for many of these regions there are area-specific culture chronologies that have been developed where cultural practices were unique within the larger region. Discussion of such specific time periods is avoided here given the programmatic nature of this document and for ease of discussion. Discussions of the history within each region are organized by overall themes of the region. This includes such things as westward expansion, transportation, and mineral development. Since this approach leads to a very general discussion of the culture regions, an effort was made to work with the USFS and BLM regional and district offices within the project area to identify areas sensitive for cultural resources.

Overviews by Region

ALASKA (ARCTIC AND SUBARCTIC)

Alaska is divided into two culture regions, the Arctic and Subarctic, which are combined into the Alaska culture region for purposes of discussion here (Figure 3-15a). The physiographic boundary between the two culture regions is essentially the tree-line (Damas 1984a; Neusius and Gross 2007). Culturally, the boundary is defined by areas occupied by the Inuit or Eskimo and the Aleut and those areas occupied by other Native American groups. Within the project area, the Arctic extends from the Yukatat Bay along the Alaska coast to the Bering Sea and includes the coast and adjacent tundra of the Yukon. Note that the portion of Alaska south of Yukatat Bay is considered part of the Northwest Coast culture region. The Aleutian Islands are included in the Arctic culture region as well. The Subarctic culture region is inland from the Arctic and encompasses interior Alaska (Damas 1984a; Helm 1981a; Neusius and Gross 2007). The southern boundary is marked by the boundary between the boreal forest and mixed deciduous-coniferous forests (Helm 1981a). The Arctic and Subarctic regions also include areas of Canada, Nunavut, and Greenland (Damas 1984a; Helm 1981a; Neusius and Gross 2007). However, since these areas are outside of the project area they are not discussed here.

USFS regions in the Alaska culture region include most of Region 10. BLM District Offices included in the region include all or portions of the Fairbanks and Anchorage offices.

Table I-1 identifies the Alaska culture region languages and tribes that have been documented within the project area, as well as the specific culture region, Arctic or Subarctic, they are associated with. Culturally, the Alaska culture region considered here is bordered by the Northwest Coast to the south.

Table I-1
Languages and Tribes of the Alaska (Subarctic and Arctic) Culture Region in the Project Area

Language (Linguistic Phylum; Culture Region)	Tribes
Athapascan (Na-Dene; Subarctic)	Holikachuk, Ingalik, Kolchan, Tanaina, Koyukon, Kutchin, Tanana, Ahtna, Han
Eskimaleut (American Arctic/Paleo-Siberian; Arctic)	Pacific Eskimo, Aleut, Mainland Southwest Alaska Eskimo, Nunivak Eskimo, St. Lawrence Island Eskimo, Bering Strait Eskimo, Kotzebue Sound Eskimo, Interior North Alaska Eskimo, North Alaska Coast Eskimo, Mackenzie Delta Eskimo

Source: Damas 1984b; Helm 1981b; Waldman 2000

Although the standard Handbook of North American Indians for the Alaska culture regions (Damas 1984c; Helm 1981c) offer region-specific chronologies for the Arctic and Subarctic, a more generalized chronology relevant to cultural patterns found in Alaska, which encompasses only a small percentage of the overall regions, is used in this discussion. Much of Alaska was ice free during the last glacial period (Clark 1981; Neusius and Gross 2007) and one would expect to find the earliest evidence for people crossing the Bering land bridge from Asia to be found in western Alaska. However, Pre-Clovis evidence for occupation of Alaska is debatable and the early coastline has been greatly altered from rising sea levels. The earliest agreed upon evidence is for a microblade tradition in the Paleoindian Subarctic similar to that of the Archaic Northwest Coast. The following outlines a general chronology used here for the culture regions of Alaska (Neusius and Gross 2007). One will note that many of the cultural traditions outlined below occurred concurrently in different regions. Such cultural patterns were too highly varied to accommodate a single general cultural period and are thus addressed separately.

- Paleoarctic: pre-8000 BP
- Archaic: 8000 – 500 BP
- Northern/Central Alaska
- Northern Archaic Tradition: 8300 – 500 BP
- Arctic Small Tool Tradition: 4500 – 3000 BP
- Norton Tradition: 3000 – 1200 BP
- Thule Tradition: 2000 BP – Modern Times
- Pacific Coast Alaska
- Ocean Bay Tradition: 7000 – 4500 BP
- Kodiak Tradition: 4500 BP – Modern Times

- Aleutian Tradition: 5500 BP – Modern Times

The Historic period then follows the Archaic Period, but as one can see many of the Archaic cultural practices continue today with minor adaptations to modern influences.

Cultural History

Prehistoric

Paleoarctic: As discussed above the evidence for Pre-Clovis occupations in Alaska are ambiguous, particularly in the far northern areas. However it would be in western Alaska that we would expect to find the earliest evidence of human occupation of North America if peoples migrated to the area via the Bering Land Bridge. As such, the archaeology of the area is considered likely to provide important information pertaining to early North American human settlement (Neusius and Gross 2007). Fluted points have been found, but like other culture regions, these are typically found as isolated surface finds or in uncertain associations, many just east of the state line in Canada (Dumond 1984; Helm 1981; Neusius and Gross 2007); unlike other areas, it appears fluted points were made later in Alaska than they were to the south and have some technologically differences. Although these points are not commonly found in direct association with bone of game in Alaska, blood residue analyses have indicated their use on such resources (Neusius and Gross 2007).

The earliest sites in Alaska are contemporaneous with Clovis sites found further south (Neusius and Gross 2007). The most confident of these early sites are comprised of stone tools and detritus (Dumond 1984). These are found western Alaska and are associated with the Nenana and Denali, dated to between 12,000 and 11,000 BP and between 11,000 and 8000 BP, respectively. The Nenana complex is a blade and biface industry, but is without microblades. Technology used to create Nenana tools is similar to that found in parts of the Southwest (Neusius and Gross 2007). The Denali complex is part of the Paleoarctic tradition seen elsewhere with inland hunters and includes microblades, wedge-shaped microblade cores, bifaces, and burins. Such toolkits are seen well into later periods of the region. It is believed that the microblade technologies are derived from Asia (Clark 1981; Neusius and Gross 2007).

Archaic: Archaic patterns in Alaska vary greatly across the region and differences between the Pacific Coast of Alaska and Interior Alaska begin to become more evident. In the northern and central regions of Alaska the Northern Archaic Tradition developed in the interior, giving way in some parts to the Arctic Small Tool Tradition and then the Norton and Thule Traditions. The first maritime adaptations are recognized along the Pacific coast in the Ocean Bay, Kodiak, and Aleutian Traditions. Throughout just about all of the Alaska region the Archaic persisted until historic times (Dumond 1984; Neusius and Gross 2007).

Central and Northern Alaska Traditions

The Northern Archaic Tradition (8000 – 500 BP) does not include microblades, but does include projectile points, bifacial tools, scrapers, and other lithic tools (Clark 1981; Dumond 1984; Neusius and Gross 2007). What little subsistence and settlement data there is would indicate that those practicing this tradition were generalized foragers who hunted on land and fished along rivers (Dumond 1984; Neusius and Gross 2007). Tracking these technologies across time and space has led researchers to believe that this tradition spread south and east following its development in interior Alaska. However, there is some indication that the tradition may have been the result of interaction with northern cultures of the Great Plains. Ultimately, the tradition appears to have been an antecedent to cultural practices of the Na-Dene or Athapaskan speakers of later times (Neusius and Gross 2007).

The Arctic Small Tool Tradition fully developed around 4000 and 3900 BP in northern Alaska midway through the Northern Archaic Tradition (Neusius and Gross 2007), ushering in a period of uniformity followed yet again by diversification of adaptations (Clark 1981; Damas 1984a). It is notably absent from the Aleutians and may have developed directly out of the Paleoarctic tradition of Siberia, migrating into Alaska. Originators of this tradition spread quickly throughout the Arctic and were the first to colonize the Arctic Ocean coast of North America, although the only known house sites are situated away from seacoast and toward the interior tundra. It is characterized blades that are smaller than those produced previously (Dumond 1984; Neusius and Gross 2007), as well as microblades, burins, adzes, oil lamps, as well as bone and antler tools (Clark 1981; Neusius and Gross 2007). Caribou hunting appears to have been the primary activity at sites of the Arctic Small Tool Tradition, but some on the Alaska Peninsula also appear to have been located so as to take advantage of salmon runs. In places where it remained, the tradition is believed to have continued until the Historic Period, appearing concurrently with other cultural traditions of the region (Neusius and Gross 2007).

In the western Arctic culture region the Norton Tradition developed and is dated to between 3000 and 1200 BP. Its tool assemblage is similar to that of the Arctic Small Tool Tradition, but incorporates ceramics. A series of three cultures, the Choris, Norton, and Ipiutak, characterize the Norton Tradition (Dumond 1984; Neusius and Gross 2007).

The Choris culture existed north of the Bering Strait between 3000 and 2500 BP and is characterized by new point styles resembling Paleoindian points of the Plains, chipped adze blades, burins, oval houses, and feather-tempered pottery. Technologies employed in Choris pottery appears to have been adopted from another region, most likely Asia, as a developed technology, as opposed to being locally invented (Dumond 1984; Neusius and Gross 2007).

The Norton complex appears around 2500 BP, apparently developing from the Choris complex. Occurring along the Alaska Peninsula and over to the northeastern border of the state and Canada, the Norton complex is characterized by caribou hunting, sealing, net fishing for salmon, and whale hunting as well as a artifacts such as check-stamp design pottery, use of ceramic and stone lamps, end and side blades, knives, including some made of ground slate, burin-like tools, scrapers, and net sinkers (Dumond 1984; Neusius and Gross 2007).

The Ipiutak complex existed in northern Alaska above the Bering Strait and first appeared around 2000 BP, sharing several traits with the Choris and Norton complexes, but lacking lamps and pottery. The tradition is best known for its art, which incorporates elaborate carvings of animal and human figures, linked chains, and entangled objects. In addition to its art, the Ipiutak complex includes a variety of utilitarian objects such as harpoons, snow goggles, ground slate tools, and houses with entry ramps (Dumond 1984; Neusius and Gross 2007).

The Thule Tradition developed out of the Norton Tradition around 2000 BP and has continued through the Historic period (Dumond 1984; Neusius and Gross 2007). It covers several cultural complexes within Alaska. The tradition is likely best known for new hunting technologies to be used in open waters, especially for whaling (Neusius and Gross 2007). This is not to say though that the capabilities of Thule terrestrial hunters were not as sophisticated as those of marine and riverine hunters. In fact, the two skills were very well matched (Dumond 1984).

Early sites of the Thule Tradition are attributed to the Old Bering Sea and Okvik cultures (2200 – 1250 BP) of St. Lawrence and adjacent islands, as well as the Asian coast (Dumond 1984; Neusius and Gross 2007). The tradition is presumed to have developed about the same time the Ipiutak complex was developing on the mainland. Artifact forms of these Old Bering Sea and Okvik cultures are very similar and are only distinguished by their decorative art styles. The toolkit of these cultures in this part of the region included bone, antler, and ivory tools. Pottery was also used for cooking pots and lamps. Sea mammal hunting constituted the primary subsistence endeavor. It is though that this was done from the ice edge, but was also likely done on open water with the use of harpoon lines and large open boats called *umiaks*. However, kayak artifacts and models provide evidence of the use of closed boats as well. Additionally, winter seal hunting is suggested by the presence of ice picks, fishing by the presence of hooks and spears, and the bow and arrow suggest terrestrial mammal hunting. Sleds were used to transport materials and kills; however, these were not the dog sleds commonly associated with Alaskan cultures (Neusius and Gross 2007).

The Birnirk culture developed in northern coasts of Alaska and spanned the same time period as the Old Bering Sea and Okvik cultures. Hunting activities

and tools were similar to those of the more southern Alaska cultures, including use of kayaks and *umiaks*, but are distinguished by the use of flat toggling harpoon heads. Sleds were used for the same purposes and by the same means. Utilitarian pottery pieces, such as lamps, were marked with impressed circular designs. Houses were square with driftwood or whalebone above-ground walls, plank-lined floors, and sod-covered roofs (Neusius and Gross 2007).

From the Birnik culture developed the Thule culture which existed between 1050 BP and 400/250 BP. The complex of material culture attributed to this culture is also associated with the historic Eskimo and Inuit. Like the other cultures in the Thule Tradition, artifacts that characterize the Thule culture include bone, antler, and ivory tools, such as arrows, spears, and harpoon heads. However, in the Thule tradition the ratio of groundstone to other artifacts rose significantly to include about half of all stone tools found. Pottery was also used, but was tempered with gravel instead of the fibers used previously (Neusius and Gross 2007). The culture spread rapidly from northern Alaska across the Arctic, marked by the Sicco-type harpoon head, eventually reaching Greenland and once again displaying a cultural continuity for the majority of the Arctic culture region, similar to the Arctic Small Tool Tradition (Damas 1984a; Neusius and Gross 2007). The expansion was likely a result of people following bowhead whales. Dogsleds first appear with this culture, possibly as a result of open water hunting of bowheads which allowed for groups to amass large stores of food that would need to be transported back for storage at a settlement. In addition to whale hunting, seals, walruses, and birds were hunted from kayaks using *atlatls* and darts (Neusius and Gross 2007).

Pacific Coastal Alaska Traditions

The Ocean Bay Tradition (7000 – 4500 BP) is certainly present on Kodiak Island and possibly on the Alaskan Peninsula and Pacific Coast. It may be related to materials found on the Aleutian Islands. Ocean Bay sites are considered to be the earliest representations of maritime adaptations along the Alaska Pacific coast. It is notable for the use of tools made of ground slate, which were introduced into an assemblage dominated by flaked stone. The subsistence economy of peoples practicing this tradition was based on hunting of marine mammals and the pattern of site locations, situated on coastlines and near the ocean, is consistent with this activity (Neusius and Gross 2007).

The Kodiak and Aleutian Traditions developed out of the Ocean Bay Tradition around 4500 – 5000 BP and 5500 BP, respectively, and continued into modern times (Dumond 1984; Neusius and Gross 2007). The Aleutian Tradition developed west of the Kodiak Tradition. Ground slate tools are absent in this tradition, at least until very late in the period, around 500 BP. Instead flaked tools are primarily relied upon. The tradition does share the use of oil lamps and similar bone tools with the Kodiak Tradition. Sea mammal hunting appears to have been important given their commonality at sites, along with land mammals, marine invertebrates, fish, and migrating and resident birds. Aleutian

Tradition sites are typically large middens along the coast that were inhabited on a semipermanent basis. Given the archaeological evidence, it is believed that the people practicing the Aleutian Tradition are the ancestors of the modern Aleuts (Neusius and Gross 2007).

As insinuated by its name, the Kodiak Tradition is centered on the Kodiak Island area and is characterized by the use ground slate, differentiating it from the Aleutian Tradition (Dumond 1984). It is separated into two stages: the Takli stage (4500 – 3500 BP) followed by the Kachemak stage (3500 – 1000 BP). In the Takli stage the toolkit included slate lance or dart points, formed initially by sawing, oil lamps, and chipped stone similar to that of the Ocean Bay Tradition. Subsistence activities focused on hunting land and sea mammals as well as fishing, and settlements are situated in areas conducive to these activities. In the Kachemak stage ground slate tools continue to be used, but are instead initially formed by chipping. In addition to slate tools, oil lamps continue to be present in sites as well as labrets of stone and bone. A variety of bone tools occur, including the toggling harpoon which improved the success of maritime hunting (Neusius and Gross 2007).

Historic

Historic continuity of earlier cultural practices is prevalent in Alaska (Clark 1981; Neusius and Gross 2007). In fact, through the 19th century, some Arctic groups had not yet had contact with Europeans (Neusius and Gross 2007). Russian exploration of the region led to the fur trade with historic Alaskan native peoples (Damas 1984; Neusius and Gross 2007) and Russian Orthodox missionaries followed. The effect of these missionaries was not as extensive as the effect of Spanish missionaries further south. As the whaling industry grew in the region and ships began wintering in the Arctic, contact between the native Alaskans and Europeans increased. This in turn led to increased trade and ultimately dependence on the fur trade to obtain European goods. Such adaptations are only one of a few historic changes in the native economies of Alaska (Neusius and Gross 2007). Mining and oil development by Europeans of the Alaskan interior began during the historic period and have continued to affect the cultures of the region into modern times (Helm 1981a; Neusius and Gross 2007)

Euro American Contact

Vitus Bering, a Danish sailor, was commissioned by Peter the Great, the Czar of Russia, in 1725 to explore the region that is present-day Alaska. Bering explored Greenland and the southwest coast, but did not explore present-day Alaska. His expeditions did heighten interest in the region because of the news he brought back to Europe of the wealth of furs and possibility of trading (Borneman 2003)

The Spanish were also interested in the region, partly out of concern that the Russians were going to settle that part of the continent. Spain also sent

expeditions to the region but did not establish permanent settlement in Alaska. (Borneman 2003)

The English were also early European explorers to the Alaska region. In 1776 Captain James Cook sailed the northwest coast of North America, mapping the inlet he discovered (named the Cook Inlet by George Vancouver) (Borneman 2003)

The first European settlement in Alaska was the Russian-American Company, established in 1784. The company was at the center of fur trade in Alaska, even though however the Russians never fully colonized the region.

Trade

Fur trade. Fur trapping and trading was one of the primary reasons Europeans were attracted to the region. The French, British, and Russians were all part of the fur trade in Alaska. The Hudson Bay Company and the Northwest Company had fur trading posts throughout Alaska, which lasted from the 1720s until it dwindled in the 1850s because of a diminishing animal populations (Neusius and Gross 2007 and Borneman 2003).

Commercial Whaling and Fishing. Shore-based Eskimo whaling was long a tradition in coastal communities. Eskimo whalers were limited to taking whales near their villages when the animals migrated past on their annual round. Because of the huge quantity of meat and oil that successful whale hunting provided to a coastal village as well as the danger involved in a whale's pursuit, whaling and whalers had special significance for such communities. Ship-based whaling flourished during the 17th-19th centuries. Scandinavian, Dutch, English, Scottish, Russian and American whale fleets pursued the whales in the 19th century. Oil reduced from blubber and baleen were the primary commodities produced by this worldwide whaling industry (National Science Foundation 2007).

Salmon fishing was a mainstay to the Alaskan economy, with the first commercial salmon cannery built in 1878. Canneries were built throughout the southeast portion of Alaska, as well as in Cook Inlet and Bristol Bay (Borneman 2003). Salteries, which processed the salmon, packed and imported it in barrels, were also established. By 1911, the salmon population in Alaska was reduced, but by the 1920s, fishing was still considered the bedrock of the Alaskan economy (Borneman 2003). Commercial fishing continues to be an important part of the local economy.

Missionaries. Russian Orthodox missionaries followed the fur explorers and traders to the region during the 1740s-1780s. They were most successful in southern Alaska, and their activities lasted into the 1800s (Neusius and Gross 2007).

Gold Mining. Although gold was first discovered in 1850 on the Kenai Peninsula by a Russian mining engineer, the discovery was not widely publicized (Borneman 2003). In 1897, the Klondike River was the site of another gold discovery which led to a major gold rush into eastern Alaska and the Yukon Territory. Many settlers and gold miners came to the area, establishing trails or sailing routes in order to reach the area. The gold boom also struck in other parts of Alaska, such as Fairbanks and Nome (Borneman 2003). Other minerals, such as copper and molybdenum were mined as well.

Oil. Oil was claimed in Alaska on the Iniskin peninsula in the 1890s. In 1898, the first Alaska wells drilled oil there, however there was not enough to support a full-scale, long-term production of oil (Alaska History and Cultural Studies 2008).

The first productive drilling of oil occurred at Katalla, just south of the Copper River Delta. In 1911, new wells in the area began to produce a significant amount of oil, which was recovered then processed at a refinery at Katalla. The cost of transportation and operating costs were high, but the yield of oil proved worthwhile. In the 1960s, oil companies bought exploration leases for work in the Cook Inlet and production of oil began. (Alaska History and Cultural Studies 2008). Oil exploration, production and transportation at continues to be the most important industry in Alaska.

Trans-Alaska Pipeline System. The system began in 1968 as a joint venture between British Petroleum, Atlantic Richfield, and Humble. It was completed in 1977 and is an 800-mile pipeline that transports oil from Prudhoe Bay south to Hickel Highway, across the Yukon and to Livengood and Fairbanks. It then crossed the Alaska Range at Isabel Pass and the Chugach mountains at Thompson Pass before dropping into the port of Valdez through the Keystone Canyon (Borneman 2003).

EuroAmerican Expansion

In 1812, the Russian hold on Alaska was becoming weak, as American hunters and trappers were encroaching on Russian territory. The settlement that gave Americans the right to trade fur only below the 55°N latitude was generally ignored, making the Russian position in Alaska even weaker. Eventually, the Russian American Company entered an agreement with the Hudson's Bay Company to allow British sailors passage through Russian territory. Russia decided to sell its lands to North America, and in 1867, William H. Seward, the US Secretary of State, secured the purchase of Alaska from the Russians. Alaska became a state in 1959. (Borneman 2003)

Railroads. The Copper River and Northwestern Railroad, which was originally constructed to bring ore from the Wrangell Mountains to the Guggenheim smelter in Tacoma, Washington, constructed in 1911 (Borneman 2003). The railroad went through Kennecott, Bennett, and other cities that underwent a

major growth spurt and a "boom" as they served the copper mines, miners, and served as railroad stops. The Great Depression and the fall in prices of copper, the railroad shut down and was no longer in use. The line was in use for only twenty-seven years (Borneman 2003).

The Alaska Railroad was established in April 1915**.** The line was to extend from Seward to Fairbanks, a seventy-two mile stretch. Completed in 1922, the rail line brought freight and passenger traffic to Alaska and serviced some of the most populated cities in Alaska, such as Seward, Anchorage, and Fairbanks. The line was instrumental in transporting military and civilian supplies and materials during World War II. The line has been upgraded several times and continues to be a transportation link (The Alaska Railroad 2008).

Alaska Marine Highway. The period after World War II was a period of expansion for Alaska. One example is the Alaska Marine Highway. By 1963, three ships in the southeast region went into service, creating the Alaska Marine Highway, which ran regularly scheduled trips to the major towns along the Inside Passage (Borneman 2003).

Trails

Iditarod Trail. The Iditarod trail was a path originally used by Native American hunters and Russian explorers. In the twentieth century, gold seekers used the trail to reach the mines, and the trail was improved. Several towns such as Seward, Iditarod, and Nome grew up around the mining districts, where miners would buy supplies from local stores and markets and stay overnight in tents prior to going off to the mines. The trail begins in two places, at Seward and at Nome, and eventually met at the Iditarod Mining District. It was officially surveyed by the U.S. Army's Alaska Road Commission in 1908. It was heavily used until 1924, but its use diminished as the use of airplanes became more common. In the 1960s, interest in dog sledding and use of the trail was revived and the first Iditarod race took place in 1967 (Bureau of Land Management 2007) The trail is now part of the National Trails Service of the National Parks System.

NORTHWEST COAST

The Northwest Coast culture region covers areas between the crest of the Cascades and the ocean from the Copper River delta and Yakutat Bay in Alaska south to the Winchuck River and Cape Mendocino in California (Figure 3-15e). The region does include parts of Canada, but since this part of the Pacific coast is not included in the project area, it is not discussed here. The region is highly varied and is divided into three subareas for purposes of discussion: North, South, and Central (Neusius and Gross 2007; Suttles 1990a). The project area encompasses part of the Northern subarea and all of the South and Central subareas

USFS regions included in the Northwest Coast region include portions of Regions 5, 6, and 10. BLM District Offices included in the region include all or portions of the Medford, Coos Bay, Roseburg, Eugene, Salem, Spokane, and Anchorage offices.

Table I-2 identifies the Northwest Coast culture region languages and tribes that have been documented within the project area. Culturally, the Northwest Coast culture region is bordered by the Arctic to the north, the Plateau to the east, California to the south, and the Subarctic to the north and east.

Table I-2
Languages and Tribes of the Northwest Culture Region in the Project Area

Athapaskan (Na-Dene)	Kwalhioqua, Clatskanie, Umpqua
Tlingit (Na-Dene)	Tlingit
Chinookian (Penutian)	Chinookans
Kalapuyan (Penutian)	Kalapuya
Kusan (Penutian)	Coosans
Takelman (Penutian)	Takelma
Yakonan (Penutian)	Alsea, Siuslaw
Wakashan (Undetermined linguistic phylum)	Makah
Salishan (Undetermined linguistic phylum)	Southwestern Coast Salish, Central Coast Salish, Southern Coast Salish, Tillamook
Chimakuan (Undetermined linguistic phylum)	Quilete, Chemakum

Source: Suttles 1990b; Neusius & Gross 2007; Waldman 2000

A general chronology of the Northwest Coast has been developed based on developments in lithic technology and social organization (Neusius and Gross 2007). Similar to California and other coastal regions, the early prehistory of the Northwest Coast has been dramatically affected by post-glacial sea level rise, resulting in inundation of the coastline and altering coastal environments. The entirety of the Northwest Coast was ice-free as of 12,000 years ago (Neusius and Gross 2007; Suttles 1990a), although lands immediately adjacent to the Pacific Ocean were never glaciated. The region though is unique in that its moist nature has led to excellent preservation in many saturated sites. Although a few sites and surface finds have been attributed to Paleoindian occupations, these are not definitive points of evidence for an early occupation of the Northwest Coast. The following outlines the general chronology of Northwest Coast (Neusius and Gross 2007).

- Paleoindian: pre-10,000 BP
- Archaic: 10,000 – 6400 BP
- Pacific: 6400 – 175 BP

- Early Pacific: 6400 – 3800 BP
- Middle Pacific: 3800 – 1800/1500 BP
- Late Pacific: 1800/1500 – 175 BP
- The Historic period then follows the Late Pacific Period.

Cultural History

Prehistoric

Paleoindian: Due to the above mentioned effects of deglaciation, much of the critical coastal areas where one would expect the earliest sites representing migration through the Northwest Coast into North America are under water (Neusius and Gross 2007). However, in general, sites older than 5000 BP are not considered abundant (Carlson 1990). Some Clovis points have been found in the region, but these are typically isolated surface finds, which makes their association with other artifacts questionable. The nearest accepted evidence of Paleoindian activity is a cache of points in the Plateau region on the opposite side of the Cascade Range (Neusius and Gross 2007). As in California, the scarcity of such artifacts in the Northwest Coast may be due to the rise of sea level and subsequent submersion of the coastline.

Archaic: Archaeological evidence suggests that Northwest Coast peoples of the Archaic Period existed in small, mobile populations with large territories. This results in primarily ephemeral sites for this period. Both terrestrial and marine resources, including salmon a basis of later diets, were exploited (Neusius and Gross 2007).

Four major technological complexes characterize the Archaic Period in the Northwest Coast culture region. These complexes occur concurrently in different areas as well as successively in the same area. These are: the Fluted and Stemmed Point Traditions, which spread between 10,950 – 9950 BP toward the coast along the Columbia River from interior North America, and the Pebble Tool and Microblade Traditions which spread southward along the coast and inland up river valleys, first appearing in the Northwest Coast between 9950 and 8950 BP (Neusius and Gross 2007; Carlson 1990).

The Fluted Point Tradition is poorly represented in this culture region, and as it is in other culture regions, is mostly documented via isolated and surface finds of fluted points. Unlike other regions, they are rarely associated with faunal remains or other artifacts. Given the relative lack of evidence for this tradition, it would appear that it did not last for very long in the Northwest Coast culture region. It is most likely derived from the Great Basin and transferred or migrated down the Columbia River and its tributaries (Carlson 1990).

The earliest sites in the Tlingit and Haida regions of northern Northwest Coast have Microblade Tradition components (Carlson 1990). Ground Hog Bay 2 and

Hidden Falls are two sites within the project area in the Northwest Coast that are attributed to this tradition, the former, on the Chilkat Peninsula, being the oldest concurred upon site of the Microblade Tradition. It is thought that these two sites represent the spread of microblade technology from interior Alaska south (Neusius and Gross 2007). The technology continued to move southward through the Archaic and subsequent Pacific Period (Carlson 1990). Some sites in the region however may represent spread in the opposite direction, from the south to the north. The Microblade Tradition is characterized by microblades, microblade cores, pebble tools, and flakes, with bifaces being rarities (Neusius and Gross 2007). Sites with components representing this tradition are typically located where access and survival demanded developed water transport technologies and use of marine resources. Additionally, the inclusion of other point types and technologies in tool kits of some sites suggest influence from the Plateau to the east (Carlson1990).

In the project area the Pebble Tool Tradition is present in archaeological sites from the Puget Sound south to the lower reaches of coastal rivers, however in totality the tradition reaches further north into Canada near the Queen Charlotte Islands. This tradition also has various local expressions that are referred to by other names (Carlson 1990). Bifaces, particularly stemmed leaf-shaped points, accompanied by pebble tools characterize this tradition (Carlson 1990; Neusius and Gross 2007). Additionally a bone and antler industry is present while microblades are absent. Some sites indicate an interface between the Pebble Tool and the Stemmed Point Traditions (Carlson 1990). Overall however, the Pebble Tool Tradition is more similar to assemblages found in the Plateau, Great Basin, California, and Southwest regions. One of the most important archaeological sites of this tradition is within the project area in The Dalles, Oregon along the Columbia River. This is a fishing site that spans the Archaic and all subsequent periods, into modern times, indicating the significant time depth of fishing in this area (Neusius and Gross 2007). The Pebble Tool Tradition began as a marine-adapted culture that spread upriver and into the mountains and interior of the Northwest Coast, most likely following salmon runs. Sites are typically situated along rivers where fishing, particularly of salmon, and terrestrial mammal hunting would have provided the major forms of subsistence resources, supplemented by marine resources. In general, occupations of the Pebble Tool Tradition suggest a fishing and sea mammal hunting culture with sufficient technology to construct and use watercraft early on (Carlson 1990).

The Stemmed Point Tradition is primarily situated along the Columbia River and emanating from interior North America. In fact, there are several early Archaic Period sites along the eastern Northwest Coast boundary with the Plateau culture region. Representation of the technological tradition along the coast is rare. It is characterized by chipped stone crescents and long stemmed points. A focus on hunting typifies the associated cultural activities (Carlson 1990).

Several of the above patterns persisted into historic times. The disparate technologies suggest different cultural traditions with their own technologies existed within the cultural region of the Northwest Coast. However, between the time of their initial appearance in the region and 4950 BP (Early Pacific Period) the differences among the cultures using these early traditions were being homogenized as people adapted to the environment, populations grew, and relationships between groups expanded (Carlson 1990).

Pacific: During the Pacific Period the Northwest Coast region developed a variety of characteristics that distinguish it from neighboring culture areas and several of the Archaic technological traditions continue (Carlson 1990; Neusius and Gross 2007). This includes increases in populations leading to increased sedentism with cyclical rounds of permanent village sites with pithouses and later the characteristic wooden plank house. Economies were focused on aquatic resources particularly salmon in some areas. Storage of resources became important and the notable woodworking and art styles of the region developed during this period. All these developments point to an increasing social complexity of Northwest Coast tribes during the Pacific Period.

The Early Pacific Period is characterized by a lack of microblade cores seen during the Archaic, and use of bone and antler tools. Groundstone tools were replaced by chipped stone tools in many areas. Midden sites are larger in size and are denser in their assemblages compared to the earlier ephemeral Archaic sites. Economies were diverse, but a focus on seafood is apparent when looking at faunal assemblages and isotopic analyses of human bone from burials, which are commonly found for this period. Other evidence points to a developing emphasis on riverine resources as well. Burials and grave goods also provide evidence of achieved status of elites in populations. Other burial data suggest violence and conflict between groups, which is supported by the location of some sites in the northern subarea on bluff tops and other such defensible locations (Neusius and Gross 2007).

During the Middle Pacific Period, certain activities were intensified, especially fishing with the extensive use of nets and large fish weirs. Wooden storage boxes are first seen during this period signaling the importance of food storage as populations continued to expand substantially. The characteristic wooden plank house makes its first appearance too during this time. Planks could be removed and re-established in other areas allowing some form of residential mobility. Incidence of violence continued to increase in the northern subarea of the region, while it appears to have been much less common in the southern areas. Social hierarchies developed throughout the region on individual and village levels and was now based on ascribed status, rather than achieved. There are even possible indications of slavery during this time. Art is rare during this time, but those examples that have been found foreshadow the characteristic styles recorded for the region (Neusius and Gross 2007).

If the Middle Pacific Period saw the early beginnings of historically recorded lifestyles of the Northwest Coast, the Late Pacific Period saw their full development and a peak in population numbers, represented by a high number of sites. Flaked stone tools are entirely replaced by bone, antler, and groundstone tools. Subsistence economies continued to become intensified, but not all were focused on salmon fishing. Groups appear to have focused on what was locally important to them. Throughout however, storage continued to be a mainstay of economies with continued use of wooden boxes and also baskets. There was greater use of nearshore and offshore resources as indicated by an array of fishing implements and tools for sea mammal hunting, including nets, weirs, traps, tackle with hooks, weights, lines, and toggling harpoons. Tools for woodworking are also prominent in archaeological assemblages, presumably a result of the focus on house construction, although they would have also been used for construction of bentwood storage boxes and canoes. Remains of plank houses are more common during this period as well, including whole ones at the Meier site near Portland, Oregon within the project area. Evidence for individual social stratification is not as apparent as previous periods based on the lack of in-site burials along the coast. Instead evidence for village hierarchies is based on the presence or lack of village-associated burial mounds, such as those in the Fraser River and Willamette Valley areas. It should be noted however, that there is evidence for social ranking within houses. Burials and village locations in defensive areas, such as bluff tops and built fortifications, provide evidence of increased violence throughout the Northwest Coast region. The distinctive Northwest Coast art style was fully developed in the Late Pacific Period, although there are fewer art objects found (Neusius and Gross 2007).

Historic

Early explorers were the first non-Native contacts in the Northwest Coast culture region. In particular, the fur trade brought much interaction between Europeans and native Northwest Coast populations. Trading posts were established in the region to facilitate such trade between the Native Americans, Russians, and other Europeans. A variety of artifacts are found in archaeological sites that were received as part of the fur trade. However, relations between the tribes and the new settlers were often hostile (Neusius and Gross 2007).

Euro American Contact

Spain and England sent explorers to the northwest coast region, during the 1770s. Russia also led expeditions to the region in 1741. Captain James Cook, a British sailor, landed in Northwest Coast region, and attracted fur traders and trappers with news of fur resources in area (Schwantes and Hayes 1999). Fur traders and trappers from the America and Canada also found new overland routes to the Northwest Coast region from the east and north through various trails.

Trade

Fur. The discovery of sea otters during the explorations of the Northwest Coast region spurred a period of fur trading for export to Asian and European markets that lasted until 1850 (Neusius and Gross 2007). Permanent trading posts were established in 1799, first by the Russians at Tlingit, and then by the Americans, who established a post on the lower Columbia in 1811. Many fur trappers and traders from the United States and Canada found new routes to the region.

Mining. The discovery of gold in the Coast Range of Oregon and Washington in the 1850s brought settlers and gold miners to the area. In addition to gold, mined resources in the northwest included silver, copper, sand, salt, gravel, phosphate, and coal (Schwantes 1989). There was a significant coal mining industry east of the Seattle and Tacoma area and west of Ellensburg during the 1870s and 1880s. This coal mining industry in Pierce and King Counties, in the foothills of Mount Rainiere, had a typical boom and bust cycle that most other mining settlements of the time shared (Washington 2008).

Fishing, Timber, and Agriculture. The economic foundation of the Northwest Coast region came from the fishing, timber and agricultural industries. Commercial fishing became popular during the late-nineteenth century, with salmon being the most desired fish product. Canneries and salteries were established along the Columbia River.

The vast forests of the region were attractive to the timber industry. California mines, cities, and ships required huge amounts of lumber, and the deep waters and forested shorelines of Pacific Northwest offered the most convenient place to get these commodities. The availability of cheap river and ocean transportation allowed entrepreneurs access to world and domestic markets through Portland, Seattle and other ports. Docks and sawmills appeared to deliver wood products to the ships that sailed away to San Francisco and other Pacific ports Farm products from the Willamette Valley, minerals from Idaho, and wheat from around Walla Walla all traveled to market via riverboats to the port cities.

Western Expansion

Trails

Oregon Trail. The Oregon Trail was a major route for trappers, traders and settlers traveling to the Pacific Northwest from the east, The Trail began as an unconnected series of trails used by the Native Americans. Fur traders expanded the route to bring pelts to trading posts in the early 1800s. The route extends roughly 2,000 miles west from Missouri toward the Rocky Mountains to the Willamette Valley. A trail to California digressed from the route in Idaho (Bureau of Land Management 2007). Several groups followed the route over time including large populations of settlers, moving from the eastern

portion of the US to settle the west between 1800 and 1880s. (Bureau of Land Management 2007)

Missionaries used the trail during the 1830s, traveling along the Platte and Snake Rivers to settle churches in the Northwest. Mormons, headed toward Salt Lake in Utah, used the trail beginning in 1847, and the discovery of gold in California caused many gold miners to use the trail in 1849. It is estimated that four thousand emigrants followed the trail west in 1847 (Schwantes 1989), many in small caravans of wagons. Military posts and spur roads were established off the Oregon Trail. It was used as a cattle driving trail eastward for a brief time as well. The construction of the Central Pacific Railroad, connecting California to the rest of the continent in 1869, decreased use of the Oregon Trail and by the early 20th century, the trail was no longer used as a major transportation corridor, as railroad lines paralleled the trail (Bureau of Land Management 2007, Schwantes 1989).

Applegate Trail. This trail was used originally to link the Northwest Coastal area to Oregon. It crosses the Black Rock Desert, the High Rock Canyon, and into the Warner Mountains to Central California. The trail ends in Oregon (Bureau of Land Management 2007). This southern route of the Oregon Trail, established in 1846 by the Applegate brothers was considered a safer route to Oregon as it bypassed the avoided the obstacles of the Burnt River Canyon, the Blue Mountains, and the Columbia River (Webtrail 2007).

Cowlitz Trail. This trail is not on BLM or Forest Service land and has not been designated as a National Historic trail. It was used in 1839, to connect the Willamette Valley with the Puget Sound Basin. The trail was a muddy footpath in 1845, used to connect Fort Vancouver to South Puget Sound. Hudson's Bay Company traders used it as had Native Americans before them. The trail has disappeared throughout the years with the construction of roads over it (City of Tumwater, Washington)

Lewis and Clark. This trail runs along the explorations of Meriwether Lewis and William Clark. The trail follows the Missouri River upstream, eventually reaching the Pacific Ocean at the mouth of the Columbia River. The route goes through Idaho and western Montana (USDA Forest Service 2003)

Railroads

The Northern Pacific Railroad was constructed in 1873, and by 1883, it was connected to Minnesota and the remainder of the eastern portion of the U.S. This rail line increased settlement and immigration to the area, as well as enabled railroad communities to be established. The railroad enabled the lumber and agriculture industries as raw materials could be transported from the Northwest Coast to more easterly regions of the United States.

Rivers and Ports

Large rivers and port towns of the northwest provided a crucial link between these remote territories and the outside world. The access provided by the Columbia River and its tributaries enabled shipment of goods to and from inland settlements. In the 1850s, timber mill towns began to develop in the Puget Sound area because of the deepwater anchorage that protected ships from Pacific storms (Schwantes 1989). These waterways enabled the industries of the northwest to supply the California coastal cities until the railroad boom of the 1880s.

PLATEAU

The Plateau culture region comprises the area drained by the Columbia and Fraser Rivers, with the exception of some areas within the Great Basin (Figure 3-15f). In general, the area covers parts of British Columbia, eastern Washington, western and northern Oregon, the Idaho panhandle, and western Montana.

USFS regions included in the Plateau region include portions of Regions 1, 4, 5, and 6. BLM Offices included in the region include all or portions of the Spokane, Vale and Prinevale District Offices and Coeur d'Alene, Cottonwood, Missoula, Dillon and Butte Field Offices..

Table I-3 identifies the Plateau culture region languages and tribes that have been documented within the project area. Generally, Salish speakers are associated with the Northern Plateau, Sahaptin speakers with the south, Chinookan speakers with the west, Klamath-Modoc speakers with the southwest, and the Cayuse and Molala speakers with isolated areas of the region (Neusius and Gross 2007). Culturally, the Plateau culture region is bordered by the Northwest Coast on the west, the Plains on the east, the Great Basin on the south, and the Subarctic on the north. The Southern and Eastern Plateau subareas are within the U.S., while the Northern area is primarily in Canada.

Table I-3
Languages and Tribes of the Plateau Culture Region in the Project Area

Language (Linguistic Phylum)	Tribes
Salish (Undetermined linguistic phylum)	Coeur d'Alene, Flathead and Pend d'Oreille, Kalispel, Middle Columbia River Salishans, Northern Okanagan, Lakes, and Colville, Spokane, Thompson
Sahaptian (Penutian)	Umatilla, Walla Walla, Nez Perce, Palouse, Western Columbia River Sahaptins, Yakima and Neighboring Groups
Chinookan (Penutian)	Wasco, Wishram, Cascades
Klamath-Modoc isolate (Penutian)	Klamath, Modoc

Table I-3
Languages and Tribes of the Plateau Culture Region in the Project Area

Language (Linguistic Phylum)	Tribes
Molalla isolate (Penutian)	Molala
Cayuse isolate (Penutian)	Cayuse
Kutenai isolate (Macro-Algonquian)	Kootenai

Source: Neusius and Gross 2007; Waldman 2000; Walker, Jr. 1998a

The Plateau region has typically experienced cool climates since glaciers cleared from the area around 11,000 BP. However, the area has witnessed a period of warming since 2800 BP (Neusius and Gross 2007). Human occupation of the Plateau culture region began around the time of glacial retreat. A cultural chronology consisting of Early, Middle, and Late Periods, the Middle and Late Periods being divided into subperiods, has been developed based on archaeological and ethnographic research (Chatters and Pokotylo 1998, Neusius and Gross 2007).

- Early Period: 11,500 – 8000 BP
- Middle Period: 8000 – 4000 BP
- Early Middle Period: 8000 – 5300 BP
- Late Middle Period: 5300 – 4000 BP
- Late Period: 4000– 230 BP
- Early Late Period: 4000 – 2500 BP
- Middle Late Period: 2500 – 1500/1000 BP
- Late Late Period: 1500/1000 – 230 BP

Area-specific culture chronologies for the Southern Plateau include Period I (11,500 – 6950/5950 BP), Period II (6950/5950 – 3850 BP), and Period III (3850 – 230 BP) (Ames, et al 1998). Within the Eastern Plateau, prehistory has been divided into a three-phased chronology including Early Prehistoric Period (pre-9950 – 6950 BP), Middle Prehistoric Period (6950 – 1450 BP), and Late Prehistoric Period (1450 – 230 BP) (Roll and Hackenberger 1998). It should be noted that areas within these subregions exemplify their own characteristics during these periods and researchers have developed additional subperiods and phases.

Archaeological research has uncovered specific common cultural patterns in this region including (Neusius and Gross 2007, Waldman 2000, and Walker, Jr. 1998b):

- Linear settlement patterns along rivers;
- Diverse subsistence base of fish, game, and roots;
- Complex fishing technology;

- Intermarriage and cooperative use of subsistence resources among groups;
- Institutionalized trading throughout the area;
- Village and band levels of social organization; and
- Relatively uniform mythology, art styles, and religious practices.

Cultural History

Prehistoric

Early Period: There is little archaeological evidence for very early human occupation of the Plateau culture region compared to subsequent time periods. In fact, only one extensive Paleoindian Clovis (11,500 – 10,800 BP) archaeological site has been found. All other archaeological evidence of human occupation during this period is found in surface scatters of artifacts and single, isolated artifacts (Chatters and Pokotylo 1998, Neusius and Gross 2007).

Post-Clovis Early Period inhabitants of the Plateau region appear to have lived in small, mobile hunter-gatherer groups (Chatters and Pokotylo 1998, Neusius and Gross 2007). Groups were organized into semi-permanent villages with temporary subsistence camps at higher elevations. Winter villages were typically located along main rivers, while summer villages were established at the higher elevations (Chatters and Pokotylo 1998, Waldman 2000, Walker, Jr. 1998b. A wide variety of subsistence resources were used including riverine resources and large game. Within most sites located along rivers, fishing is demonstrated by artifact assemblages to be the most important subsistence activities. The majority of sites from the Early Period are open sites where large game and hunting implements dominate the artifact assemblage. However, fish bones are still quite common in these assemblages (Neusius and Gross 2007).

Projectile points are also very common artifacts within the region. Specific styles can provide excellent temporal markers for Plateau archaeological sites and they vary spatially (Neusius and Gross 2007). Other artifacts that are common to Plateau region Early Period archaeological sites include a variety of stone tools (cobbles, bifaces, scrapers, gravers, burins, and bola stones), bone tools (points, awls, and needles), beads, and antler wedges. Sometimes millingstones, anvil stones, abraders, and antler flakers are also found (Neusius and Gross 2007).

There is spatial variation of settlement and artifacts patterns within the Early Period. Typically, sites in the northern portion of the Plateau region have limited assemblages that include microblades and flake tools. Meanwhile southern Plateau region sites appear to be short-term occupations with small, low-density artifact assemblages lacking microblades. Towards the end of the Early Period, a pattern of increased numbers of expedient tools emerges (Chatters and Pokotylo 1998, Neusius and Gross 2007).

Middle Period: Settlement patterns during the Middle Period are mostly within low-elevations. However, near the end of the period there is evidence in the eastern Plateau of limited collecting activities in higher elevations (Neusius and Gross 2007).

The Early Middle Subperiod is largely a continuation of Early Period cultural patterns with some distinct variations (Chatters and Pokotylo 1998, Neusius and Gross 2007). In the northern Plateau people practiced a foraging strategy hunting for deer, elk, and other game, as well as fish and birds. Given this dominant subsistence pattern, it is no surprise that pithouses are absent from northern Plateau sites of this age. There is also evidence in the northern Plateau of local populations being replaced by Salishan speakers from the coast, possibly a result of these coastal populations following salmon upstream (Neusius and Gross 2007). Meanwhile, in the southern Plateau region tool technology became more simplistic and expedient (Chatters and Pokotylo 1998, Neusius and Gross 2007). Subsistence remains from sites indicate use of an optimal foraging strategy, where more productive foods are obtained over less productive ones (Neusius and Gross 2007). Throughout the region a new burial pattern, the Western Idaho burial complex, appears between 6000 and 4000 BP. The pattern incorporates multiple interments in a single burial, and sometimes includes cremations. The burials are located away from habitation sites and include a wide variety of grave goods that appear to indicate long-distance trade (Neusius and Gross 2007).

The mobile hunter-gatherers of the Early Middle Subperiod became more sedentary during the subsequent Late Middle Subperiod (Chatters and Pokotylo 1998, Neusius and Gross 2007). Artifact assemblages and other patterns of the Early Middle Subperiod are generally the same during this later subperiod. The occurrence of pithouses at Middle Period sites and their location in areas where a majority of resources can be collected are considered indicative of sedentism. Most often the pithouses will be found close to the steppe-forest margins of the lowlands (Chatters and Pokotylo 1998, Neusius and Gross 2007). A drop in sites with pithouses occurs however near the end of the Late Middle Subperiod, possibly indicating a drop in the population, particularly in the southern Plateau region. Throughout the period though there is an increase faunal diversity, riverine resources, and trade goods compared to the Early Middle Subperiod. In fact, salmon storage begins to appear in the northern Plateau, indicating a very high reliance on riverine resources (Neusius and Gross 2007).

Late Period: The ethnographically recorded traits of Plateau tribes formed during the Late Period. The period also witnessed the introduction of the horse to the region.

Once again, sedentism in the Plateau region increases during the Early Late Subperiod, signified by the presence of food storage at permanent camps with pithouses and intensive use of resources such as salmon (Chatters and Pokotylo

1998, Neusius and Gross 2007). In the southern Plateau region, this was the first reappearance of pithouses after several centuries (Chatters and Pokotylo 1998). Studies of human skeletons from this time period have shown that more than half the protein in individual's diets came from marine resources (Neusius and Gross 2007). This change in subsistence patterns may partially be due to a changed environment during this subperiod. With cooler, moister climate at this time, salmon availability increased as well as forest cover, which led to less large game populations. It should be noted that the people of the Eastern Plateau remained somewhat mobile (Neusius and Gross 2007). Reliance on trade may have decreased during this time, as indicated by an increase in stone tools of locally available materials and the development of local regional styles of projectile points (Chatters and Pokotylo 1998, Neusius and Gross 2007)).

Sedentism continued to increase during the following Middle Late Subperiod. Also occurring during this time was the development of a hierarchical social organization. Traded exotic items are found in concentrations in some elaborate burials of this time, indicating the developing social hierarchy, along with other luxury items, distinct variations in house size, and incidents of violence. Large pithouse villages are most common in the lower reaches of large rivers (Neusius and Gross 2007). Although salmon fishing remained a staple of people's diets, the importance of root crops increased during the Middle Late Subperiod and people expanded their collection activities into the uplands (Chatters and Pokotylo 1998, Neusius and Gross 2007). A boom in bison populations in the Columbia Basin may have attracted Plateau peoples to this arid part of the region where large bison kill sites are found (Neusius and Gross 2007). The bow and arrow was adopted during this subperiod between 2400 and 2100 BP in the south and around 1500 BP in the north (Chatters and Pokotylo 1998, Neusius and Gross 2007).

Many of the Middle Late Subperiod archaeological characteristics continue into the Late Late Subperiod of the Plateau region. However, evidence points to a decline in population, with the exception of the Upper Columbia River, and perhaps an evening out of the social hierarchy (Chatters and Pokotylo 1998, Neusius and Gross 2007). Use of the uplands appears to have diminished during this time as well (Chatters and Pokotylo 1998). There is also evidence of population migrations within the region during this late time, establishing the historically recorded tribal territories. Such movements are most often indicated by changes in house form and artifacts (Chatters and Pokotylo 1998, Neusius and Gross 2007).

Historic

Euroamerican influences began to have a major effect on the native cultures in the Plateau region between 1600 and 1750 AD. Explorers and traders brought disease, new trade goods, market economies, introduction of the horse, and missionization. Epidemics appear to have infiltrated the Plateau from the Northwest Coast as explorers moved inland. Trade and kin relations between

the regions and within the Plateau only encouraged the spread of the diseases. Burial patterns were altered in response to these widespread deaths, including cremation, canoe burials, and burials in cedar cists, fenced enclosures, and log enclosures (Neusius and Gross 2007, Walker, Jr. 1998b).

Native trade became more long range during the historic period, mostly due to the introduction of the horse. Plateau peoples even traded with non-Native Americans in New Mexico, along the Upper Missouri River, and in the California Central Valley. Trading within the Plateau culture region typically took place at major trading locales, like The Dalles and Kettle Falls, where trade was important prehistorically (Neusius and Gross 2007). The horse also led to increased warfare among tribes and culture regions as mounted warriors had a distinct advantage over those on foot. Warfare was most common along the boundary between the Plateau and the Plains culture regions where war chiefs and warrior societies developed (Neusius and Gross 2007).

Euro American Contact

European contact with Native Americans in the Plateau region may have occurred as early as the sixteenth century with Russian and Spanish explorers. An early documented contact between the Euro-American and Native Americans was the expedition of Lewis and Clark in 1805 (Walker and Sprague 1998). Missionaries were also among the early non-Native settlers to the region. The first permanent missionaries established in the Oregon area were Presbyterian, who converted the Nez Perce tribe from 1836 to 1847. Jesuit missionaries arrived in 1838, and Mormon missionaries in Idaho by spring 1860. Catholic missionaries also set up churches in the region, beginning in 1838, and by 1855, there were Mormon missions in the Plateau region (University of Washington 2007).

The period of the 1850s to the 1870s, Native Americans were placed on reservations, as Americans formalized control of the region (Boyd 1998).

Trade

The Fur Trade. Fur trading attracted Euro-American settlers to the region from the 1790s until 1846. (Schwantes 1989). The fur trade began as maritime fur trading and then land-based fur trade reached the region by the mid-1890s (University of Washington 2007). The fur trade played an important role in the history of the region as it facilitated contact between Russian, French and British traders and Native Americans. Native Americans participated in this industry by selling or bartering pelts to the European traders who then resold them in other markets, such as China (University of Washington 2007)

One of the oldest and most best known fur trading companies in the area was the British Hudson's Bay Company, established as early as 1670 which controlled the fur trade throughout much of North America. The most popularly traded fur was the beaver and sea otter. Fur trading companies such

as the Hudson's Bay Company established forts and posts and devised interior routes of travel which had lasting impacts for settlers to the region. Fur traders also used local natural resources such as timber, fish, and farmland which showed future settlers how the area could be used for sustenance. The Hudson's Bay Company guided the policies of the area, and most native American plateau peoples were under the administration of the company until that time, although the region did not have many Euro-American settlers until 1846 (Walker 1998). Thousands of settlers came to the region by 1846.

Competing fur trading companies established themselves in the area in the 1780s (Schwantes 1989). For example, the North West Company had a fort where the Columbia and Walla Walla Rivers met in 1818, sending fur trappers into the Snake River region until 1821 (Schwantes 1989). The company successfully opened the interior of Oregon but was eventually absorbed by the Hudson's Bay Company (Schwantes 1989)

Mining. Mining has been a part of the Plateau region history since the 1850s when gold was discovered in several locations in Southern Oregon (Schwantes 1989). Discoveries of gold in Idaho and Montana in the 1860s gave way to a large flow of settlers to the region. Gold was discovered in the Plateau region on Gold Creek, a tributary of the Clark Fork River in Montana in1860 (US Forest Service 2007). The discovery of gold triggered an influx of miners into the Plateau region in large numbers, mining for not only gold but silver, led, iron, copper, salt, sulpher, mica, marble and sandstone in areas such as present-day Idaho, Washington, and Montana (Idaho State Historical Society 2007)

Agriculture and Fishing. Farming, fishing, logging, and ranching were other economic mainstays in the Plateau region. Hudson's Bay Company was among the first to develop the region's agriculture, timber and marine resources (Schwantes 1989). Logging became an economic mainstay Thousands of acres were dedicated to orchards producing prunes, walnuts, filberts, and other fruit and nut crops.

Salmon was the primary product for fisheries in the region, although oysters, clams, shrimp and halibut were also caught and sold commercially (Schwantes 1989). During the 1820s through the 1860s, numerous fisheries and canneries were established along the Columbia River. Eventually, the salmon population was depleted because of over-fishing. In the twentieth century, the salmon population was further inhibited by the construction of the Grand Coulee Dam in 1941, which was constructed without fish ladders, and the Bonneville Dam, constructed in the 1930s, which altered the fisheries and opened new areas to agriculture and ranching through irrigation and flood control (Schwantes 1989). Although conservation measures were put into place in later years, the salmon population was not fully restored because of overfishing, agricultural diversion and hydroelectric (damming) activities (Schwantes 1989).

Agricultural production of wheat and ranching of cattle were other economic activities in the region. Crops such as wheat, nuts, fruit, and hops were among those grown in the area, beginning in the mid-1800s. Western Oregon saw the planting of a wider range of crops such as hops for beer brewing, flax for making linen, and hemp for rope and paper. Irrigation and transportation improvements allowed expansion of agriculture and the development of large-scale fruit orchards between 1905 and 1915 (Oregon Secretary of State 2007). Logging was also an economic mainstay, and with the advent of the railroad, lumber could be hauled to steam-operated mills along the railways. The region was shipping large portions of its timber by railroad to a quickly growing U.S. population by the late 1800s (Oregon Secretary of State 2007). The flat farmlands of the region were also used for cattle and sheep raising, and cattle were run from California, through the Willamette Valley and over the Oregon Trail (Schwantes 1989). Cattle were raised in eastern Oregon to provide meat to feed gold miners in the 1860s (Oregon Secretary of State 2007).

Western Expansion

Originally Spain, Great Britain, Russia, and the United States each claimed the land encompassing the Plateau and northwest coast regions. Claims were settled by treaties and diplomacy over the course of 30 years in the first half of the 19th century. A continuous flow of American settlers to the region led to the establishment of the Oregon Territory in 1848. This was followed by the Washington Territory in 1853, Idaho Territory 1863 and Montana Territory in 1864. (Schwantes 1989) These territories secured American position in the region. Military presence increased in the Plateau region with the establishment of several forts including: Fort Dalles (1850), Fort Cascades (1853), Fort Walla Walla (1856) and Fort Klamath (1863) (Beckham 1998). The Plateau region was further settled after 1859 when treaties opened the area east of the Cascade Mountains for settlement.

Oregon Trail. The Oregon Trail was used by settlers traveling to the Plateau Region or to pass through the area on their way to more westerly points. The Trail began as an unconnected series of trails used by the Native Americans. Fur traders expanded the route to bring pelts to trading posts in the early 1800s. The route extends roughly 2,000 miles west from Missouri toward the Rocky Mountains to the Willamette Valley. A trail to California digressed from the route in Idaho (Bureau of Land Management 2007). Several groups followed the route over time including large populations of settlers, moving from the eastern portion of the US to settle the west between 1800 and 1880s. (Bureau of Land Management 2007)

Missionaries used the trail during the 1830s, traveling along the Platte and Snake Rivers to settle churches in the Northwest. Mormons, headed toward Salt Lake in Utah, used the trail beginning in 1847, and the discovery of gold in California caused many gold miners to use the trail in 1849. It is estimated that four thousand emigrants followed the trail west in 1847 (Schwantes 1989), many in

small caravans of wagons. Military posts and spur roads were established off the Oregon Trail. The trail was the major connection between the east and western portions of the US. It was used as a cattle driving trail eastward for a brief time as well. The construction of the Central Pacific Railroad, connecting California to the rest of the continent in 1869, decreased use of the Oregon Trail and by the early 20th century, the trail was no longer used as a major transportation corridor, as railroad lines paralleled the trail (Bureau of Land Management 2007, Schwantes 1989).

Railroads. The completion of the Northern Railroad in 1883 furthered population growth and economic development of the Plateau region. The farming and agriculture industries benefited from the construction of the railroad because it allowed for transportation of crops to eastern states, and farming equipment manufactured in the eastern states were shipped to the Plateau territories. The construction of the railroad supported the logging industry as well because steam engines were used to export lumber to mills and logging could be done in rugged areas that were inaccessible prior to the railroad (Oregon Secretary of State Archives 2007).

GREAT BASIN

The cultural region of the Great Basin is based on the hydrographic region of the same name, but is extended to include the area between the Sierra Nevada and the Rocky Mountains (Figure 3-15c). In general, the area covers most of Nevada and Utah, parts of Oregon and Idaho, eastern California, western Colorado, and western Wyoming. Like other culture regions, the Great Basin is varied in landform and climate with high peaks overlooking deep valleys with broad and arid floors. These different environments within the region require a variety of adaptations that have resulted in diverse cultural traditions (Neusius and Gross 2007).

USFS regions included in the Great Basin region include portions of Regions 1 though 6. BLM Offices in the region include all or portions of the Elko, Ely, Battle Mountain, Carson City, Winnemucca, Las Vegas, Vale, Burns, Lakeview and Prinville District Offices as well as Salt Lake, Filmore, Ceder City, Eagle Lake, Surpise, Bishop, Jarbidge, Owhee, Bruneau, Burley, Pocatello, Shoshone, Challis and Upper Snake Field Offices

All ethnographically recorded Great Basin culture region tribes spoke languages of the Uto-Aztecan family (Aztec-Tanoan Phylum) (D'Azevedo 1986a; Waldman 2000). The one exception are the Washo of northern Nevada and northeastern California whose language is often classified as Hokan (Neusius and Gross 2007), but bears no strong relation with any other language. Numic is the branch of the Uto-Aztecan language family that includes many of the languages spoken by Native American peoples traditionally living in the Great Basin, Colorado River basin, and southern Great Plains. Culturally, the Great

Basin culture region is bordered by the Plateau to the north, California to the west, Southwest to the south, and the Great Plains to the east.

A general chronology of the Great Basin has been developed, however the region exemplifies an Archaic stage for nearly all of prehistory. The following outlines a general chronology of the Great Basin culture region (Neusius and Gross 2007).

- Pre-Archaic: pre-9000 BP
- Archaic: 9000 – 500 BP
- Early Archaic: 9000 – 4000 BP
- Middle Archaic: 4000 – 1500 BP
- Late Archaic: 1500 – 500 BP
- The Protohistoric and Historic period then follows the Late Archaic.

Cultural History

Prehistoric

Pre-Archaic: As in other culture regions, evidence is sparse and scattered for early occupations prior to the Archaic in the Great Basin culture region. Such data are found primarily in the form of isolated fluted points, similar in form to Paleoindian evidence in the Great Plains, on the ground surface, particularly in Utah and the western Great Basin (Jennings 1986; Neusius and Gross 2007). Only one big game kill site has been confidently identified and attributed to this period and that was in Idaho (Jennings 1986). Several important, pre-Archaic sites representing other activities have been found in caves of the region. Other forms of data are less credible and comprised of the bones of extinct animals without direct association to man-made artifacts. The accepted forms of evidence suggest that sheep hunting in the Great Basin culture region has a time depth at least as far back as the pre-Archaic. Additionally, lithic sourcing of tools from this period suggest that mobility and foraging patterns were established at this early time, although they did change throughout time with changes in resource distributions (Neusius and Gross 2007).

Archaic: Much of the early work on Archaic Great Basin occupation focused on cave sites and led to a biased inventory and understanding of the region's prehistory. Once researchers began to focus on other topographic areas, new patterns of distributions and typologies began to surface. Surveys in Surprise Valley of northeast California for instance, demonstrated that semi-subterranean pithouses in substantial base camps were situated in valleys while temporary camps were found in varying settings from lakeshores to mountains.

The Western Pluvial Lakes Tradition developed in during the later years of the pre-Archaic and into the Early Archaic of the western Great Basin between 12,000 and 7000 BP. Sites of this tradition are typically located along pluvial lake margins, such as Lake Mohave in southern California and Lake Lahonton in northern Nevada. However, points associated with this tradition have been found in other environmental settings, suggesting the suitability of their use in other areas. Some researchers believe that the Western Pluvial Lakes Tradition represents adaptations suited to acquiring lakeside or riverine resources left over from the Pleistocene, before the lakes and associated rivers of the culture region dried. Others believe the tradition is a more focused hunting way of life (Neusius and Gross 2007).

In the southwestern Great Basin, the Pinto Period of the Early Archaic developed between 7000 and 4000 BP, immediately following the drying of the region's pluvial lakes. Although generally being seen as subsequent to the Western Pluvial Lakes Tradition, some artifacts of the Pinto Period resemble the form of those attributed to the earlier tradition. This suggests at least some continuity in the region. It should be noted however that several artifact types were added to Pinto site assemblages. The Lahontan Basin includes many Early Archaic sites of this kind. Many are cave sites that were used when water was available in Lahontan Lake. Very few are believed to be residential sites; most were used for burials and caches. Food caches such as these served as forms of storage, eliminated the need for transport, and helped to even out the availability of food across the desert landscape (Neusius and Gross 2007).

The Early Archaic of the eastern Great Basin is divided into three subperiods: Bonneville (11,000 – 9500 BP), Wendover (9500 – 6000 BP), and Black Rock (6000 – 1500 BP). Only a few sites have been found to have been occupied during the Bonneville subperiod. However, what evidence has been found seems to point to a connection to the Western Pluvial Lakes Tradition to the west. Some researchers have suggested that Bonneville sites may represent a transition period between big-game hunting and more plant-oriented subsistence strategies.

More sites have been found and attributed to the Wendover subperiod. Sites are found in a wide variety of environments, indicating a very mobile settlement pattern at this time, likely changing locations with the seasons and using a greater variety of plants. Cave sites from this period include well-preserved plant remains and evidence of the continued use of large game, killed using the *atlatl.*

There was an increase in the number of sites during the Black Rock subperiod corresponding with an increasingly arid environment. There was also a shift in site locations to upland areas that were previously less frequently occupied. It is thought that the changes exhibited during this period can be attributed to the change in climatic conditions of the eastern Great Basin. The Black Rock

subperiod extends into and through the subsequent Middle Archaic (Neusius and Gross 2007).

During the Middle Archaic, an increase in the amount of local obsidian in archaeological sites is thought to indicate a decrease in mobility during this period. In southwestern Great Basin the Gypsum Period developed in a climate that was moister, leading to the filling of some desert lakes and extensive marshlands. This was a time of intensive occupation in the Mojave Desert and diversification of subsistence activities. The area east of Barstow in the Mojave Desert has yielded important archaeological sites that have provided data leading to greater understanding of this period. Split-twig figurines are an interesting artifact found in northern Arizona, Nevada, Utah, and California. Made of split twigs, the figurines are of stylized quadrupeds thought to be used in hunting rituals. Rock art depicting quadrupeds and found in the same regions are also thought to be a part of such rituals. The Coso Range is well known for such depictions (Neusius and Gross 2007).

As noted above, the Black Rock subperiod continued from the Early Archaic through the Late Archaic in eastern Great basin. The bow and arrow was introduced in this region during the Middle Archaic years of this period. By the end of this period the region had returned to more moist conditions (Neusius and Gross 2007).

Once the Late Archaic commenced the climate had returned to more arid conditions. In southwestern Great Basin the Saratoga Springs (1500 – 800 BP) and Shoshonean Periods (800 BP – contact) developed. The Saratoga Springs Period is similar to the earlier Gypsum Period, but with smaller projectile points. This is thought to indicate the introduction of the bow and arrow in the region. Various parts of the southwestern Great Basin exhibit influences from their neighboring culture regions during this time. One of the more notable interactions occurred in southern Nevada and southeastern California with the Southwestern Anasazi. Influence of the Anasazi is seen in pottery of the Mojave Desert. Evidence of their physical presence in the region between 1300 and 1100 BP has been found at the turquoise mines of Halloran Spring which were then used by the Hakataya of the Southwest and then the Southern Paiute of the Great Basin (Neusius and Gross 2007).

The Shoshonean Period is marked by the introduction of Desert Side Notched points and brownware pottery. This would be concurrent with the end of the Anasazi occupation of southern Nevada. Trade with coastal people becomes evident. Many Antelope Valley and upper Mojave River village sites appear to have been positioned along trade routes and played a major role in the movement of goods. The Shoshonean Period also marks the spread of Numic speakers out of the southwestern Great Basin. However, there is debate as to whether the Late Archaic Shoshoneans are the same as the Numic-speakers that occupied almost all of the Great Basin at the time of European contact.

This is because of a noted discontinuity between ethnographically recorded Numic speakers and the archaeological sites of the Shoshoneans (Neusius and Gross 2007).

In northwestern Great Basin, Rose Springs and Eastgate points, indicating adoption of the bow and arrow, are seen as markers of the Late Archaic. Lithic technology also changed to focus on expedient production of simple flake tools made from local materials. Subsistence activities became more diversified here during this time as more ecological zones and resources were exploited. Additionally, smaller game became increasingly important (Neusius and Gross 2007).

The Late Archaic of the eastern Great Basin is attributed to what is called the Fremont Period. Although Fremont patterns are first seen in the last 100 years of the Middle Archaic the majority of the time it covers (1600 – 700 BP) is in the Late Archaic. Sites attributed to this cultural period are found in the area between southern Idaho in the north, the Colorado River in the south, northwestern Colorado in the east, and eastern Nevada in the west. Generally sites of this area during the Fremont include growth of maize, sometimes associated with irrigation ditches, plain grey ceramics, small-sized projectile points, one-rod-and-bundle coiled basketry, Utah metates, broad-shouldered anthropomorphic figures found as clay figurines or in rock art, and moccasins. Village sites are often comprised of pithouses and adobe architecture and caves were also used for habitation and storage. For some sites, hunting and gathering continued to be a primary source of subsistence rather than concentrating on maize cultivation. It is thought that the people of the Fremont region and period may have combined with the later Numic speakers of the Great Basin, but there is significant evidence that would suggest the Fremont peoples moved into the Great Plains as Numic speakers expanded into the Great Basin (Neusius and Gross 2007).

Influence from both the Southwest and the Great Plains culture regions are often seen in the area of the Fremont. Five regional variants have been identified for the Fremont Period: Uinta, San Rafael, Parowan, Sevier, and Great Salk Lake. The Uinta variant of the Uinta Basin on the Colorado Plateau of northeastern Utah appeared between 1350 and 1050 BP. Sites of this region are characterized by pithouses with isolated storage rooms built on rock ledges being the only aboveground structures. Subsistence focused on hunting small and large game and collecting plants. Uinta Fremont sites are typically located on knolls, buttes, and creek slopes (Neusius and Gross 2007).

The San Rafael Fremont variant is situated on the Colorado Plateau just south of the Uinta variant and east of the Wasatch Range. Sites are typically small, but with the same habitation and storage features, often made of stone, as seen in the Uinta region. Small caves and rockshelters are also sometimes used for storage or habitation. It appears maize occupied a more prominent place in the

San Rafael Fremont subsistence spectrum, but wild foods were also important (Neusius and Gross 2007).

To the west of the San Rafael region is the Parowan Fremont in southwestern Utah. Settlements are large and consist also of pithouses and storage features, but here made of adobe. Such sites are typically found on valley floors of the region where water is available. Instead, projectile point styles and several types of bone artifacts distinguish the variant from its neighbors. Like the San Rafael, maize cultivation with irrigation appears to have been central to subsistence practices, but supported with hunting and wild plant gathering (Neusius and Gross 2007).

The Sevier Fremont regional variant is north of the Parowan variant and east of the Uinta variant, in central western Utah and adjacent parts of Nevada. Sites on the eastern edge of the region are thought to have been permanent settlements near marshes while sites in the western portion of the region are thought to have been seasonal sites or camps. The sites in the region of Sevier Fremont are typically small and comprised of a few pithouses with adobe surface rooms. However, architecture and artifact styles are variable throughout the region (Neusius and Gross 2007).

North of the Sevier region is the Great Salt Lake Fremont variant around the Great Salt Lake and north into southern Idaho. Artifact types of this variant differ from those found in other Fremont sites. Most sites of the Great Salt Lake variant were seasonal and lacked masonry. Caves were often used as campsites. Wild crops instead of maize were emphasized along with hunting (Neusius and Gross 2007).

The spread of the Numic speakers into the eastern Great Basin is marked by distinctive brownware pottery and utilization of a variety of wild seeds. Environmental modifications by humans have also been documented, including making bow staves by scoring juniper trees, which would then leave a scar on the tree, and creating controlled burns to promote production of seed plants. Many researchers believe this spread was rapid and began as recently as 950 BP. It would have originated in the southwestern Great Basin culture region in the vicinity of southeastern California, but did not expand into the eastern areas until after Fremont characteristics disappeared. However, the why and how of this spread is not well understood by archaeologists (Neusius and Gross 2007).

Historic

The Great Basin region was one of the last areas to experience contact between Native American populations and Spanish and European explorers. Euroamerican populations were comparatively small following contact so that Native American lifeways were able to continue relatively uninfluenced. The introduction of the horse however brought about some of the most notable changes, similar to other culture regions. The horse allowed for more efficient

transportation across the region and into neighboring regions. However, in areas where vegetation was too sparse to support grazing horses, the animals were instead seen as a source of food. European contact did increase somewhat as the fur trade and migrants headed west entered the region. Conflicts were sometimes violent, but often the more important impacts of these contacts were on the productive habitats and traditional subsistence practices of the region (Neusius and Gross 2007).

Euro American Contact

The Great Basin region remained largely unexplored by Europeans until 1776 and 1777 when Spanish priests, Fathers Dominguez and Escalante, explored Utah and the Colorado Plateau. The area was not explored in any major way again until the 1840s, after a long period of nominal Spanish and Mexican rule. The vast arid expanse and lack of conspicuous resources inhibited interest in settlement and development. However, large numbers of settlers and travelers passed through the Great Basin on their way to California or Oregon, especially after gold was discovered in the 1848. The migration of Mormon settlers to Utah beginning in 1846 brought the first large numbers of American settlers to the Great Basin region (Neusius and Gross 2007).

Trade

Mining. The discovery of gold during the historic period first occurred in the Great Basin area in 1859 at the Comstock Lode near Virginia City in Nevada. Silver was discovered in the Humboldt Mountains in 1860 (Neusius and Gross 2007). Mining opportunities of gold, silver, copper, coal, and tungsten spurred immigration to the Great Basin as well as travel through the area on the way to California.

Ranching and farming. Ranching and farming has historically been a strong economic staple to the Great Basin region. Extensive ranching and farming began as an economic alternative to mining. Several legislative acts such as the Homestead Act of 1862, Desert Land Act of 1877, and the Taylor Grazing Act of 1934 attracted setters with the promise of inexpensive land. The Homestead Act alone transferred more than 270 million acres of land from Federal to private ownership (National Park Service 2006). In 1877, the Desert Land Act was passed by Congress to encourage and promote the economic development of the arid and semiarid public lands of the Western United States. Through the Act, individuals could apply for a desert-land entry to reclaim, irrigate, and cultivate arid and semiarid public lands (Bureau of Land Management 2004). The Taylor Grazing Act of 1934 assisted farmers and ranchers in acquiring land or increasing their land holdings through the ability to graze on public lands by way of permit. The Taylor Grazing Act was more favorable to beef ranchers than sheep raisers and cattle ranching became dominant in the region. Ranching continues to be an important economic activity in the region, with public land grazing permits often passed down through families (National Parks Service 2006).

Western Expansion

Treaty of Guadalupe Hidalgo 1848. This treaty was signed in 1848 after the Mexican-American War. The treaty required that Mexico cede 55% of its territory (present-day Arizona, California, New Mexico, and parts of Colorado, Nevada and Utah) in exchange for fifteen million dollars as compensation for war-related damage to Mexican property (Library of Congress 2005).

Boom Towns. When gold miners came to an area in the hope of striking it rich in the mid and late 1880s, many small towns and mining communities sprang up near the mines to service and support the miners. Rapidly built towns consisting of retail stores, hotels, and saloons were established and some were later were abandoned as the mines of the Great Basin were either depleted or gold ran scarce. Remnants of some of these ghost towns of the west still exist as either tourist attractions or state parks (Neusius and Gross 2007).

Railroads. In 1862, President Lincoln signed the Pacific Railroad Act, which allowed construction of a railroad line from Sacramento east, built by Central Pacific Railroad and from Omaha West along the Missouri River, built by Union Pacific Railroad. The rail lines met in Promontory, Utah in 1869, completing the first Pacific Railroad (California State Railroad Museum Foundation 2007 and Library of Congress 2006). The majority of the Union Pacific track was built by Irish laborers, civil war veterans, and Mormons who wished to see the railroad pass through Ogden and Salt Lake City, Utah. The Central Pacific track was mostly built using Chinese immigrant laborers. The completion of the railroad meant that agricultural produce, lumber, and gold could be shipped to eastern parts of the US, while settlers were able to emigrate from the east to live in the west. The railroad had a large impact on California immigration, which continued through the 20th century.

Trails

Mormon Trail. One of the major forces of settlement in the West was Mormon emigration. Thousands of Mormons (1,600) left Illinois in February 1846, crossing into Iowa, in an attempt to escape religious persecution (Forest Service 2007). Their leader, Brigham Young, opted not to follow the Oregon Trail, but instead forged a new route just north of the Platte River because the route was better suited to wagon travel and because he wished to avoid other travelers from Missouri who frequented the Oregon Trail (Billington 1960). The Mormons crossed Mississippi and established temporary headquarters there, then went on to Missouri, through the Great Plains, where they spent an icy winter and lost 600 people from their party (Billington 1960). They reached the Valley of the Great Salt Lake, where they settled, in June 1847.

Old Spanish Trail. This trail was first established by a Mexican trader, Antonio Armijo, in 1829. He traveled from New Mexico to Los Angeles on a commercial caravan, carrying Mexican woolen goods and planning to bring horses back from California (National Park Service 2007). Prior to the Old

Spanish Trail, an established overland southern route to California from New Mexico did not exist although portions of the trail had been used by Native Americans and early traders. The trail runs through present-day Colorado, Utah, Arizona, Nevada, and California (Cultures and Histories of the American Southwest 2007)

California Trail. The trail was used by over 250,000 farmers and gold miners from Missouri during the 1840 and 1850s. The route starts along the Missouri River, and then converges on the Great Platte River Road, overlaps with the Oregon Trail and to the Rocky Mountains. After the crossing the Rockies, many routes were used to get to and cross the Sierra Nevada Mountains. The total system of trails and alternate routes that make-up the California Trail is approximately 5,664 miles (US National Park Service 2007)

Nez Perce. This trail extends from Wallowa Lake in Oregon to Bear Paw Mountain in Montana. It is named for the Nez Perce tribe of Native Americans who fled their lands when the US Army pursued them in 1877. Approximately 750 Nez Perce men, women, and children traveled over 1,170 miles through the mountains, on a trip that lasted from June to October of 1877 (US Forest Service 2007). The trails extends from Wallowa Lake, Oregon, through the Snake River at Dug Bar, entering Idaho at Lewiston and then over to north central Idaho, entering Idaho at Bannock Pass and traveling back to east Montana at Targhee Pass to cross the Continental Divide. It bisects Yellowstone National Park in Wyoming, and then follows the Clark Fork River out of Wyoming into Montana. The trail then heads north into Bear's Paw Mountains and ends forty miles from the Canadian Border (US Forest Service 2007). This trail crosses 90 miles of BLM land and 221 miles of USFS land within the project area.

GREAT PLAINS

The area between the Saskatchewan River in the north, the Rio Grande in the south, the foothills of the Rocky Mountains in the west, and the upper Mississippi River valley in the east makes up the Great Plains culture region (Figure 3-15d). In general, the area covers parts of southern Alberta, Saskatchewan, and Manitoba in Canada and in the US, parts of Montana, Wyoming, Colorado, Texas, Oklahoma, Missouri, Iowa, and Minnesota, far eastern New Mexico, and all of North Dakota, South Dakota, Nebraska, and Kansas. The majority of this culture region is east of the planning area (DeMallie 2001; Neusius and Gross 2007); planning area states within the Great Plains culture region include eastern areas of Montana, Wyoming, and Colorado (the easternmost planning area in New Mexico is included in the Southwest culture area). These areas are considered to be a part of the Northwestern and Western Periphery/western Central subunits of the Great Plains region (Gunnerson 2001; Frison 2001; Neusius and Gross 2007). The cultures of the Great Plains region are quite varied, primarily due to the diverse environs it covers. Different environments require unique adaptations by the occupants.

However, all cultures of the Great Plains regions have at least one trait in common and that is bison hunting

USFS regions included in the Great Plains region include portions of Regions 1 and 2. BLM Field Offices included in the region include all or portions of Miles City, Bilings, Malta, Glasgow, Lewistown, Havre, Butte, Casper, Buffalo, Newcastle, Rawlings, Royal George offices.

Table I-4 identifies the Great Plains culture region languages and tribes that have been documented within the project area. Culturally, the Great Plains culture region is bordered by the Plateau, Great Basin, and Southwest regions on the west and the Northeast and Southeast on the east.

Table I-4
Languages and Tribes of the Great Plains Culture Region in the Project Area

Language (Linguistic Phylum)	Tribes
Siouan (Macro-Siouan)	Assinibone, Crow
Algonquin (Macro-Algonquian)	Cheyenne, Gros Ventre, Arapaho
Uto-Aztecan (Aztec-Tanoan)	Comanche

Source: DeMallie 2001; Goddard 2001; Waldman 2000

A general chronology of the Great Plains has been developed based on developments in lithic technology with some regional variations and intermediate lithic forms between traditions (Neusius and Gross 2007). The earliest evidence of occupation of the Great Plains may represent the pre-Clovis period, however evidence is scant. The most definitive evidence for early occupation occurs during the Paleoindian Period, comprised of the Clovis and Folsom Periods. The following outlines a general chronology of the Northwest and Western Periphery/western Central subregions of the Great Plains (Neusius and Gross 2007).

- Pre-Clovis: pre-11,500 BP
- Paleoindian: 11,500 – 8500 BP
- Archaic: 8500 – 1500 BP
- Early Archaic: 8500 – 5000 BP
- Middle Archaic: 5000 – 3500 BP
- Late Archaic: 3500 – 1500 BP
- Late Prehistoric: 1500 – 500 BP
- The Protohistoric and Historic periods then follow the Late Prehistoric.

Cultural History

Prehistoric

Pre-Clovis: As stated above, there is very scant evidence for human occupation of the Plaines prior to 11,500 BP. Primarily, this evidence is in the form of bone breakage patterns and a few tools. Even these are sometimes questionable in their linkage to humans. Although there are a number of mammoth bone sites it is difficult to attribute these to human activities. The patterns of breaks in the bones and their distributions suggest as association with humans, but the sites either have few or no stone tools. As such, a pre-Clovis occupation of the Great Plains is not well established at this time (Neusius and Gross 2007).

Paleoindian: There is considerable more evidence of Clovis and later Paleoindian occupations of the Great Plains region. In fact, it is in the Great Plains that archaeologists first encountered evidence of a Paleoindian occupation of the US. There are two definitive subperiods of this time based upon distinct forms of projectile points that are assumed to represent temporally and possibly spatially distinct populations. These are Clovis (11,500 – 10,900 BP) and Folsom (10,900 – 10,200 BP). The style of Clovis points is found in strata below those of Folsom points throughout the region. There are several point styles found in specific sub-areas that are viewed to be area-specific transitional styles that occurred between the periods of Clovis and Folsom points. The style of Plano points, comprised of unfluted lanceolate, stemmed, and unstemmed projectile points, represent lithic technologies of the Late Paleoindian period. Again, there is regional variation of lanceolate point styles. Between 9000 and 8500 BP a larger variety of lanceolate points is found, denoting a transition to the Archaic period and perhaps could be called a Terminal Late Paleoindian Period (Neusius and Gross 2007).

Combined with other tools in the Paleoindian toolkit, these projectile points suggest an emphasis on hunting and the use of high-quality raw materials suggest the importance of quality and reliability in the tools (Neusius and Gross 2007). In the foothill-mountain groups of the northwestern subregion, materials were typically extracted from local sources. Additionally, projectile points were not as important as in other subregions, possibly reflecting the use of different procurement strategies adapted specifically to this area (Frison 2001). Caches of blades and bifaces found in the region, such as the Anzick Cache in Montana, do indicate an overall importance placed on lithics. Some of these are even associated with burials (Neusius and Gross 2007).

However, the majority of Great Plains Paleoindian sites are large game kill sites. Clovis points are most often associated with mammoth kill sites, although other large game is also found. Bison hunting appears to have begun with Folsom points, probably due to the environmental conditions of the time creating stable grasslands for the bison to roam in. Bison hunting strategies were carried out by individuals as well as small and large groups. Ambushes conducted at springs

and playa lakes appear to have been the most common during the Folsom period based on archaeological evidence. Later bison drive, trap, and jump sites, such as the Jones-Miller site in east Colorado, became more common (Neusius and Gross 2007). It should be noted however that bison was not the only meat package used by the Great Plains Paleoindians as some sites contain a diverse faunal assemblage (Frison 2001).

Overall, archaeological evidence indicates that the Great Plains Paleoindians existed in small, mobile bands that ranged between the mountains and high plains. There is debate however as to whether these were specialized or general hunter-gatherers. Additionally, the archaeological record is biased toward large kill sites, such as those described above (Neusius and Gross 2007). Very few non-kill sites are represented in the record resulting in a gap in our knowledge of the region during this period. Similarly, the adaptations of the foothill-mountain groups of the northwest subregion are not as well known as other Great Plains groups. Further study of sites in the northwest would provide a better understanding of the niche adaptations that occurred here (Frison 2001).

Archaic Period: Subsistence and settlement patterns are basically the same during the Archaic Period of the Great Plains as they were during the Paleoindian Period. The period is denoted by a change in lithic technology, namely a replacement of lanceolate points by notched points across the Great Plains (Neusius and Gross 2007). The most notable change indicating the Archaic is the development of horticulture, also called "Woodland," around 2500 BP. This occurred primarily in the eastern portions of the Great Plains region while the west and northwest remained mostly reliant on large game hunting. In the Northwestern as well as in the western Central Great Plains, however, there is a continuation of mobile hunting and gathering cultures (Frison 2001), hence the term "Hunting and Gathering Tradition" alternatively used to refer to this period. Groups established a seasonal settlement pattern that adjusted to conditions. They also established a flexible social organization to allow for aggregation of bands during hunts (Neusius and Gross 2007).

The Early Archaic is represented by more cave and rockshelter sites than open sites, presumably due to unusual environmental conditions during this time (Frison 2001). Grinding implements such as manos and metates were developed during this period of Great Plains occupation as well as earthen fire pits. These developments reflect an increased emphasis on vegetal foods (Frison 2001; Neusius and Gross 2007). This is also when horticulture developed in the river valleys and the Eastern Great Plains, although not in the Northwest and western Central Great Plains. In this area, faunal remains are scarce; however there are still a few bison kill sites in limited areas as well as evidence of communal hunting (Frison 2001). Throughout the Archaic, such sites are typically associated with arroyos, sand dunes, steep bluffs, or artificial corrals (Neusius and Gross 2007), remains of which may still be present. The

large side-notched projectile point is the typical diagnostic marker for the Early Archaic in Northwest Great Plains (Frison 2001; Neusius and Gross 2007). However, in the western Central Great Plains, corner-notched points are prevalent (Frison 2001). The evolution from Paleoindian lanceolate points to notched points may indicate the new use of the *atlatl* by hunters (Neusius and Gross 2007) or it could represent the local development, transmission of outside ideas and technology, or population movements (Frison 2001). In either case, caching of lithic tools such as these does appear to continue on from the Paleoindian period (Frison 2001).

Although there is definitive evidence of housepits at Early Archaic sites, often associated with storage pits (Neusius and Gross 2007), there are not a significant number of sizable occupations in Northwest and western Central Great Plains, with the exception of caves and rockshelters (Frison 2001). However, there is no doubt that Early Archaic peoples existed here given the common surface finds of diagnostic artifacts. The apparent lack of large cultural occupations should not be attributed to a lack of human population, but may be related to site preservation and population mobility (Frison 2001). Similarly, the higher incidence of sites in caves and rockshelters may simply be due to their excellent preservation conditions.

The Middle Archaic saw many of the Early Archaic characteristics carry on, including grinding tools, fire pits, and numerous occupations of caves and rockshelters, especially along the Bighorn and Absaroka Mountains of Wyoming and Montana, respectively. Many of these sites have little to no stratigraphic separation between deposits of the two subperiods, indicating continuous occupations. Alterations in projectile point styles are the most notable Middle Archaic diagnostics. McKean and Mallory type projectile points are the diagnostic styles that occur throughout the Northwest Great Plains; McKean points also occurring in the western Central Great Plains.

Bison remains become more frequent and bison jumps are still present, but vegetal foods also continued to be consistently represented in people's diets. Overall, the subsistence base during the period of McKean points would indicate a strategy adapted to ecotones that provided the most variety of resources (Frison 2001).

Changes in point form, particularly the appearance of the Pelican Lake corner-notched projectile point, indicate Late Archaic sites in the Northwest Great Plains (Frison 2001). It is thought that some Late Archaic points are small enough to have functioned as arrow points (Neusius and Gross 2007), the bow and arrow becoming prevalent in the subsequent Late Prehistoric Period. Little in subsistence strategies changes between the Middle and Late Archaic periods. Caves and rockshelters of the Big Horn Mountains and northern Wyoming still yield Archaic archaeological sites of this time period, including perishable materials such as basketry (Frison 2001).

Late Archaic peoples expanded further into the intermontane basin interiors as well as the foothills and mountains of the western Great Plains during the Late Archaic. This is indicated by fire pits, which at some sites can cover hectares and at others just a single pit will be found. The pits, often characterized by perimeters of red oxidized clay due to heat exposure or stone linings, are associated with other features and artifacts such as boiling pits, grinding stones, and flake tools. Although some of these were most certainly used for cooking, some were also probably used for a source of heat within structures. Prehistoric lakeshores created by retreating glaciers were often used for Archaic occupations. Many of these have been affected by modern efforts for water storage. These Archaic lifeways in the Northwestern and western Central Great Plains regions, concentrating on vegetal resources, continued into the Late Prehistoric period, while in other more "plainslike" environments economies were oriented more toward bison hunting (Frison 2001).

Stone rings, one of the most characteristic artifacts of the Late Prehistoric period on the Northwest Great Plains, first began to occur in large quantities during the Late Archaic. Raised topographic features in the interior basins and plains as well as in the foothills are the most sensitive for these kinds of sites, including butte tops, barren ridges, minor topographic rises, and stream terraces, particularly cobble-filled terraces. The rings occur singly or in clusters and vary in diameter. Association with cultural refuse is rare, making dating difficult in some cases (Frison 2001). Functions attributed to these rings range from structure bases, such as tepee rings, to ceremonial, such as medicine wheels (Frison 2001; Neusius and Gross 2007). Other features attributed to the Late Archaic, but are also difficult to date include petroglyphs, pictographs, and stone cairns and lines (Frison 2001).

Late Prehistoric Period: Dependence upon bison hunting, pottery making, and use of the bow and arrow combine to characterize the Late Prehistoric Period. In general, however the adaptive strategies of previous times continued into the Late Prehistoric. This period occurred concurrently with the Great Plains Woodland and Great Plains Village Periods of the majority of the Great Plains cultural region to the east of the project area. Some of the historically documented Great Plains tribes can be documented by the archaeology of the region during this time (Neusius and Gross 2007).

Historic

Initial European contact with Great Plains tribes occurred first in the Southern and Central Great Plains. The Great Plains regions of the project area continued to support mobile bison hunters while further east several migrations and relocations occurred creating a tangled history of movement in those areas. Such movements represent the fluidity of the Great Plains Native American cultural geography during the Historic Period (Neusius and Gross 2007).

Three other factors contribute to the historic character of Native Americans in the Great Plains: introduction of the horse, trade in European goods, and disease. The horse allowed extended trade through the increased mobility that it brought, impacting economies and intergroup relations. Social structures were also impacted as individuals sought to gain more of these luxury items. The increased mobility brought by the horse also impacted political tribal relations as groups traveled farther into neighboring territories, often resulting in increased violence and raiding. Trade in European goods, guns in particular, also contributed to the increased violence. Europeans also brought Native Americans into their trades, including the fur trade. European diseases, however, decreased Native American populations, forced migrations and created changes in settlement patterns, as well as political breakdowns and unions (Neusius and Gross 2007).

Euro-American Contact

The first European explorers to explore the Great Plains came from Spain and France by way of three routes: the Spanish came to the Southern Plains and were explored by Alvar Nunez Vaz de Vaca from 1528 to 1536 across Texas. The Central Plains was explored by Francisco Vasquez de Coronado, who came to the Great Plains region (present day Texas and Kansas) in approximately 1540-1542. Coronado explored present-day Arkansas, New Mexico, Colorado, Kansas, and Nebraska. The Northern Plains was explored by Pierre Esprit Radisson and Medard Chouart, from France in 1659. Alvar Nunez de Vaca crossed Texas and parts of northern Mexico from 1528 to 1536 (Swagerty 2001). The French also explored area between 1742-1743, passing through North Dakota, Wyoming and Montana.

Euro-Americans began taking more of an interest in the Great Plains area after the Louisiana Purchase in 1803. The Lewis and Clark Expedition of 1804-1806 included present-day Missouri, South Dakota, North Dakota, Montana and other areas in the west. Fur and hide trading was one of the results of exploration of the area, and was the reason thousands of Europeans came to the Great Plains (Scott 1952). The Great Plains region continued to support mobile Native bison hunters while further east several migrations and relocations occurred creating a tangled history of movement in those areas (Neusius and Gross 2007).

Trade

Fur Trade. The fur trade was an attractive economic pull for settlers to the Great Plains area. Trappers and traders from France, Spain, Russia, Britain and US came to the region to trade furs and hides. Native American tribes acted as middlemen and indirectly traded with other tribes and societies (Neusius and Gross 2007). After Lewis and Clark's exploration of the area, Americans also established trading posts within the Great Plains. Much of the trade industry began in the northern portion of the Great Plains with Hudson's Bay Company and the American Fur Trading Company. The French established trading posts

there as well (Swagerty 2001). The Hudson's Bay Company controlled most of the trade in areas that drained into the Hudson Bay, including North Dakota and Minnesota as well as the Canadian portion of the Northern Plains. The French traded on the tributaries of the Mississippi, or west from the Great Lakes, where they established posts along the rivers (Neusius and Gross 2007). This prosperous trade lasted from 1806 to 1850, and included trappers from France, Spain Brittan, Russia and the United States. Construction of trading posts lasted from 1822 until 1850, when supply and demand for beaver fur ended.

Ranching. Ranching on the Great Plains developed initially using the open range lands where cattle were free to roam without fences or barriers. In most areas land was not surveyed, settled or fenced. The lack of forests and trees also made it difficult to build fences to control livestock. The commercial development of barbed wire in 1870 was instrumental in providing fencing material for cattle, which enabled ranchers to separate their cattle and control grazing (International Information Programs 2007 and Webb 1931). The use of open ranges continued in some places into the 20th century.

After the Civil War, railroads were used to transport cattle to eastern and northern markets. Cattle were driven hundreds of miles along established routes overland to railroad towns like Abilene, Kansas. The industry grew steadily as Native populations were displaced, more land became available for settlement, and more rail transportation was developed. The last brief boom in the ranching economy occurred in the early 1880s when there was a large influx of ranchers that settled in the region (Webb 1931). Soon after drought, harsh winters, overgrazing, and competition resulted in disastrous setbacks for the ranching industry, which began to collapse in the mid-1880s (Webb 1931). Ranching continues to be an important economic mainstay in many parts of the Great Plains region.

Mining. Gold, silver, and copper mining were important resources within the Rocky Mountain States of the Great Plains in the nineteenth century. Energy resources such as petroleum, natural gas and coal are currently important resources in the Plains (USDS 2006).

Western Expansion

Hide hunters and trappers were first attracted to the region because of the large numbers of bison in the area. A prosperous fur trade took place in the early decades of the nineteenth century, which led to the eventual depletion of the bison population. Early American emigrants came to the Great Plains region in larger numbers beginning in 1840, many passing through on their way further west. Gold discovered in Colorado, Montana and California greatly increasing overland travel (Fowler 2001). In 1850 alone, 100,000 emigrants crossed the Great Plains, many bound for the gold fields of California (Swagerty 2001). Permanent settlement in the Great Plains was avoided because of the lack of

trees, water sources, and difficultly in producing crops (International Information Programs 2007). Many crops failed in the Great Plains largely due to rainfall fluctuation in the region, and the marginal quality of farming lands. Early settlers often bypassed the Great Plains region in order to settle in areas more hospitable to farming (International Information Programs 2007). Those that did settle in the region had more success with ranching, an alternative to farming.

In 1854, Congress passed the Kansas-Nebraska Act, which created the Kansas and Nebraska Territories. The acquisition of lands originally held by Native Americans expanded the boundaries of the United States west of the Mississippi. The Homestead Act of 1862 attracted setters, many of whom were recent immigrants from Europe. The Homestead Act transferred more than 270 million acres of land from Federal to private ownership. Large numbers of homesteaders settled in the Great Plains, especially the western portion. Many of these new settlers tried to establish farms and homesteads that failed due to the poor suitability of the land for agriculture. Extensive irrigation in the area eventually led to productive crop growing, and livestock raising was consistently part of the area's economy (National Park Service 2006).

Trails

Oregon Trail. The Oregon Trail was used by settlers traveling to the Great Plains region or to pass through the area on their way to more westerly points. The Trail began as an unconnected series of trails used by the Native Americans. Fur traders expanded the route to bring pelts to trading posts in the early 1800s (Bureau of Land Management 2007). The route extends roughly 2,000 miles west from Missouri toward the Rocky Mountains to the Willamette Valley. A trail to California digressed from the route in Idaho (Bureau of Land Management 2007).

Several groups followed the route to settle the west between 1800 and 1880s. Missionaries used the trail during the 1830s, traveling along the Platte and Snake Rivers to settle churches in the Northwest. Mormons, headed toward Salt Lake in Utah, used the trail beginning in 1847, and the discovery of gold in California caused many gold miners to use the trail in 1849. Military posts and spur roads were established along the Oregon Trail. Fort Laramie in Wyoming was established in 1849 as the base for protecting a long stretch of the Oregon Trail (National Park Service no date). The trail was used for driving cattle driving trail eastward for a brief time as well. The construction of the Central Pacific Railroad, connecting California to the rest of the continent in 1869, decreased use of the Oregon Trail. By the early 20th century, the trail was no longer a major transportation corridor, as railroad lines paralleled the original route in many places (Bureau of Land Management 2007, Schwantes 1989).

Mormon Pioneer Trail. One of the major forces of settlement in the West was Mormon emigration. A large colony of Mormons left Illinois in February

1846 and crossing into Iowa, in an attempt to escape religious persecution (Forest Service 2007). Their leader, Brigham Young, opted not to follow the Oregon Trail, but instead forged a new route just north of the Platte River because the route was better suited to wagon travel and because he wished to avoid other travelers from Missouri who frequented the Oregon Trail (Billington 1960). The Mormons crossed Mississippi and established temporary headquarters there, then went on to Missouri, through the Great Plains, where they spent an icy winter and lost 600 people from their party (Billington 1960). They reached the Valley of the Great Salt Lake, where they settled, in June 1847. The trail is approximately 1,300 miles long (American West 2007).

Nez Perce. This trail extends from Wallowa Lake in Oregon to Bear Paw Mountain in Montana. It is named for the Nez Perce tribe of Native Americans who fled their lands when the US Army pursued them in 1877. Approximately 750 Nez Perce men, women, and children traveled over 1,170 miles through the mountains, on a trip that lasted from June to October of 1877 (US Forest Service 2007). The trails extends from Wallowa Lake, Oregon, through the Snake River at Dug Bar, entering Idaho at Lewiston and then over to north central Idaho, entering Idaho at Bannock Pass and traveling back to east Montana at Targhee Pass to cross the Continental Divide. It bisects Yellowstone National Park in Wyoming, and then follows the Clark Fork River out of Wyoming into Montana. The trail then heads north into Bear's Paw Mountains and ends forty miles from the Canadian Border (US Forest Service 2007). This trail crosses 90 miles of BLM land and 221 miles of USFS land within the project area.

Railroads

*T*he construction of the Union Pacific and Central Pacific Railroad, linking Missouri to California was completed in 1869. These completed railroad lines increased settlement in the Great Plains area from emigrants from the eastern US. The rail lines not only transported people, but was also used to transport hides and cattle to markets in the east (National Park Service 2007). Many of these lines were constructed in an east-west direction instead of a north-south direction because early travelers were merely passing through the region, not settling there (Webb 1923). An important exception was the Kansas Pacific Railroad from Abilene to Chicago which established in 1867 a gateway for cattle from the southern plains to reach eastern consumer markets through the stockyards of Chicago.

The construction of the railroads often required temporarily quarters for the construction crews to inhabit while they built stretches of railroad. These towns would consist of large tents that held dance floors, gambling areas, dance floors and bars. Many of the rural "boom towns" eventually became ghost-towns due to a loss of population and because much of the agricultural land was unsustainable (Billington 1963). However, many towns and cities within the Great Plains region have their origins in the small boom towns associated with

railroads line. Some of these cities continue to be important to the economy of the Great Plains (International Information Programs 2007.

CALIFORNIA

The California culture region resembles the modern state, however it excludes parts of the northwest and northeast corners of the state (Northwest Coast and Plateau culture regions, respectively), as well as the Mojave Desert and areas east of the Sierra Nevada (Great Basin culture region) (Figure 3-15b). The region does extend south into Mexico and Baja California, but since these areas are not included in the project area, it is not discussed here. Although the region is not consistently split into subregions, the terms Southern California, Central Coast, and Northern California are used here (the Central Valley is not discussed because it is mostly excluded from the potential development area). Southern California is considered to include the area south of Santa Barbara; the Central Coast is covers primarily Santa Barbara, San Luis Obispo, and Monterey Counties; and Northern California is considered to be the area from the San Francisco region north.

USFS regions included in the California region include all of Region 5 and a small southern portion of Region 6 in Oregon. BLM Field Offices included in the region include all or portions of the El Centro, Palm Springs/South Coast, Barstow, Needles, Ridgecrest, Bakersfiled, Hollister, Folsom, Ukiah, Eagle Lake, Redding, Arcata, Alturas, Surprise and Lakeview offices.

Table I-5 identifies the California culture region languages and tribes that have been documented within the project area. Culturally, the California culture region is bordered by the Southwest and Great Basin culture regions to the east and the Plateau and Northwest Coast culture regions to the north.

A general chronology of California has been developed based on developments in social organization and bead forms (Neusius and Gross 2007). The early prehistory of California has been dramatically affected by post-glacial sea level rise, resulting in inundation of the coastline and altering coastal environments. Although a few sites have been attributed to Pre-Clovis occupations, many archaeologists do not agree these are true representations of a very early occupation of California. Rather, the earliest agreed upon evidence is for a Clovis-like occupation. The following outlines the general chronology of California (Neusius and Gross 2007). It should be noted that this chronology is not based on the summary regional chronology given in the standard *Handbook of North American Indians* (Heizer 1978b), but is instead based on more recent archaeological data.

- Paleoindian: pre-11,000 BP
- Archaic: 11,000 – 4000 BP
- Early Archaic: 11,000 – 8000 BP
- Middle Archaic: 8000 – 6000 BP

Table I-5
Languages and Tribes of the California Culture Region in the Project Area

Language (Linguistic Phylum)	Tribes
Athapascan (Na-Dene)	Tolowa, Hupa, Chilula, Whilkut, Mattole, Nongatl, Sinyone, Lassik, Wailaki, Cahto
Algonquian (Macro-Algonquian)	Yurok, Wiyot
Uto-Aztecan (Aztec-Tanoan)	Tubatulabal, Tataviam, Gabrielino, Luiseño, Kitanemuk, Serrano, Cahuilla, Cupeño
Karok (Hokan)	Karok
Chimariko (Hokan)	Chimariko
Shastan (Hokan)	Shasta
Palaihnihan (Hokan)	Achumawi, Atsugewi
Pomo (Hokan)	Western Pomo, Northeastern Pomo, Eastern Pomo, Southeastern Pomo
Yanan (Hokan)	Yana
Esselen (Hokan)	Esselen
Salinan (Hokan)	Salinan
Chumashan (Hokan)	Eastern Coastal Chumash, Obispeño Chumash, Purisimeño Chumash, Interior Chumash
Yuman (Hokan)	Tipai and Ipai
Miwok-Costanoan (Penutian)	Lake Miwok, Eastern Miwok, Coast Miwok, Costanoan
Wintun (Penutian)	Wintu, Nomlaki, Patwin
Maidu (Penutian)	Maidu, Nisenan, Konkow
Yokutsan (Penutian)	Monache, Southern Valley Yokuts, Northern Valley Yokuts, Foothill Yokuts
Yukian (Undetermined linguistic phylum)	Yuki, Coast Yuki, Huchnom, Wappo

Source: Heizer 1978a; Shipley 1978; Neusius & Gross 2007; Waldman 2000

- Late Archaic: 6000 – 4000 BP
- Pacific: 4000 – 500 BP
- Early Pacific: 4000 – 2500 BP
- Middle Pacific: 2500 – 1500 BP
- Late Pacific: 1500 – 500 BP
- The Historic period then follows the Late Pacific Period.

Cultural History

Prehistoric

Paleoindian: The most accepted evidence of first cultures in California is comprised of Clovis-like fluted points found primarily as surface scatters. As in other regions however, such finds are rare (Neusius and Gross 2007). Their scarcity may be due to the rise of sea level at the end of the Pleistocene. Consequently any sites formed during the Paleoindian period along the now submerged coastline, would also be submerged.

Evidence from one archaeological site, Borax Lake, in the North Coast Range of northern California supports a notion that early inhabitants of the northern region were generalized foragers, opposed to the big-game hunters of other regions. Other sites in the southern California region include lithic hunting and cutting tools, and lack millingstones, indicating an emphasis on large game hunting. A series of Paleoindian sites are located along the California coast and are associated with coastal rivers, lagoons, and estuaries. These sites indicate a possible early maritime adaption that is separate from the Clovis-like occupations. Fluted points are not found at these sites. Also indicated is a use of watercraft suitable for ocean crossings, given the location of some sites on the Channel Islands of the Santa Barbara region (Neusius and Gross 2007).

Archaic: The Archaic period witnessed warmer and drier conditions that required adaptations by prehistoric populations in the California culture region. However, Early Archaic sites were most certainly affected by rising sea levels, becoming inundated by rising sea levels or eroded from cliffs by wave action. The period saw a slow, but necessary evolution of subsistence activities, beginning with hunting, followed by an emphasis on seed collection, followed by a variety of specializations adapted to the range of environments in the region (Wallace 1978).

Archaic adaptations included the incorporation of seeds into the diet, requiring development of millingstones. Along the coast in southern California, many Archaic sites incorporate numerous amounts of shell with simple flake and cobble tools as well as manos and metates. However, many inland southern California sites include many more flaked stone tools and often not made from cobbles, like those along the coast, and they lack shell. Along the Central Coast in the Santa Barbara region some pithouses have been attributed to the Archaic and mortars and pestles appear rather than metates. In the San Francisco Bay region the earliest times of the Archaic period are poorly represented, probably due to sea level rise creating for the Bay for the first time (Neusius and Gross 2007). As such, the area may not have been resource-rich prior to sea level rise. In the same thought, any sites that would have been in the Bay would now be underwater. Archaic sites that are present in the San Francisco Bay region exhibit the same millingstone tool kit as other areas, as well as mortars and pestles and simple shell beads. Along the coast north of San Francisco Bay the

Borax Lake tradition is prominent. This tradition is based on the presence of a distinctive projectile point with a square stem, millingstones, mortars, pestles, simple lithic tools, knives and bifaces (Neusius and Gross 2007). Additionally, charmstones, presumably of ceremonial significance, are found throughout the culture region during this period.

Patterns of settlement during the Archaic period are best known from the archaeological record of Southern California. During the earliest period of the Archaic prior to sea level rise, sites were situated along the coast on higher ground, such as bluffs and marine terraces. As sea levels rose, the sites became concentrated on such topographic features near the forming lagoons and estuaries. However, it is unknown if these are true cultural patterns or if it is a biased pattern formed as a result of site inundation along the coast (Neusius and Gross 2007). As sea levels continued to rise during the Archaic sediments carried down streams and rivers to the ocean began to fill the lagoons and estuaries that had formed at their mouths. The result for some was the formation of mudflats while others were entirely cut off from the ocean, depleting their original productivity. Late Archaic populations adapted to these changes by moving to the open coast and permanent bays and wetlands. In Southern California, sites along the coast acted as seasonal base camps while inland sites were occupied only for parts of the year. Such a pattern indicates small, highly mobile groups. Alternatively, along the Central Coast there are large base camp sites along the coast accompanied by a variety of smaller, season al camps more inland. This pattern indicates a semi-sedentary lifestyle (Neusius and Gross 2007).

The earliest Archaic peoples made great use of the varied environments of California in their diets. Along the coast shellfish were favored and supplemented by seeds and land mammals, but surprisingly fish is not as common in archaeological sites as would be expected. Millingstones appeared in earnest along the coast around 8000 – 9000 BP, indicating intense use of seeds. Meanwhile in more inland areas large game and seeds were the staples of diets there. In the Middle Archaic, hunting became increasingly more important throughout the culture region. There is also an increase in incidence of mortars and pestles during the early part of Late Archaic, indicating increased use of acorns (Neusius and Gross 2007).

Pacific: The Pacific Period is similar to other post-Archaic patterns in North America. Stable food supplies were adopted and economies developed that were based on those supplies. Populations grew and developed social hierarchies as a reaction to the imbalance of the population and available resources. An increased importance on trade in specialized and luxury items helped to maintain the developing hierarchy. In coastal and southern California cultural time periods during the Pacific are based primarily on changes in shell bead and ornament typologies (Neusius and Gross 2007).

A variety of sites characterize the Pacific Period, namely permanent villages, seasonal camps, specialized resource procurement sites (such as quarries) that replaced the more generalized camp sites of the Archaic, rock art sites, and trading sites. Populations were sedentary primarily in the Santa Barbara region, while in other parts of the project area they were semi-sedentary with permanent villages and seasonal base camps. For instance, along the northern coast semi-sedentary villages were established in the lowlands and camps in the uplands, the latter occupied by a portion of the village population. Often, bedrock milling features (such as bedrock mortars and grinding slicks) are associated with many of the sites of the Pacific Period (Neusius and Gross 2007), further indicating the importance of seeds and other vegetal foods.

Along the coast shellfish remained an important part of the prehistoric diet and the importance of fishing apparently increased. Along the Central Coast hunting of marine and land mammals supplemented this diet, while in the south acorns and seeds were more common supplements (Neusius and Gross 2007). The increase in fishing may have been supported by new technologies in watercraft, such as the *tomol*, or plank canoe. It should be noted that ocean going watercraft apparently were in use during the Early Archaic given the location of sites on the Channel Islands.

With the intensification of stable resources such as acorns, hard seeds, fish, and marine resources, the development of storage became a requirement. Acorn granaries are in fact a prominent feature of most California sites. In the desert areas of Southern California, acorns were often replaced with honey and screwbean mesquite. In the areas farthest south ceramic vessels were commonly used for storage rather than granaries (Neusius and Gross 2007).

Later in the Pacific Period artifacts begin to be elaborated with engraving and shell ornamentation along the coast. The numbers of groundstone artifacts such as millingstones, mortars, and pestles, increases there is extensive use of marine resources. Additionally small arrowheads are found in sites. Along the south coast and in the southern foothills and mountains sites have a more diverse assemblage, including ceramics, triangular and side-notched arrowheads, mortars, metates, and manos. Evidence of cremation is also present at sites, whereas during the Archaic individuals were commonly buried. The practice of cremation along with similarities in artifact styles seem to indicate interaction between this southern portion of the California culture region and parts of the Southwest region. Likewise, along the northern coast of California, similarities are seen in the settlement patters of the northern California coast and the adjoining Northwest Coast region, likely indicating interactions between the two areas (Neusius and Gross 2007).

The use of the plank canoe not only allowed people of the Pacific Period to venture farther out for fishing, but also allowed interdependent economic systems to develop between the mainland and islands. This, along with the

increased population indicated by larger sites (Neusius and Gross 2007), only further developed the social hierarchies of settlements. Those with resource surpluses could afford to have canoes built and could therefore exercise control of trade along the California coast, continuing to attain and control luxury and specialized items, such as the *Olivella* shell beads used for money and made using lithic materials available only on Santa Cruz Island in the Santa Barbara Channel.

Historic

Contact with a variety of European ethnicities brought exotic goods such as glass beads, china, and iron to the California region, as well as the diseases that were brought in the same way to other cultural regions. The decrease in California populations as a result of European diseases most certainly affected the social organization and subsistence activities of the people (Neusius and Gross 2007).

As the Spanish established missions, pueblos, and presidios across the region, missionaries sought to convert the Native Americans to Christianity and settle them at the missions. Missions were established in areas with large Native American populations and where water and other resources were readily available (Neusius and Gross 2007). Some Native Americans did move to the missions, assisting with the construction of the missions and their systems (such as irrigation), others did not. Uprisings of Mission Indians are recorded as some realized that they did not want to stay at the missions. The Mission life was much different than what native groups were used to, however studies have shown that female activities continued relatively unchanged, while male activities resembled more Spanish-derived pursuits (Neusius and Gross 2007).

After Mexico gained independence from Spain, much of the land of California was transferred to private ownership in the form of ranchos and haciendas; however, the Spanish pueblos also grew. The presence of Native Americans at these locations varies across the state. At some, there is no evidence of their presence, while at others there is evidence of their use as laborers (Neusius and Gross 2007).

Euro American Exploration

The first known Europeans to explore the area that became California were the Spanish, British, and Russians.

Spanish exploration of the California region began in the sixteenth century. Francisco Coronado and Hernando de Alarcon, along with Melchor Diaz led expeditions in 1540. Juan Rodriguez Cabrillo, from Spain, led an expedition to the region in 1542 (Castillo 1978). By the end of the century, the Spanish authorities in Mexico hoped to secure the California coast and find ports and expand its thriving Pacific trade. Manila galleons, heavy sailing ships with many decks for cargo, brought silks, jewels, spices, and fine china to western Mexico from the Philippines, returning with cargoes of gold and silver from the mines of

New Spain. Cabrillo explored the coast along present day San Diego, Catalina Island, San Pedro, and the Channel Islands area (Wagner 1929).

Sir Francis Drake, a British explorer, landed on the California coast in 1579. He explored the present-day Bodega Bay or Drake's Bay area, and claimed it as Britain's territory (Castillo 1978). Two hundred years later, Captain James Cook explored and mapped the coast of California and Alaska all the way to the Bering Strait.

The Russians are not known to have entered California in the sixteenth century, but beginning in 1742 they began exploring the Aleutian Islands and the west coast of Alaska seeking furs. They established a permanent settlement on Kodiak Island in 1784. Soon thereafter, native Alaskan hunters working for the Russians traveled south to hunt sea otters along the coast of California.

The Spanish were eager to establish a settlement in California because of the fear that British and Russian would continue to expand control and begin to settle along the California coast (Castillo 1978). In 1769, the Spanish organized an expedition led by Captain Gaspar de Portola and Father Junipero Serra. The expedition also resulted in the establishment of the first of twenty-one missions along the California coast, in San Diego, named San Diego de Alcala (Castillo 1978 and Library of Congress 2006). The missions functioned both as economic and religious outposts of the Spanish empire.

The expedition to California also resulted in the founding of the first presidios, and by 1800 there were three presidios established along the coast. Presidios were military forts the Spanish used to obtain control of an area and to defend coastal harbors against attack. During the next fifty years, the Spanish continued to explore the coast of California, establishing missions, presidios and pueblos (civilian towns) from San Diego to Sonoma (Neusius and Gross 2007).

Western Expansion

Mexico including California became independent from Spain in 1821. This led to the secularization of missions and the removal of Native Americans from missions (Castillo 1978). Independence meant a shift of power from church to private landowners. Governors of Mexico were able to secure land grants in the form of ranchos, large pieces of lands, to individuals. The ranchos often contained buildings made from adobe, including large residences. During the Mexican period, cattle-raising, and the marketing of beef and hides became an economic staple in California (Library of Congress 2006). Fur traders and trappers settled in California during this period, and many visitors came through California on their way to Oregon.

The Mexican American War was won by the US in January, 1847, ending the Mexican Period. The population of California at that time was 150,000 Native Americans and 14,000 Mexican and European descendants (Library of Congress

2006). This was soon followed by the discovery of gold in the Sierra Nevada Mountains. The discovery of gold meant new settlers to the region, many of whom did not respect the property rights of rancho owners and squatted on their lands.

Chinese were among the largest emigrants to California during the gold rush. They were not welcome by the Anglo-miners, and the Chinese often set up camps and small enclaves which were entirely populated by Chinese (California Historical Society 2000).

California was admitted to the union as a free state in late 1850. The population and economy of the state grew rapidly in the 19th and 20th centuries. Agriculture became an important part of the economy and other industries developed, such as the oil and entertainment industries (California Historical Society 2006).

Major Industries

Mining. The discovery of gold in 1848 in Coloma, California marked a huge transition. Thousands of miners and gold-seekers came from other parts of the United States and other countries and continents. Many who came traveled by routes through seas and came through the port of San Francisco (California Historical Society 2000). Mining became a thriving industry during the 1880s, and technical advances in mining equipment, such as hydraulic mining, became a thriving industry (Library of Congress 2006).

Settlers who came to California for the gold rush found business and farming lucrative and settled in the region. Ports, such as San Francisco (then Yerba Buena) experienced growth in exports and businesses catering to the mining community thrived during the 1880s into the early 1900s. Other mining towns, called "boomtowns" were established during this period, to service the miners who traveled distances to work in the mine fields. The biggest boomtowns in near the gold fields were Sacramento and Stockton.

Agriculture, Ranching

Commercial agriculture and ranching in California had its roots in the missions and pueblos. The Spanish introduced a wide variety of Old World and Asian cereal and fruit crops and domesticated livestock to California. They also brought in irrigation systems, metal tools and crop processing methods. The missions were not only expected to be self sustaining, but they also needed to support the Presidios and provide goods to be traded. Livestock was raised for meat, but also for wool, leather, and tallow, and for cultivating the land.

After secularization there was a decline in agricultural production. With the discovery of gold, the needs of the miners and the growing cities caused a rapid increase in both crops and ranching. . Wheat became a strong agricultural product in California by 1850 (Library of Congress 2006) and cattle ranching peaked in the 1860s. Direct access to the eastern markets through the railroad

in 1869 and later through refrigerated train cars allowed expansion of agriculture through the 19th century. A later transformation was the change from dryland agriculture to intensive-irrigated agriculture at the turn of the last century. California has historically produced a variety of crops including vegetables, fruit, nuts, diary, livestock, poultry, and flowers for export to other regions in the U.S. as well as to other countries (University of California 2007). While much of the current agricultural activity is located inland, there is crop production along the coastal valleys of northern and southern California (Johnston 1994). Field crops continue to be the mainstay of the agricultural economy of California.

Railroads. Shortly after California became a state in 1850, rail lines were constructed. In 1862, President Lincoln signed the Pacific Railroad Act, which allowed construction of a railroad line from Sacramento east, built by Central Pacific Railroad and from Omaha West along the Missouri River, built by Union Pacific Railroad. The rail lines met in Promontory, Utah in 1869, completing the first Pacific Railroad (California State Railroad Museum Foundation 2007 and Library of Congress 2006). The completion of the railroad meant that agricultural produce, lumber, and gold could be shipped to eastern parts of the US, while settlers were able to emigrate from the east to live in the west. . The railroad had a large impact on California immigration, which continued through the 20th century.

Trails

Juan Bautista de Anza. This trail was used by a party of 300 Spanish colonists, led by Colonel San Juan Bautista, from Mexico to California in 1775. The party intended to establish a mission and presidio in present-day San Francisco in order to secure the area from Russians and British. The party contained thirty families, a dozen soldiers, cattle, mules, and horses. It took three months to follow the trail through the southwest desert before reaching the California Coast. The trail is over 1,200 miles long. It took another three months to travel from the southern coast up to the northern coast to present-day San Francisco (USDA Forest Service 2007). This was the first overland route established to connect New Spain with San Francisco (National Park Service 2007).

Old Spanish Trail. This trail was first established by a Mexican trader, Antonio Armijo, in 1829. He traveled from New Mexico to Los Angeles on a commercial caravan, carrying Mexican woolen goods and planning to bring horses back from California (National Park Service 2007). Prior to the Old Spanish Trail, an overland southern route to California from New Mexico did not exist. The route was used often by traders and also traded with Native Americans along the route. This combination of footpaths of Native Americans, early trade explorations, and horse and mule routes make up the Old Spanish Trail. The trail was 1,200 miles long and extends from two trailheads. The trail

ran through present-day Colorado, Utah, Arizona, Nevada, and California (Cultures and Histories of the American Southwest 2007)

California Trail. The trail was used by over 250,000 farmers and gold miners from Missouri during the 1840 and 1850s. The route starts along the Missouri River, and then converges on the Great Platte River Road, overlaps with the Oregon Trail and to the Rocky Mountains. After the crossing the Rockies, many routes were used to get to and cross the Sierra Nevada Mountains. The total system of trails that make-up the California Trail is approximately 5,664 miles (US National Park Service 2007).

Pony Express National Historic Trail. This trail began in 1860 as a mail route connecting the eastern US with California. It was privately financed was used only for eighteen months before the telegraph system was constructed and replaced the Pony Express. Riders on horseback transported mail from Missouri to California in ten days, traveling over 1,800 miles. The transcontinental railroad later followed much of this route (National Park Service 2007).

SOUTHWEST

The Southwest culture region covers all of Arizona, the western majority of New Mexico, the southern tip of Nevada, southern Utah, extreme southern and western Texas, and parts of southwest Colorado (Figure 3-15g). The region does include parts of northern Mexico, but since this part of the region is not included in the project area, it is not discussed here. This is a highly varied region culturally that is rich in cultural resources and it should be noted that many of the tribes and pueblos within the cultural region may have more in common with neighboring cultural regions because of their shared environmental contexts. As a whole though, the Southwest culture region is demanding of its inhabitants and requires extensive adaptations to its environments for survival. This is recognized in the development of agriculture, domestication, stone and masonry architecture, and irrigation systems as well as the mysterious abandonments in some areas. A wide array of other traditions, some having been adopted from Mesoamerican cultures, also characterizes the cultures of the region. However, because of the diversity of the environments these adaptations vary among the subregions of the area (Neusius and Gross 2007; Ortiz 1979a; Woodbury 1979).

USFS regions included in the Southwest region include portions of Regions 2 and 4 and all of Region 3. BLM Field Offices in the region include all or portions of all field offices in New Mexico and Nevada with the exception if the Arizona Strip Office. In addition the cultural region covers a portion of the Royal Gorge Field office.

Table I-6 identifies the Southwest culture region languages and tribes that have been documented within the project area. Culturally, the Southwest culture

region is bordered by the California to the west, Great Basin to the west and north, Plains to the north and east, and Southeast to the east.

Table I-6
Languages and Tribes of the Southwest Culture Region in the Project Area

Language (Linguistic Phylum)	Tribes
Yuman (Hokan)	Walapai, Havasupai, Yavapai, Mohave, Halchidhoma, Quechan, Cocopa, Maricopa
Uto-Aztecan (Aztec-Tanoan)	Papago and Upper Pima, Hopi, Jocome and Jano, Tewa, North Tiwa, South Tiwa, Jemez, Pecos, Tano
Athapascan (Na-Dene)	Navajo, Western Apache, Chiricahua Apache, Mescalero Apache, Jicarilla Apache
Zunian (Penutian)	Zuni
Keresan (Undetermined linguistic phylum)	Rio Grande Keresans, Acoma, Laguna
Kiowa-Tanoan (Aztec-Tanoan)	Piro, Tompiro

Source: Ortiz 1979b; Neusius & Gross 2007; Waldman 2000

No single framework of Southwest cultural chronology is entirely appropriate for the whole culture region given the high degree of variability across it. However, there is enough similarity in the development of the major characteristics of the culture region for researchers to have established a very general chronology while limiting the amount of subareas discussed for each period (Neusius and Gross 2007; Ortiz 1979a; Woodbury 1979). Throughout the region the evidence for a Pre-Clovis occupation is rare, but there is definite evidence of a Clovis and post-Clovis Paloeindian occupation. The following outlines the general chronology of the Southwest culture region. Unlike other regions, the more recent cultural and technological patterns of the Southwest do not allow for an overall chronology after the Archaic Period and more localized patterns must be used (Neusius and Gross 2007).

- Paleoindian: pre-8000 BP
- Archaic: 8000 – 1750 BP
- Early Archaic: 8000 – 3500 BP
- Late Archaic: 3500 – 1750 BP
- Fully Developed Regional Traditions: 1750 – 400 BP

The Historic period then follows the localized regional traditions in the Southwest.

Cultural History

Prehistoric

Paleoindian: Southwest populations of the Paleoindian Period were organized into small, mobile groups of hunter-gatherers and resembled the Great Plains in many ways (Irwin-Williams 1979; Neusius and Gross 2007). Evidence for Pre-Clovis (pre-11,500 BP) people in the region is scant and what does exist is not very reliable. Evidence for Clovis hunters is much more accepted and found across the Southwest culture region, if not still in small numbers. In fact, Clovis points are named after the town in New Mexico, where examples were found in 1929. Such evidence comes from mammoth and bison kill and butchering sites where bones of the large game are associated with Clovis points as well as surface finds of Clovis points throughout the Southwest culture region (Neusius and Gross 2007). Paleoindian lifeways in general in the Southwest were intimately tied to the changing environmental and climatic context, technological innovations and adaptions, changing population sizes, and changing social organization (Irwin-Williams 1979; Neusius and Gross 2007).

Following the early Paleoindian Period, distinct patterns developed in the east and west portions of the Southwest, marked by the Arizona and New Mexico state line. In the east, a definite Folsom lithic technology with large game hunting is seen beginning around 11,000 BP. In the western Southwest, post-Clovis evidence is rare and what evidence has been found does not seem to indicate a reliance on big game hunting. This pattern continued throughout the rest of the Paleoindian Period, however late Paleoindian sites of the eastern Southwest, which tend to be situated in the foothill and mountain areas, appear to lack the diagnostic Folsom points (Neusius and Gross 2007).

Archaic: Unlike other culture regions, there is less distinction between the subperiods of the Archaic in the Southwest culture region (Neusius and Gross 2007). Additionally, Paleoindian similarities between the region and the Great Plains disappear (Irwin-Williams 1979). As a whole however, sites of this age are typically ephemeral because they were used for comparatively short periods of time, although simple houses first occur in the region during the first half of this period. The Archaic Period brings the first indication of regional variation among groups in the Southwest culture region (Neusius and Gross 2007).

The Early Archaic corresponds with a climatic interval called the Altithermal when moisture levels varied locally and temperatures were unusually warm. Pleistocene large game disappeared presumably due to this environmental shift. These factors combined to require new adaptations by Southwest culture region populations. The largest difference is in technology. Groundstone occurs much more frequently in sites, including millingstones which indicate an increased reliance on seeds in the diet. Projectile points become smaller and their form changed from Folsom-type fluted and stemmed points to side- and corner-notched points with new hafting techniques. A variety of other stone

tools are also included in the Archaic toolkit. The foragers of this time likely followed blooming and ripe plants. In the southern portion of the Southwest, this likely drew people to the valleys of permanent rivers. Caves and rockshelters of these kinds of areas were frequently used (Neusius and Gross 2007).

Four Archaic regional variants developed during the Early and continued into the Late Archaic Periods, incorporating the above adaptations as necessary: San Dieguito-Pinto in the west, Oshara in the north, Cochise in the southwest, and Chihuahua in the southeast. Pinto sites are often found as surface sites in dry lake basins and along drainages. Oshara sites develop into seasonal fall or winter camps. The Cochise concept is under debate, but later sites attributed to it tend to include simple houses. Chihuahua sites are similar to Oshara and Pinto sites, but are not well understood incorporating their own distinct artifacts and patterns. Although each of these areas and traditions have their own expressions, the Late Archaic Southwest populations practiced a broad-spectrum subsistence method, based on hunting large game and supported by trapping small game and gathering and storing seeds (Irwin-Williams 1979; Neusius and Gross 2007).

The Late Archaic saw the onset of modern, moister conditions. This change once again demanded additional adaptations by populations in the above traditions, most notably with the planting of crops. The skill of plant cultivation spread to the Southwest culture region from Mesoamerica (Woodbury and Zubrow 1979; Neusius and Gross 2007). It should be noted that not all cultigens of Mesoamerica transferred to North America. Crops grown in the Southwest included maize, cotton, squash, and the common bean and bottle gourd. Foragers of the Southwest did not immediately give up their mobile lifeways following the adoption of crop planting. Early crops were likely "casual" with people providing minimal tending so a lost crop would not have represented a total loss of effort (Neusius and Gross 2007). However, sedentism eventually did take place and populations increased (Irwin-Williams 1979; Neusius and Gross 2007). This was likely due to a symbiotic relationship between agriculture and population size. The better people got at agriculture, the larger the population grew. Increased populations become more dependent upon agriculture since the naturally occurring resources cannot support the higher numbers manipulated plants can. The increased dependence of a population on crops would have required people to restrict their mobility in order to consistently tend to the crops and ensure their productivity. The extreme investment made in crop productivity and populations' dependence on crops is evident in the irrigation systems developed at some sites of the Late Archaic (Neusius and Gross 2007).

Regional Traditions: Beginning and continuing on since the Archaic agriculture became widespread throughout the Southwest culture region. Subsistence became dependent upon crops, especially maize, beans, and squash. Other

crops were eventually grown in the more southern areas of the Southwest where extensive irrigation systems of canals and wells were dug (Woodbury and Zubrow 1979; Neusius and Gross 2007). This is not to say that agriculture was the only means of subsistence. Hunting and seed collecting continued to play a part in obtaining food. Additionally turkeys and dogs began to be domesticated. As all of these resources became increasingly more reliable for groups, people became more sedentary and healthy. More productive areas attracted more people. So settlements in the Southwest culture region began to grow through increased births and in-migration. Architecture began to become elaborated with development of pueblos and features that were conducive to community integration, such as the multi-family pueblo dwellings (Neusius and Gross 2007).

Although these general patterns were experienced across the culture region the varying environmental conditions across the region demanded some different adaptations for survival. The settled village dwellers of the Southwest culture region are generally divided into five groups based on their unique regional traditions: the Anasazi in the Plateau country of the northern Southwest culture region, the Hohokam in the low deserts of Arizona, the Mogollan in the area from southern New Mexico west to Arizona's Verde River and south in northern Mexico, the Patayan in the Colorado River Valley and adjacent lands, and the Sinagua in the area from Flagstaff to Phoenix in Arizona. The Anasazi culture is recognized by its coil-and-scrape red and white ceramic pottery with black paint, the early construction of pithouses and masonry surface rooms that later developed into large pueblos, kivas, and cliff dwellings, likely due to population aggregation and political and social integration, and the practice of dry farming although some simple irrigation canals were developed later. The Anasazi subregion was abandoned sometime between 950 and 850 BP, likely due to environmental conditions, but was re-populated again later. The Hohokam culture is recognized by its paddle-and-anvil red or buff pottery with red paint, irrigated farming along rivers as well as flood farming in arroyo mouths, and clusters of houses built in pits developing into groups of clusters with associated integrative facilities (i.e. ball courts, plazas, and platform mounds). The culture was centered on the Gila and Salt River basins near Phoenix, Arizona. The Mongollon culture is characterized by coil-and-scrape red- and brownwares early on with red- and black-on-white pots later and Mimbres pottery even later, pithouses that developed into surface pueblos, and dry farming supported with hunting. Early Mongollon sites tend to be walled, suggesting defense, and situated on hilltops and mesas. Site location then shifted to along rivers and on river terraces. The Patayan culture includes paddle-and-anvil pottery with buffware in the lowlands of the subregion and brown pottery in the uplands, dry masonry rock features, including walls and earth ovens, and flood agriculture along the Colorado River and rainfall farming elsewhere in the subregion supported with hunting and gathering. Settlements during the growing season were situated along rivers, where flooding and modern development have had destructive effects, and in the uplands at other times where pit and surface structures were constructed as well as making use of

rockshelters. The Sinagua culture is the most poorly known of these groups. What is known is that the culture is characterized by farming, pueblo-style communities, and paddle-and-anvil red- and brownware pottery tempered with cinders or crushed volcanic rock. Many settlements have been buried by volcanic eruptions that began in 866 BP, the ash of which may have made the soils of the region more productive for agriculture attracting more people, but the northern part of the subregion was eventually abandoned around 650 BP (Neusius and Gross 2007).

As noted above, a number of abandonments occurred throughout the Southwest culture region, including Virgin Anasazi area of southeast Arizona, the Kayenta Anasazi of northern Arizona, the Mesa Verde region of southwest Colorado, most of the Sinagua region, and some parts of the Mogollan area highlands. Groups appear to have relocated and aggregated into large settlements in several localities, making them more sensitive for cultural resources of this time period. Such areas include the Rio Grande valley, west central and eastern New Mexico, and eastern Arizona. It is believed that a drought in the northern parts of the Southwest culture region, which was abandoned by 650 BP, caused these population movements. Other theories involve warfare and violence forced the movements and cooperation between some groups. However, a clear line of descendency between prehistoric populations and modern Native American populations in the Southwest culture region is apparent in the continuity of lifeways (Neusius and Gross 2007).

Historic

Spanish explorers in the Southwest were the first to have contact with the Native Americans of the culture region (Neusius and Gross 2007; Ortiz 1979a). As Spanish towns, presidios, and missions were established contact increased, particularly at missions where the intent was to introduce Christianity to native populations and were thus built near existing population centers. Although some populations rejected Christianity and Spanish governmental institutions, they still adopted some useful items including metal plows and hoes and expanded their crops to include items like apples, peaches, and apricots. As in other areas, Native Americans participated in trade relations with the Spanish and other Europeans. Some Spanish pueblos traded with tribes of other regions, such as the Plains. Of course relations were not always so mutually beneficial though and in fact some tribes were often the adversaries of US soldiers later in time as the US continued to expand and explore westward (Neusius and Gross 2007).

Euro American Contact

The Spanish explored the region beginning in 1540s by following the Rio Grande north from Mexico. Vasquez de Coronado and his men traveled through much of the southwestern United States, ventured deep into the plains of Kansas, descended the walls of the Grand Canyon, and visited all the major Indian villages in the region. Although the gold Coronado was seeking was not found,

the Spanish started settling the area soon thereafter and established a colony with the capital at Santa Fe (Neusius 2007). Other cities and towns were established primarily in river valleys and associated with existing Native American communities. Missions, military outposts and towns were founded, primarily in New Mexico, but also in Arizona and Texas to convert natives, protect settlers and solidify colonial rule. Santa Fe was founded in 1610, Albuquerque in 1706, Las Trampas in 1751, and Taos between 1780 and 1800 (Neusius 2007 and National Park Service 2007). In Northern New Mexico, the Pueblo people revolted and drove out the Spanish in 1680, but the Spanish were able to return by 1692. In Arizona, Father Eusebio Kino, a Jesuit, founded the missions of Guevavi (1692) and Tumacacori (1696), near Nogales, and San Xavier del Bac (1700), near Tucson. The Spanish Empire, however, expelled the Jesuits in 1767, and those in Arizona subsequently lost their control over the indigenous people.

Mexico obtained control over the Southwest region in 1821 following the Mexican war of independence from Spain. With independence came commercial freedom and expansion of trade between Mexico and the United States. The U.S. gained control over the region during the Mexican- American War (1846-1848). Under the Treaty of Guadalupe Hidalgo parts of Colorado, Arizona, New Mexico, and Wyoming, as well as the whole of California, Nevada, and Utah were ceded to the U.S. The remaining parts of what are today the states of Arizona and New Mexico were later ceded under the 1853 Gadsden Purchase. Although military posts, stage routes, ranches, mines and American settlements were established, the region retained many of the well-established Spanish and Mexican traditions (Simmons 1982).

Trade

Missions. The Spanish colonial system was based on rights that the Pope had reserved to the monarchy which granted them newly discovered lands in the New World on the condition that they evangelize the native inhabitants. The missions of New Spain were economic outposts in addition to opportunities to save souls. The Spanish introduced new crops, animals, industries and forms of agriculture from Europe, but also established a trusteeship labor system over the indigenous people they conquered. They had the authority to tax the people under their care and to require them to perform labor. In return, the Spanish were expected to maintain order and to provide teachings in Catholicism. Because in practice there was little respect for native populations and their traditions, they were exploited. Many of the original missions were destroyed in the Pueblo Revolt. When the Spanish returned, the economic importance of the missions waned and trade and commerce in the towns became less dependent on native labor.

Mining. Turquoise had been mined in the Ortiz Mountains south of Santa Fe and traded throughout the Southwest and Mexico long before the Spanish arrived. Other minerals were mined for use in pottery production. The search

for mineral wealth was a major reason for the initial interest in the Southwest by the Spanish. Silver was discovered in the 1730s, and was much more abundant than gold (Statistical Research, Inc. 2000). After the Mexican-American War and the Gadsden Purchase, the population of the southwest grew as miners from America rushed in. Mining districts were abundant by the 1860s (Statistical Research 2000). Gold was found in the Ortiz Mountains in 1828 (New Mexico Economic Development 2007). Copper was also a prominent mineral in southern New Mexico and Arizona, especially after the decline of the silver market in the late 1880s. Mining was originally done by placer and vein mining, but changed to open pit mining after World War II (Statistical Research Inc. 2000). The copper industry continues to be a force in the economy. After World War II uranium became an important mineral resource in the Navajo Nation in northern Arizona and New Mexico, as did coal. Towns, made up of commercial centers, saloons, and hotels, were established in close proximity to mines in order support the miners. Many of these towns followed a boom/bust cycle and were abandoned when the mines were depleted.

Ranching. Ranching continues to be important part of the Southwest region's economy. The Spanish brought sheep, goats, cattle and horses, which became the mainstay of livestock raised in the area. Spanish land grants and Indian lands were often broken up or acquired through legal maneuvering. The Homestead Act of 1862 and the Desert Land Act of 1877 further encouraged and promoted the economic development of the arid and semiarid public lands of the Southwest. These laws opened inexpensive land to farmers and attracted settlers. The construction of rail lines was responsible for the growth of cattle ranching, because cattle could be transported via rail to markets in the eastern portions of the US. (New Mexico Economic Development 2007). Homesteading continued into the twentieth century through the end of World War I.

Western Expansion

New Mexico was recognized as a territory of the United States in 1850, Nevada became a territory in 1861, and Arizona Territory was formed in 1864. The Gadsden Purchase of 1854 added roughly 30,000 square miles of to the New Mexico Territory. More ranches and farms were established during this period, and mining was a booming part of the economy. Several towns and cities sprang up around the mines and were later abandoned as the mining industry waned and mineral deposits were depleted (Neusius 2007).

Trails

Juan Bautista de Anza. This trail was used by a party of 300 Spanish colonists, led by Colonel San Juan Bautista, from Mexico to California in 1775. The party intended to establish a mission and presidio in present-day San Francisco in order to secure the area from Russians and British colonization. The party contained thirty families, a dozen soldiers, cattle, mules, and horses.

It took three months to follow the trail through the southwest desert before reaching the coast of California. It took another three months to travel from the southern coast up to the northern coast to present-day San Francisco. The trail is over 1,200 miles long (USDA Forest Service 2007). This was the first overland route established to connect New Spain with San Francisco (National Park Service 2007).

El Camino Real de Tierra Adentro. This trail dates dating back to the Spanish Colonial era during the 16th to 19th centuries, when it was the primary route between Mexico City, the Spanish capital, and other Spanish provincial towns (Bureau of Land Management 2008). From Mexico, the trail crosses briefly into West Texas at El Paso and north through New Mexico, primarily in the Rio Grande corridor to Santa Fe. The trail was also used for trade and interaction between Europeans, Spaniards, Mexicans, and Native Americans and affected settlement and development within the southwest (National Park Service 2006)

Old Spanish. This trail was first established by a Mexican trader, Antonio Armijo, in 1829. He traveled from New Mexico to Los Angeles on a commercial caravan, carrying Mexican woolen goods and planning to bring horses back from California (National Park Service 2007). Prior to the Old Spanish Trail, an overland southern route to California from New Mexico did not exist. The route was used often by traders and also traded with Native Americans along the route. The trail has been used as a Native American footpath, an early trade route, and a horse and mule trail. The trail runs through present-day Colorado, Utah, Arizona, Nevada, and California (Cultures and Histories of the American Southwest 2007)

Santa Fe Trail. The Santa Fe Trail was used for trade and commerce between Missouri and Santa Fe, New Mexico from 1821 and 1880 (National Park Service 2008). Near Cimarron, Kansas the Trail branches into two routes: the Mountain Route through Colorado and the Cimarron Route through the Oklahoma panhandle to New Mexico (Santa Fe 2008). Except for a short hiatus during the Mexican-American War between 1846 and 1848, the trail provided international passage of goods and travelers. The trail was important in changing over time the culture of the Southwest from the Spanish and Mexican to American. Both during and after the war, the Santa Fe Trail was used heavily for freighting of military supplies to forts in the southwest. Once the railroad extended into the southwest territory, the trail was no longer used.

Railroads. Mineral wealth in the area attracted Americans living in the east to the southwest region and an efficient mode of transportation was needed (US Department of State 2007). The Gadsden Purchase allowed the development of a southern route across the continent. The Atchison, Topeka, and Santa Fe rail lines were constructed in New Mexico by the late 1800s. The Southern Pacific Railroad went through Arizona from the west and into New Mexico. There, it

met the Atchison, Topeka, and Santa Fe rail lines in Deming in 1881 (New Mexico Economic Development 2007). The development of this railroad network served the primary purpose of exporting mineral resources out of the southwest. However, as the Southern Pacific Railroad developed westward, and the Atchison, Topeka, and Santa Fe lines linking it to the north, Albuquerque quickly became an important hub of commerce and travel. The Southern Pacific line provided a link to the east coast, which fostered the "Americanization" of the southwestern states, bringing settlers, goods, industry, and missionaries (Bohme 1957) The Atchison, Topeka, and Santa Fe lines provided a north-south movement of the same. Albuquerque was advertised as a premiere destination for emigrants traveling from the east (Dreesen 1980).

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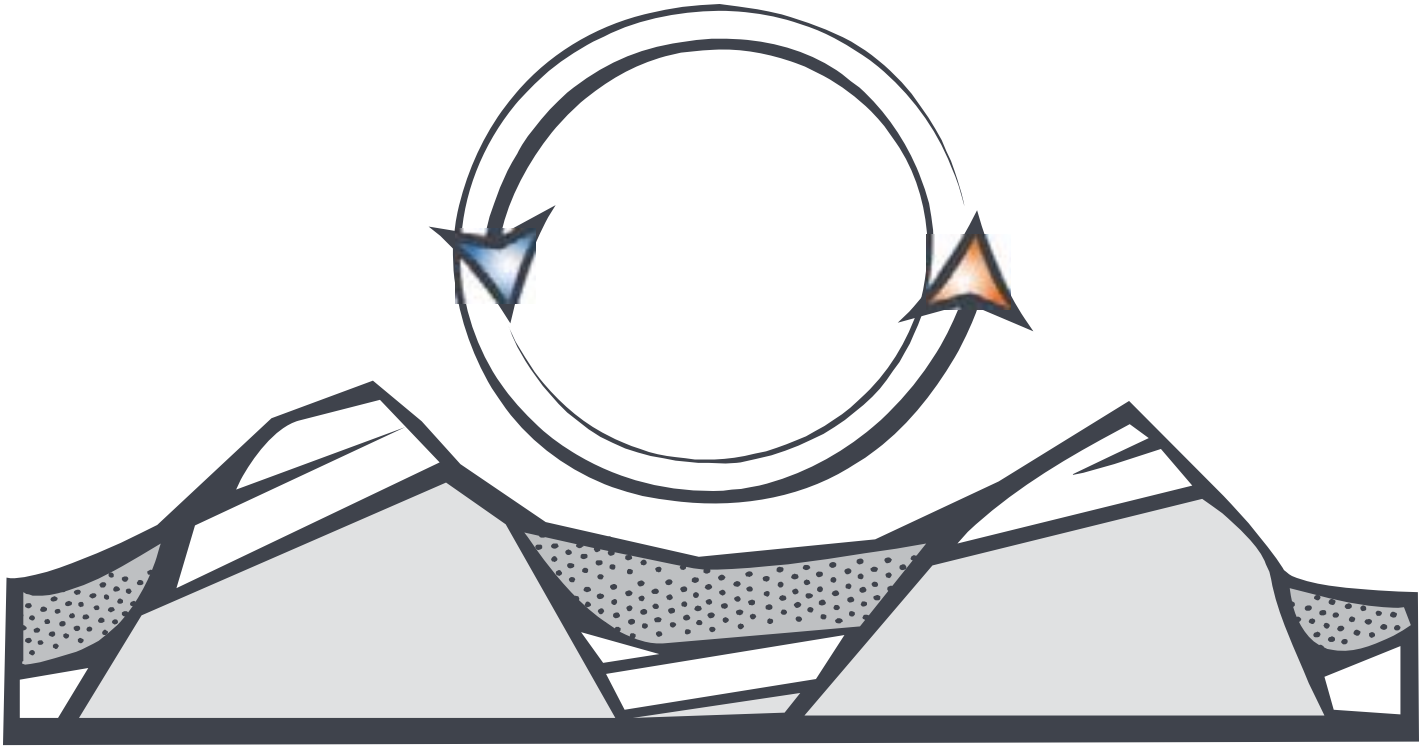

Appendix J

Special Designation Areas on BLM and FS Lands in the 12 Western States

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APPENDIX J
SPECIAL DESIGNATION AREAS ON BLM AND FS LANDS WITHIN THE PROJECT AREA

The following tables list acreage of congressional and administrative designations within the project area by government agency, type of special designation and state or national forest. Because the same area of land can be assigned multiple designations, total acreage of specially designated land within the project area is not calculated here, as combining totals would include acreage overlap.

Table J-1 lists acreage on BLM lands by state and type of designation.

Table J-2 lists acreage on FS lands by national forest and type of designation. Categorization by state was not possible as many national forests cross state lines.

Table J-1
Special Designation Areas on BLM Public Lands within the Project Area

Acreage						
State	Congressional Designations				Administrative Designations	
	Wilderness Areas	National Conservation Areas	Wild and Scenic Rivers	National Monuments	Wilderness Study Areas	Areas of Critical Environmental Concern (BLM)[1]
Alaska	0	2,012,082	297,656	0	87,060	2,926,672
Arizona	1,385,882	119,123	0	1,742,579	63,990	676,749
California	3,656,240	10,792,788	39,000	296,951	1,035,027	1,304,474
Colorado	139,529	173,075	178	162,785	619,442	358,146
Idaho	693	484,638	56	272,640	1,333,574	656,171
Montana	6,126	0	33,897	367,507	412,481	2,906,653
Nevada	1,998,197	1,053,119	0	6,548	2,546,992	198,347
New Mexico	151,137	228,591	22,897	4,108	960,463	468,488
Oregon/Washington	193,306	422,907	237,921	52,843	2,737,779	825,622
Utah	132,162	5,081	0	1,864,264	3,273,285	1,212,014
Wyoming	0	0	0	0	571,501	917,212
Total	**7,663,272**	**15,291,405**	**631,605**	**4,770,225**	**13,641,594**	**12,450,547**

[1] Areas of Critical Environmental Concern are a BLM-specific designation

Source: BLM2008

Table J-2
Special Designation Areas on NFS Lands within the Project Area

Forest	Acreage							
	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Areas	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Angeles National Forest	81,907				14,168			200,290
Apache-Sitgreaves National Forests	22,214							337,219
Arapaho and Roosevelt National Forests	305,779		35,623	20,528	10,659			393,401
Ashley National Forest	271,540		200,115					795,625
Beaverhead-Deerlodge National Forest	219,161						154,988	1,830,896
Bighorn National Forest	191,921							620,561
Bitterroot National Forest	754,257						101,694	405,883
Black Hills National Forest								9,259
Boise National Forest	64,945							1,109,148
Bridger-Teton National Forest	1,297,005						109,352	1,430,637
Caribou-Targhee National Forest	134,606							1,587,205
Carson National Forest	84,391			1,997			43,739	161,071
Chugach National Forest							1,969,892	1,972,397

Table J-2
Special Designation Areas on NFS Lands within the Project Area

Forest	Acreage							
	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Areas	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Cibola National Forest	137,628				49,927			246,220
Clearwater National Forest	261,923			23,802	16,481			988,597
Cleveland National Forest	75,580							130,755
Coconino National Forest	179,346			2,918				52,705
Colville National Forest	31,451							181,693
Comanche National Grassland	337,256						61,341	679,997
Coronado National Forest	331,728						143,995	144,947
Custer National Forest	182,716			27,067	42,950			136,467
Deschutes National Forest	82,836							851,970
Dixie National Forest	101,751							101,056
Eldorado National Forest								716,903
Fishlake National Forest	1,076,152		15,274	23,594				478,673
Flathead National Forest	115,536			11,904				118,718
Fremont-Winema National Forests	717,860				35,050		143,995	703,843

Table J-2
Special Designation Areas on NFS Lands within the Project Area

Forest	Acreage							
	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Areas	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Gallatin National Forest	179,127	33,077						212,623
Gifford Pinchot National Forest	261,923			23,802	16,481			988,597
Gila National Forest	791,784						59,869	749,056
Grand Mesa, Uncompahgre and Gunnison National Forests	551,800		50,969		27,754			1,203,841
Helena National Forest	112,241							444,809
Humboldt-Toiyabe National Forest	913,911		275,634				178,756	3,383,841
Idaho Panhandle National Forest	10,387			23,288			6,014	828,950
Inyo National Forest	639,253	119,238		2,259				966,391
Kaibab National Forest	108,831							53,055
Klamath National Forest	372,503			44,118	18,196			454,277
Kootenai National Forest	93,765	4,808					34,605	638,266
Lassen National Forest	78,109				16,351			186,846
Lewis and Clark National Forest	365,570						169,143	1,003,874
Lincoln National Forest	82,097						20,929	213,182

Table J-2
Special Designation Areas on NFS Lands within the Project Area

Forest	Acreage							
	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Areas	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Lolo National Forest	147,965		25,463					758,439
Los Padres National Forest	807,856			1,378				1,037,208
Malheur National Forest	78,353			10,801				181,508
Manti-Lasal National Forest	46,358							645,971
Medicine Bow-Routt National Forest	329,668							821,679
Mendocino National Forest	136,211			4,550				214,202
Modoc National Forest	63,937							202,416
Mt Baker-Snoqualmie National Forest	703,934		8,675	18,780	143,121			415,304
Mt. Hood National Forest	187,268	42,582		51,334	82,328			118,026
Nez Perce National Forest	869,442			10,532				502,240
Ochoco National Forest	35,201			7,575	83,910			61,010
Okanogan National Forest	627,335							427,097
Okanogan-Wenatchee National Forests	844,055				87,862		15,980	579,183

Table J-2
Special Designation Areas on NFS Lands within the Project Area

Forest	Acreage							
	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Areas	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Olympic National Forest	87,577				312,297			85,607
Payette National Forest	780,261			465				904,516
Pike-San Isabel National Forest	425,845							688,086
Plumas National Forest	23,697			18,794	18,423			85,986
Prescott National Forest	101,515			1,511				165,490
Rio Grande National Forest	430,175				1,410			669,024
Rogue River-Siskiyou National Forests	299,684			70,754				368,716
Salmon-Challis National Forest	1,209,082		28					2,264,053
San Bernardino National Forest	130,535							223,329
San Juan National Forest	423,907				62,356			696,594
Santa Fe National Forest	283,541		44,680	51,757				375,008
Sawtooth National Forest	217,737		566,485					1,227,815
Sequoia National Forest	293,786			9,282		286,505		467,232
Shasta-Trinity National Forest	495,678		167,900	20,178	13,112			500,142

Table J-2
Special Designation Areas on NFS Lands within the Project Area

Forest	Acreage							
	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Areas	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Shoshone National Forest	1,366,372			6,369	30,050		13,526	686,864
Sierra National Forest	566,927			9,738	33,028	24,279		417,354
Siskiyou National Forest	22,230							51,911
Siuslaw National Forest	121,162		204,668	63,122	7,756			314,659
Six Rivers National Forest	215,413		30,637	9,662	1,662			232,480
Stanislaus National Forest	49,184			7,521	2,895			219,399
Tahoe National Forest	430,175				1,410			669,024
Tongass National Forest	5,745,617		7,009		853,882			6,486,542
Tonto National Forest	577,676			757				271,657
Uinta National Forest	58,458							527,676
Umatilla National Forest	297,685			6,636				282,220
Umpqua National Forest	71,785			6,485	37,008			109,731
Wallowa-Whitman National Forest	372,212		625,090	20,382				514,674
Wasatch-Cache National Forest	309,202							598,385

Table J-2
Special Designation Areas on NFS Lands within the Project Area

	Acreage							
	Congressional Designations						Administrative Designations	
Forest	**Wilderness Areas**	**National Scenic Areas**	**National Recreation Areas**	**Wild and Scenic Rivers**	**Other Congressionally Designated Areas (FS)[1]**	**National Monuments**	**Wilderness Study Areas**	**National Roadless Areas (FS)[2]**
White River National Forest	748,158							639,602
Willamette National Forest	391,247			14,272	18,897			170,168
Total	**32,352,798**	**199,705**	**2,258,250**	**604,110**	**2,021,534**	**310,784**	**3,227,819**	**52,934,355**

[1] "Other Congressionally Designated Area" is a FS-specific designations
[2] "National Roadless Area" is a FS-specific designation

Source: FS2008a

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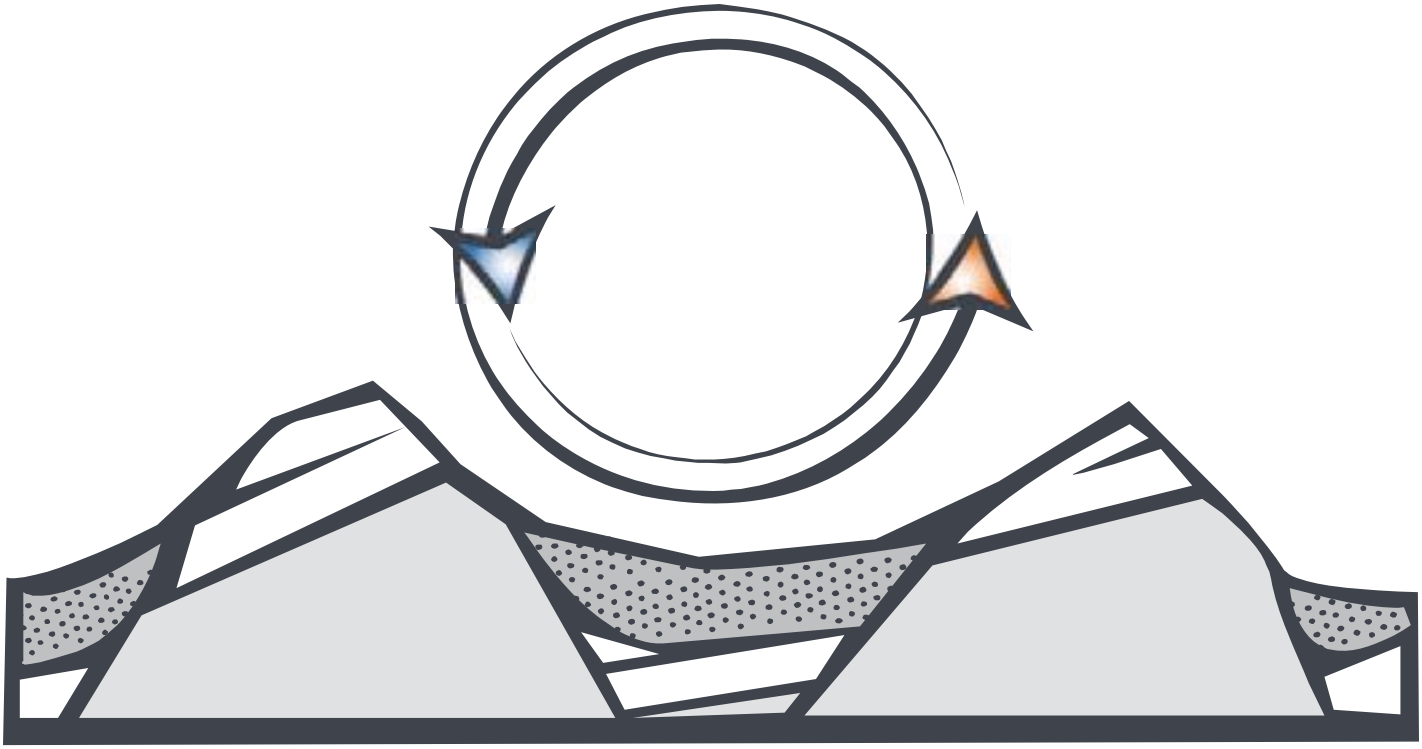

Appendix K

Special Designation Areas on BLM and FS Lands in the Potential Geothermal Area

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APPENDIX K
SPECIAL DESIGNATION AREAS ON BLM AND FS LANDS WITHIN THE PLANNING AREA

The following tables list acreage of congressional and administrative designations within the planning area by government agency, type of special designation and state or national forest. Because the same area of land can be assigned multiple designations, total acreage of specially designated land within the planning area is not calculated here, as combining totals would include acreage overlap. Total acreage of special designations within the planning area can be found in Section 2-2.

Table K-1 lists acreage on BLM lands by state and type of designation.

Table K-2 lists acreage on FS lands by national forest and type of designation. Categorization by state was not possible as many national forests cross state lines.

Table K-1
Special Designation Areas on BLM Public Lands within the Planning Area

Acreage						
	Congressional Designations				Administrative Designations	
State	Wilderness Areas	National Conservation Areas	Wild and Scenic Rivers	National Monuments	Wilderness Study Areas	Areas of Critical Environmental Concern (BLM)
Alaska	0	935,659	85,415	0	0	1,378,832
Arizona	1,114,774	551,557	0	551,557	63,795	597,113
California	2,813,231	296,933	8,682	296,933	1,003,587	1,457,961
Colorado	69,206	104,780	178	104,780	377,655	262,551
Idaho	693	272,640	56	272,640	1,306,415	794,889
Montana	6,126	49	0	49	209,844	45,815
Nevada	1,998,197	6,548	0	6,548	2,546,992	1,282,282
New Mexico	151,137	4,108	22,897	4,108	861,796	452,988
Oregon/Washington	184,705	51,422	216,026	51,422	2,737,779	864,162
Utah	103,861	0	0	0	520,953	186,907
Wyoming	0	0	0	0	422,108	920,063
Total	**6,441,930**	**2,223,694**	**333,254**	**1,288,035**	**10,050,923**	**8,243,565**

[1] Areas of Critical Environmental Concern are a BLM-specific designation

Source: BLM2008a

Table K-2
Special Designation Areas on FS Lands within the Planning Area

Acreage								
Forest	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Area	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Angeles National Forest								
Apache-Sitgreaves National Forests	81,907	0	0	0	14,168	0	0	200,290
Arapaho and Roosevelt National Forests	4,290	0	0	0	10,659	0	0	230,624
Ashley National Forest	305,769	0	35,622	20,527	0	0	0	385,305
Beaverhead-Deerlodge National Forest	0	0	102,682	0	0	0	0	29,285
Bitterroot National Forest	219,150	0	0	0	0	0	154,980	1,830,896
Boise National Forest	754,229	0	0	0	0	0	101,690	405,883
Bridger-Teton National Forest	64,942	0	0	0	0	0	0	1,109,148
Caribou-Targhee National Forest	712,267	0	0	0	0	0	109,347	758,939
Carson National Forest	134,602	0	0	0	0	0	0	1,587,205
Cibola National Forest	84,391	0	0	1,997	0	0	43,739	161,071
Clearwater National Forest	73,467	0	0	0	30,482	0	0	239,071
Cleveland National Forest	261,915	0	0	23,665	0	0	0	333,364
Coronado National Forest	75,580	0	0	0	0	0	0	130,755
Custer National Forest	29,981	0	0	0	0	0	0	47,148

Table K-2
Special Designation Areas on FS Lands within the Planning Area

Acreage								
Forest	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Area	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Deschutes National Forest	182,711	0	0	27,067	42,949	0	0	136,467
Dixie National Forest	57,255	0	0	0	0	0	0	504,124
Fishlake National Forest	0	0	0	0	0	0	0	484,666
Fremont-Winema National Forests	115,534	0	0	11,904	0	0	0	118,718
Gallatin National Forest	651,552	0	0	0	35,048	0	143,991	544,958
Gifford Pinchot National Forest	179,126	33,077	0	0	0	0	0	212,623
Gila National Forest	791,776	0	0	0	0	0	59,869	749,056
Grand Mesa, Uncompahgre and Gunnison National Forests	551,793	0	50,967	0	27,753	0	0	1,192,054
Helena National Forest	1,176	0	0	0	0	0	0	269,501
Humboldt-Toiyabe National Forest	795,845	0	275,629	0	0	0	98,446	3,337,293
Inyo National Forest	597,938	104,641	0	2,259	0	0	0	938,360
Klamath National Forest	0	0	0	0	18,195	0	0	4,033
Lassen National Forest	43,970	0	0	0	16,350	0	0	119,188
Lewis and Clark National Forest	0	0	0	0	0	0	0	7,618
Lincoln National Forest	0	0	0	0	0	0	0	30,493

Table K-2
Special Designation Areas on FS Lands within the Planning Area

Acreage								
Forest	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Area	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Lolo National Forest	38,108	0	0	0	0	0	0	127,775
Los Padres National Forest	797,759	0	0	1,374	0	0	0	1,037,208
Malheur National Forest	78,351	0	0	10,801	0	0	0	181,508
Manti-Lasal National Forest	0	0	0	0	0	0	0	76,907
Medicine Bow-Routt National Forest	250,639	0	0	0	0	0	0	505,938
Mendocino National Forest	36,294	0	0	0	0	0	0	113,800
Modoc National Forest	63,936	0	0	0	0	0	0	202,416
Mt Baker-Snoqualmie National Forest	703,906	0	8,675	18,779	143,119	0	0	415,304
Mt. Hood National Forest	187,265	42,581	0	51,333	82,326	0	0	118,026
Nez Perce National Forest	869,412	0	0	10,532	83,909	0	0	502,240
Ochoco National Forest	35,199	0	0	7,574	0	0	0	61,010
Okanogan National Forest	621,814	0	0	0	87,859	0	0	338,748
Okanogan-Wenatchee National Forests	737,119	0	0	0	144,112	0	15,194	272,402
Payette National Forest	780,233	0	0	465	0	0	0	904,516
Pike-San Isabel National Forest	425,836	0	0	0	0	0	0	688,086
Plumas National Forest	4,408	0	0	6,623	22	0	0	21,313

Table K-2
Special Designation Areas on FS Lands within the Planning Area

Acreage								
Forest	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Area	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Rio Grande National Forest	430,173	0	0	0	1,410	0	0	669,024
Rogue River-Siskiyou National Forests	75,877	0	0	11,748	0	0	0	30,503
Salmon-Challis National Forest	1,209,036	0	28	11,812	0	0	0	2,264,053
San Bernardino National Forest	130,535	0	0	0	0	0	0	223,329
San Juan National Forest	423,902	0	0	0	62,355	0	0	696,594
Santa Fe National Forest	283,542	0	44,680	12,916	0	0	0	374,307
Sawtooth National Forest	217,724	0	566,454	0	0	0	0	1,227,815
Sequoia National Forest	275,549	0	0	9,282	0	192,228	0	422,243
Shasta Trinity National Forest	35,231	0	0	0	13,112	0	0	35,335
Shoshone National Forest	225,036	0	0	0	6,870	0	0	68,171
Sierra National Forest	259,672	0	0	0	0	0	0	99,746
Tahoe National Forest	2,353	0	0	0	0	0	0	32,902
Tongass National Forest	647,656	0	0	0	300,918	0	0	948,574
Tonto National Forest	127,728	0	0	0	0	0	0	25,868
Uinta National Forest	41,396	0	0	0	0	0	0	147,652
Umatilla National Forest	297,671	0	0	6,636	0	0	0	267,459

Table K-2
Special Designation Areas on FS Lands within the Planning Area

Acreage								
Forest	Congressional Designations						Administrative Designations	
	Wilderness Areas	National Scenic Areas	National Recreation Area	Wild and Scenic Rivers	Other Congressionally Designated Areas (FS)[1]	National Monuments	Wilderness Study Areas	National Roadless Areas (FS)[2]
Umpqua National Forest	71,447	0	0	554	37,007	0	0	61,822
Wallowa-Whitman National Forest	372,188	0	625,070	20,381	0	0	0	514,674
Wasatch-Cache National Forest	104,974	0	0	0	0	0	0	245,945
White River National Forest	748,147	0	0	0	0	0	0	639,602
Willamette National Forest	391,235	0	0	41,911	18,896	0	0	166,415
Total	**19,057,887**	**180,299**	**1,709,808**	**310,140**	**1,177,521**	**192,228**	**788,597**	**31,457,013**

[1] "Other Congressionally Designated Area" is a designation utilized solely by USFS Region 5 (Alaska)
[2] "National Roadless Area" is a FS-specific designation

Source: FS2008a

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