SUMMER LAKE BASIN

ENVIRONMENTAL ANALYSIS RECORD

FOR PROPOSED

GEOTHERMAL LEASING

LAKEVIEW DISTRICT
OREGON

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

SUMMER LAKE BASIN GEOTHERMAL LEASING

ENVIRONMENTAL ANALYSIS RECORD

Prepared by:

Christopher Broili	Geologist
William Cannon	Archaeologist
Edwin Depaoli	High Desert Area Manager
Larry Doughty	Wildlife Biologist
Marvin Hammersmark	Range/Watershed Specialist
Dennis Hill	Recreation Specialist
Melvin Schlagel	Realty Specialist

JUN 1976

TABLE OF CONTENTS

MAPS

FIGURES

TABLES

APPENDIXES

LOCATION MAP

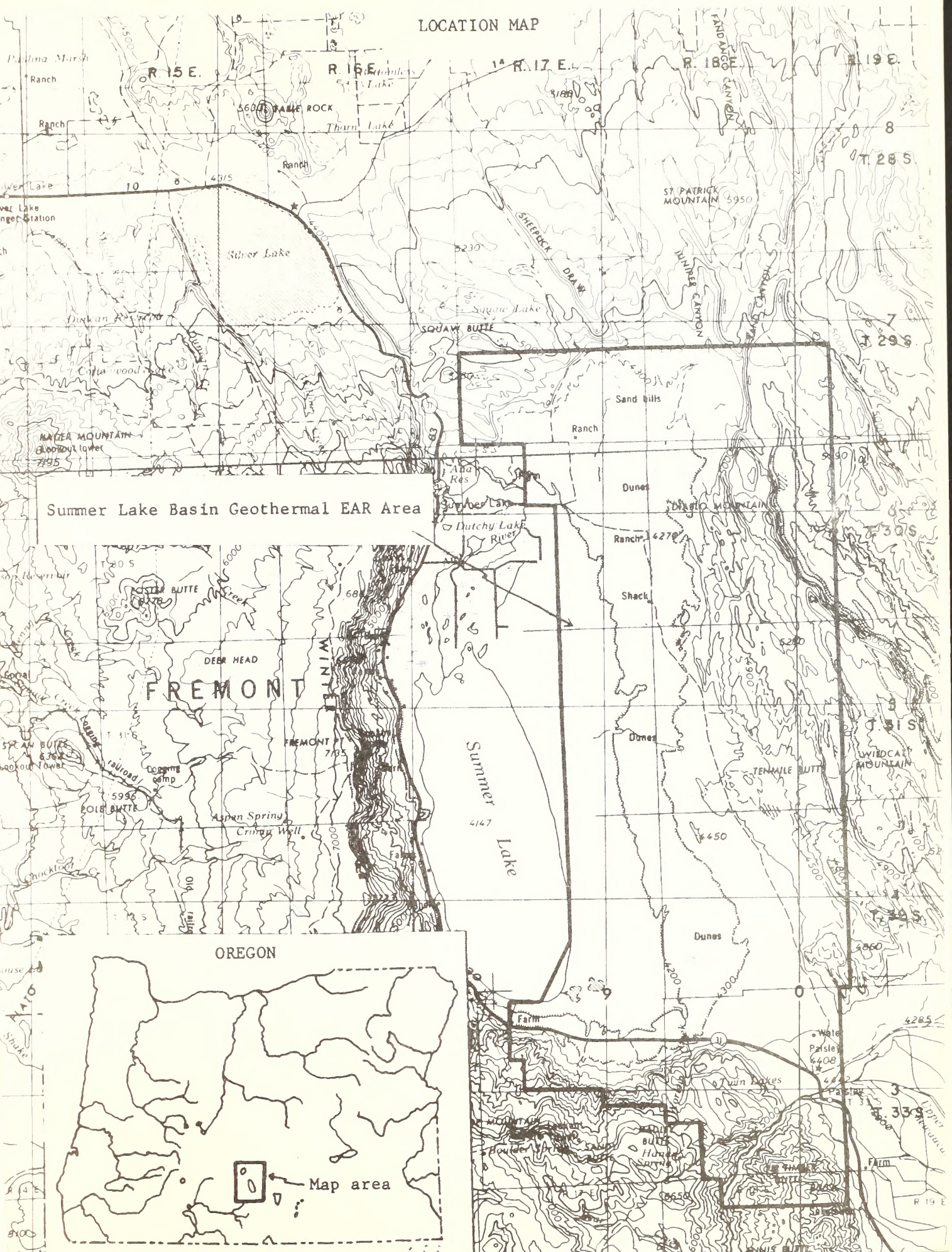
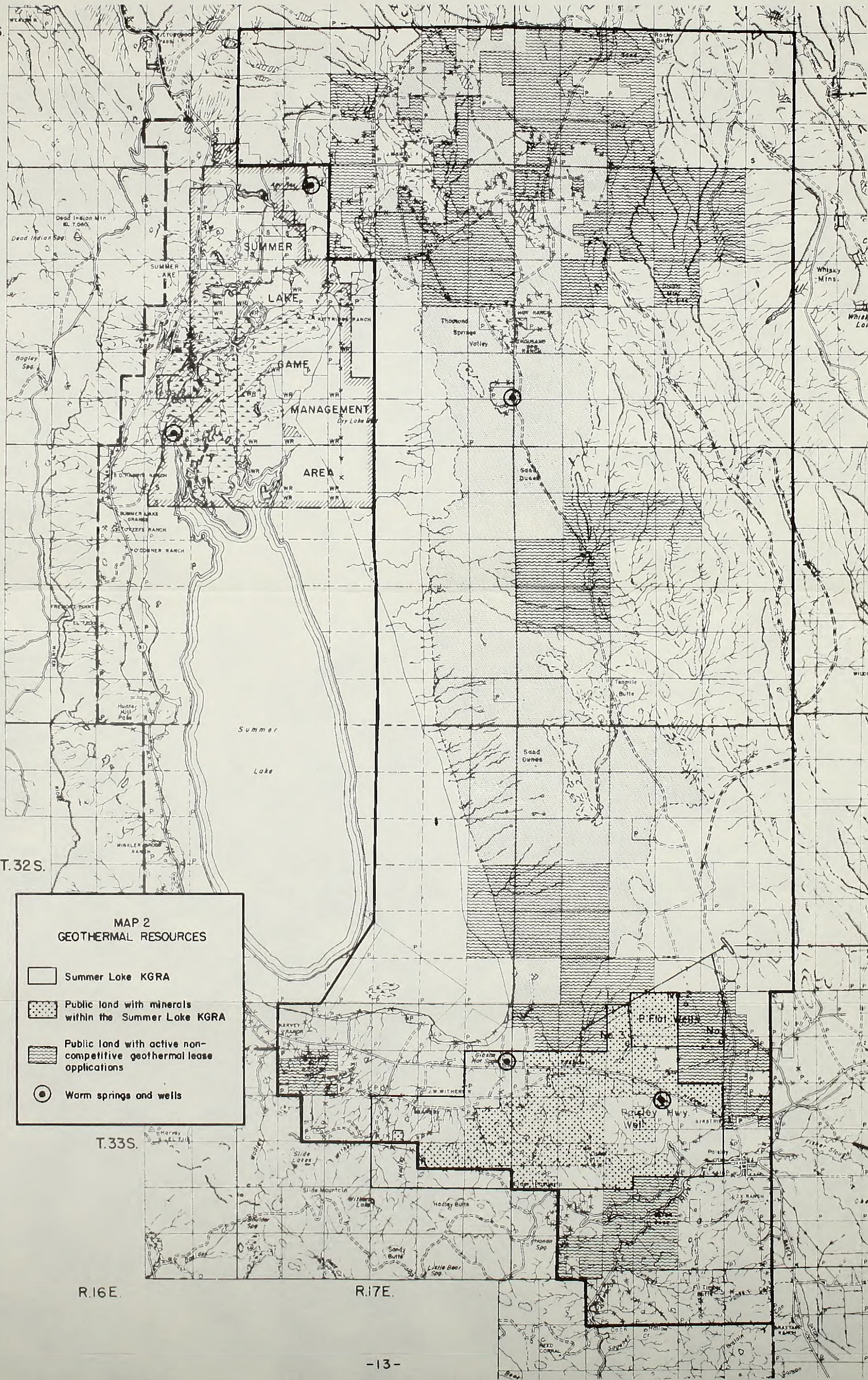


Fig. 1 - The foothill physiographic unit south of Twin Lakes.

Fig. 2 - The low plateau physiographic unit northeast of Ana Reservoir.

Fig. 3 - The basin physiographic unit north of the Paisley Flat Well No. 1.


T.29S.
T.30S.
T.31S.
T.32S.
T.33S.
R.16E.
R.17E.
SUMMER
LAKE
GAME
MANAGEMENT
AREA
Summer
Lake
Dead Indian Spg.
Bogley Spg.
Thousand Springs Valley
Rocky Butte
Whisky Mtns.
Seed Dunes
Tenmile Butte
Hunter Hill Pass
Slide Mountain
Hedley Butte
Sandy Butte
Little Bear Spg.
Harvey Ranch
Gibson Hot Spg.
Bogley Hwy. Well
Paisley
Fisher Slough
Coon Hollow Cr.
Sagehen
Bear
Garden
MAP 2
GEOTHERMAL RESOURCES
Summer Lake KGRA
Public land with minerals within the Summer Lake KGRA
Public land with active non-competitive geothermal lease applications
Warm springs and wells

The other mineral resources in the analysis area consist of a couple of gas shows, some prospects for quicksilver, precious and base metals, soda ash, and calcareous tufa and some sand and gravel deposits.

The two small gas shows are in water wells on the west side of Summer Lake, about one mile north of Hunter Hill. No oil or gas wells have been drilled in the EAR area.

The one quicksilver prospect in the area is on the Currier Ranch southwest of Summer Lake. The cinnabar occurs in a hydrothermally and brecciated zone 50 feet wide in an andesite flow. During the 1930's, 2½ flasks were produced (Brooks, 1963).

The precious and base metal prospect constitutes the Brattain District, four miles south of Paisley, and is the best p precious and base metal prospect in Lake County. The mineralization occurs as sphalerite and galena with minor chalcopyrite and pyrite along narrow siliceous veins. In the early 1900's, an operator mined enough ore to support his family and a small working crew (Peterson & McIntyre, 1970).

The soda ash prospect is located on Summer Lake. The deposit of salt crusts consists mostly of soda ash (Na_2CO_3) with some common salt (NaCl), baking soda ($NaHCO_3$), and sodium sulfate (Na_2SO_4). The deposit has never had any serious prospecting (Mason, 1969).

The calcareous tufa deposit ($CaCO_3$) is located one mile northeast of Tenmile Butte. The deposit has several mining claims, but no mining has ever occurred.

The material sites with sand, gravel, and rip-rap are located along Highway 31 in the southern part of the analysis area, and along Ana Springs Road in the northwest corner of the area. These materials, used primarily for roads and construction, appear to be plentiful.

References

Berg, J.W., and Baker, D.C., 1963, Oregon earthquakes, 1841 through 1958: Seismo. Soc. America Bull., vol. 53, no. 1, p. 95-108.

Bowen, R.G., and Peterson, N.V., 1970, Thermal springs and wells in Oregon: Ore. Dept. Geol. and Min. Indust. Misc. Paper 14.

Brooks, H.C., 1963, Quicksilver in Oregon: Ore. Dept. of Geol. and Min. Indust. Bull. 55.

7. Aquatic Plants

Aquatic plants are limited to the basin and foothill physiographic units.

In the foothill area, aquatic vegetation is limited to springs, lakebeds, and streamside or riparian sites. Common species present include algae, willows, sedges (*Carex spp.*) and rushes (*Juncus spp.*).

The greatest variety and density of aquatic plants in the basin is on the marshlands of the Summer Lake Wildlife Management Area, which lies outside of the EAR area. Some of the common genera represented here include algae, cattail (*Typha latifolina*), spikerush (*Eleocharis spp.*) bullrush (*Scirpus spp.*), pondweed, (*Potameogeoton spp.*), horsetail (*Equisetum spp.*), sedges (*Carex spp.*) and rushes (*Juncus spp.*).

Other aquatic types outside the management area are limited to springs and artesian well areas, most of which are on private lands. The same genera are represented here, only to a much lesser degree, due to the limited amount and quality of aquatic habitat.

8. Terrestrial Plants

Vegetation in the basin physiographic unit varies from very salt tolerant plants such as the greasewood (*Sarcobatus vermiculatus*)- salt grass (*Distichlis stricta*) association, to the non-salt tolerant big sagebrush (*Artemisia tridentata*)-squirreltail (*Sitanion hystrix*) association. Within the basin unit there are areas completely devoid of vegetation such as playas and areas of very high salt concentration. Vegetation on the dune land is sparse, mainly salt grass, basin wildrye (*Elymus cinereus*), and greasewood (Fig. 6). The area below and surrounding springs and artesian wells support vegetation typically found in wet meadows such as sedges, carex, and others. The dryer portions of the basin support a dense community of big sage, rabbitbrush (*Chrysothamnus spp*), squirreltail, some sandberg bluegrass (*Poa secunda*), and annuals. Select areas within this big sage community have been altered by removal of the shrubs and converted to crested wheatgrass (*Agropyron cristatum*).

The low plateau physiographic unit has two main plant communities. These are the shadscale (*Atriplex confertifolia*)-budsage (*Artemisia spinescens*) association on alkaline soil, and the big sagebrush - squirreltail association which

Fig. 6 - Greasewood covered dunes west of Diablo Mountain.

occupies some of the drainage patterns where soils are deeper and less alkaline. Cheatgrass (Bromus tectorum) also occupies these sites. The low plateau unit receives low precipitation which limits production, reduces density, and restricts the type of vegetation to drought resistent species.

The foothill physiographic unit is located in a higher precipitation zone next to the conifer forest. Several plant communities exist in this unit. A low sagebrush (Artemisia arbuscula)- sandberg bluegrass association is located in shallow soils underlain with a hardpan. A big sagebrush association or a juniper (Juniperus occidentalis) association occurs on the deeper soils. Other dominate species found in these associations are: bluebunch wheatgrass (Agropyron spicatum), Idaho fescue (Festuca idahoensis), needlegrass (Stipa species), and bitterbrush (Purshia tridentata). Species which occur to a lesser degree are ponderosa pine (Pinus ponderosa) and curlleaf mountain mahogany (Cerocarpus ledifolius).

No threatened or endangered plant species are known to exist within the analysis area. A detailed list of major plant species is in Appendix III.

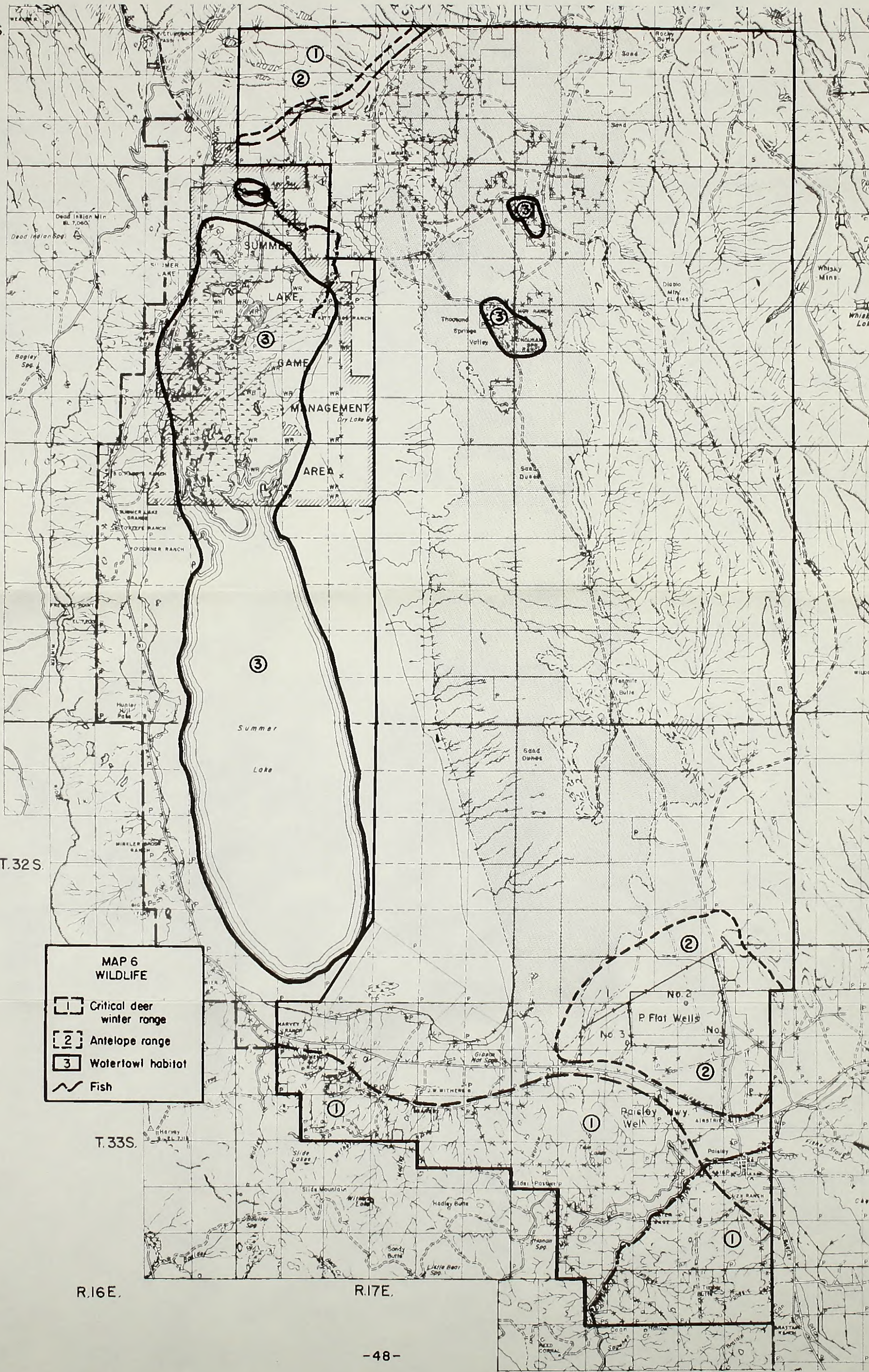
9. Wildlife - Aquatic and Terrestrial Animals

Wildlife within portions of the Summer Lake area is quite diversified. Literature review and data obtained from state and federal wildlife agencies indicate there are about 64 species of mammals, over 200 species of birds, and several species of amphibians, reptiles, and fish present in the general area at some time. A listing of these species is presented in Appendix II. The majority of the aquatic oriented species listed are found primarily on the Summer Lake Wildlife area, which lies adjacent to the EAR area.

The following statements concerning wildlife use within the designated area is based on data obtained from the Oregon Department of Fish and Wildlife and the Paisley Unit Resource Analysis. More detailed data on species distribution and habitat is available in this document (see Map 6).

(a) Basin

The greatest abundance and diversity of wildlife in the basin unit is on the Summer Lake Wildlife Management Area. This state managed area consists of about 18,000 acres of marsh and other lands that are highly productive for wildlife. It is an important breeding and resting area for migratory waterfowl in the Pacific flyway, as well as habitat for shorebirds and many other nongame aquatic species. In 1974, recreational use of the area totaled over 9,000 days. This use included hunting, trapping, fishing, and other non-consumptive activites.


T. 29S.
T. 30S.
T. 31S.
T. 32S.
T. 33S.
R. 16E.
R. 17E.
SUMMER
LAKE
GAME
MANAGEMENT
AREA
Summer
Lake
Paisley
Hwy.
P. Flat Wells
No. 2
No. 3
MAP 6
WILDLIFE
1 Critical deer winter range
2 Antelope range
3 Waterfowl habitat
Fish

Within the designated basin unit, big game animals are limited to a herd of antelope (about 30 head) centering their activities in the Paisley Flat Seeding area. Specific kidding areas have not been identified. A few mule deer may be found on private fields or just below the foothill unit during the fall and early spring when green grass is present.

Upland game consists of pheasant, valley quail, doves, and some sagegrouse associated with agricultural areas. With the exception of the mourning dove, most upland game use is restricted to private lands.

As previously stated, waterfowl use is concentrated primarily on the management area. However, resting and feeding use is made of Summer Lake proper, and on the fields, springs, and artesian areas on private lands within the basin.

Coyotes, bobcats, jackrabbits, small rodents, songbirds, raptors, and several species of amphibians and reptiles are present at some time. The specific distribution of these animals is dictated by habitat preference.

Fisheries in the basin is restricted to Ana Reservoir and River and the Lower Chewaucan River (Fig. 7). Both are a trout fishery. Other fish species present are listed in Appendix II. No attempt was made to list the smaller aquatic insects and invertebrates.

(b) Low Plateau

The low plateau physiographic unit is characterized by sagebrush and salt desert shrub types. The only concentration of big game species is the low sage plateau located in the northwest corner of the EAR area. This site provides important mule deer winter range and is also utilized by antelope during the spring, summer, and fall. The area east of Summer Lake receives little use by big game animals. Some resident mule deer and occasionally a few antelope are seen in the higher parts of this area. This lack of use is due primarily to the homogeneous nature of the existing vegetation and shortage of water.

Upland game is limited primarily to sagegrouse, mourning doves, valley quail, and chukars. Densities of all species are low, with sagegrouse in the low sage and rim areas being the most abundant of the species present. To date no strutting grounds have been located, however, they probably exist in the area.

Raptors, coyotes, bobcats, rabbits, small desert rodents, desert song birds, and reptiles are present in varying

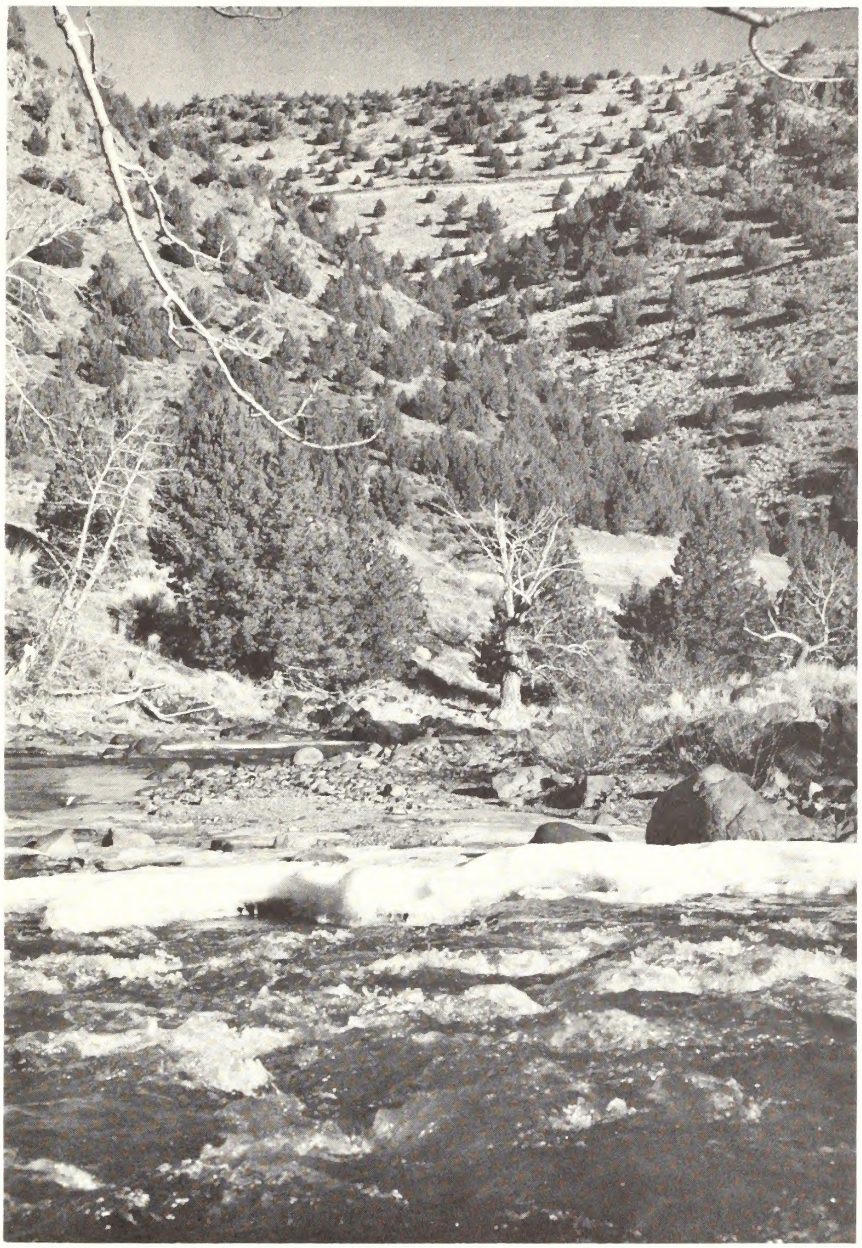


Fig. 7 - Chewaucan River at the mouth of Mill Creek.

densities during some season of the year. It is possible that prairie falcons may utilize the rim areas east of Summer Lake. The habitat is potentially suitable, but at this time no observations have been made, and no nesting sites located.

This unit overall is not highly productive for wildlife species.

(c) Foothill

The entire foothill unit is considered important deer winter range. Mule deer summering on the National Forest move down to these lands in late fall, remaining throughout the winter and returning back to the forest in late spring. A large number of animals are dependent on this area for forage and cover to fulfill their winter requirements. In addition, some summer deer use occurs on the forest fringe area of this unit. Fawning, while limited in extent, would be concentrated near the heavy brush and Aspen-timber types with available water.

Upland game birds found include sagegrouse, chukar, valley quail, and mourning doves. Fair populations of these species are present. Again strutting grounds have not been located.

Due to the increase in variety of vegetation and presence of Juniper, pine and aspen on the moister sites, several species of non-game birds inhabit the area. Forest birds and mammals are represented, as well as those requiring riparian habitat, which is provided by Mill Creek and the Chewaucan River.

As in the other physiographic units, coyotes, bobcats, badgers, rodents, raptors, amphibians, and reptiles are present. No raptor nesting sites have been identified.

The Chewaucan River provides a good trout fishery, with about four miles of stream running through the EAR area. Overall, this unit is quite productive for a variety of wildlife species.

(d) Threatened and Endangered Species

The only species on the current Federal Threatened and Endangered List, which may be present, is the American Peregrine Falcon. This bird may fly over the area, but observations are rare. There are no known nesting sites within the Summer Lake Basin. They may be present in any physiographic unit.

The following species are on the State of Oregon Threatened List:

1 Northern Bald Eagle - While not common, observations are made along the forest fringe and Summer Lake Management area. (Generally aerial)

2 Kit Fox - Although shown on the species list in Appendix II, this species is extremely rare, if present at all. No observations have been made in this area to our knowledge. (Generally terrestrial)

3. Western Spotted Frog - While its presence has not been verified, literature indicates that this area is within its range. (Generally aquatic)

4. Western Snowy Plover - This species is listed as common during the spring, summer, and as nesting at the Summer Lake Management Area. (Generally aquatic)

References:

Bailey, V. 1936. The Mammals and Life Zones of Oregon. North American Fauna No. 55. USGPO Washington, D. C. 416 pp.

Ingles, L. G. 1965. Mammals of the Pacific States. Stanford University Press, Stanford. 406 p.

Stebbins, R. C. 1954. Amphibians and Reptiles of Western North America. McGraw-Hill Book Co., New York.

Peterson, R. T. 1961. A Field Guide to Western Birds. Houghton Mifflin Co., Boston. 309 p.

Odum, Eugene P. 1959. Fundamentals of Ecology. 2nd edition. W. B. Saunders Co., Philadelphia.

Birds of Hart Mountain National Antelope Refuge. USDI, Bureau of Sport Fisheries and Wildlife.

Birds of the Summer Lake Wildlife Area. Summer Lake, Oregon. Oregon Wildlife Commission.

10. Domestic Livestock

Eight livestock operators use portions of the analysis area both in the early spring (March through May) and winter (December to February). Approximately 2400 AUMs (Animal Unit Months) are used annually, all by cow calf operations. There are no completed allotment management plans within the area. The area provides an important link in the eight grazing operations involved, even though the grazing season is short

(in most cases about 60 days). Without this use, the livestock operators would have difficulty providing adequate spring and winter feed.

Most livestock leave the operators base property early in the spring, use the BLM land between March and May, then move to the National Forest until October when the livestock return to the livestock operators property for the winter.

Intensive grazing management is practiced in a portion of the basin (T. 33S., R. 18E.) where 4171 acres has been developed by spraying, seeding, fencing, and water developments (Fig. 8). This use is made during the spring. Some grazing use in the basin is also made during the winter months when the plants are dormant.

The foothill unit provides grazing for livestock during April and May prior to using National Forest land.

Grazing use on the low plateau area is alternated between use areas in the spring. This provides some management options without the need for fencing.

The eastern portion of the analysis area on the higher elevations of the low plateau is used primarily by wild horses in the winter. This area has a history of horse grazing, however, when horse numbers were low (several years prior to 1973), they did not use the area. During the winter of 1973, a band of 13 entered and grazed the area. In 1974, two bands totalling 31 grazed the area most of the winter, and are presently grazing there now.

Because wild horses were not present in 1971, when the wild horse legislation was enacted, no portion of the analysis area is being considered as necessary to maintain wild horses. When management is implemented, all horses will be removed from the analysis area.

An area of 121,000 acres is being considered as a wild horse management unit. This unit lies east of Diablo Rim, outside of the EAR boundary.

11. Ecological Interrelationships

a. Plant Succession

The successional process within portions of the designated area is complex and diversified due to the

Fig. 8 - The Paisley Flat seeding in the foreground.

variety of sites and corresponding plant communities. The following basic statements are intented to give merely a broad overview of the more prominent successional patterns that may be related to this proposed action.

Plant succession in the basin area is governed to a large degree by pH and moisture. Only salt tolerant species are able to survive in these highly alkaline soils. The large dry flats east of Summer Lake are dominated by greasewood and saltgrass, which can probably be considered climax for this site under present climatic conditions. Adjacent to springs, artesian flows, or other moving water, the increased moisture has reduced pH, thus altering the site to allow a greater variety of vegetation to become established.

The low plateau contains both salt desert shrubs and sagebrush communities. Here again, alkalinity plays an important role in determining species composition on a particular site. The salt tolerant species occupy the higher pH soils and generally lower moisture areas (Fig. 9). Low sage occurs on the shallow, stony sites of the well drained plateaus. Big sagebrush is best adapted to deeper well drained soils. All of these communities are interpersed throughout the low plateau physiographic unit. Successional trends in this zone are probably governed more by climate than man caused factors. Grazing use has generally been light and occurred when it was not harmful to preferred plant species.

The foothill unit is more complex, being comprised of several plant types. Big sagebrush-grass, Big Sagebrush-bitterbrush, Sagebrush-Juniper, low sagebrush, meadow, Ponderosa pine, mahogany, Quaking Aspen, and riparian communities are present. All obviously, are site specific, with successional patterns being modified by grazing (both big game and livestock), fire control, logging, and climatic changes. Over a long time span, sensitive species subjected to the impacts stated above, have been replaced by more competitive or better adapted plants. In many places where these disturbing factors have not been in play, little change has taken place.

b. Food and Community Relationships

Within the broad area involved there are numerous food relationships between plants and animals and among animals themselves. All, however, are dependent initially upon the production of food materials by green plants. The existing vegetation and associated climate dictates what animal species will inhabit an area.

Fig. 9 - Salt tolerant vegetation on the low plateau southwest of Diablo Mountain.

Following are examples of some of the basic relationships that exist within the area.

Deer are dependent upon specific seasonal use areas to provide year long forage, water and cover. Forage requirements and availability change with the season. A forage deficiency on a particular seasonal range (intermediate, summer or winter) will limit populations even though surplus forage is available on other seasonal use areas. (Winter ranges within the Summer Lake Basin are limited in geographical area.) These ranges are the only sites with suitable characteristics for providing winter deer habitat. This increases the importance of these areas in fulfilling a critical segment of the life cycle for existing deer populations.

Predatory animals such as coyotes, bobcats, badgers, golden eagles, hawks and owls prey primarily upon rodents, rabbits, and other small animals. Rodent and rabbit populations are somewhat cyclic and governed to a large extent by production of plant material (green forage and seeds) for food. Food production is related to site capability and climatic conditions for a given area in a given year. During periods of low rodent and rabbit populations, many predators will shift to a degree to other prey species that are available (birds, deer, sheep, calves, etc).

Waterfowl production is dependent upon the maintenance of quality aquatic habitat. This includes production of aquatic plants for food and cover and water levels in the lakes and marshes in the basin. Any changes in these components will be reflected in waterfowl use and production.

12. Human Values

a. Landscape Character

The most striking landscape feature within the area of analysis is the large blocky dark basalt rimrocks in the north and northeastern portions of the plateaus. They arise abruptly from the Summer Lake Basin adding a startling interuption to the basin land form. Colors of the plateau are drab browns and grays during midday but acquire hues of blue and purple during morning and evening hours. These colors are enhanced by the reflective and contrasting qualities of adjacent Summer Lake.

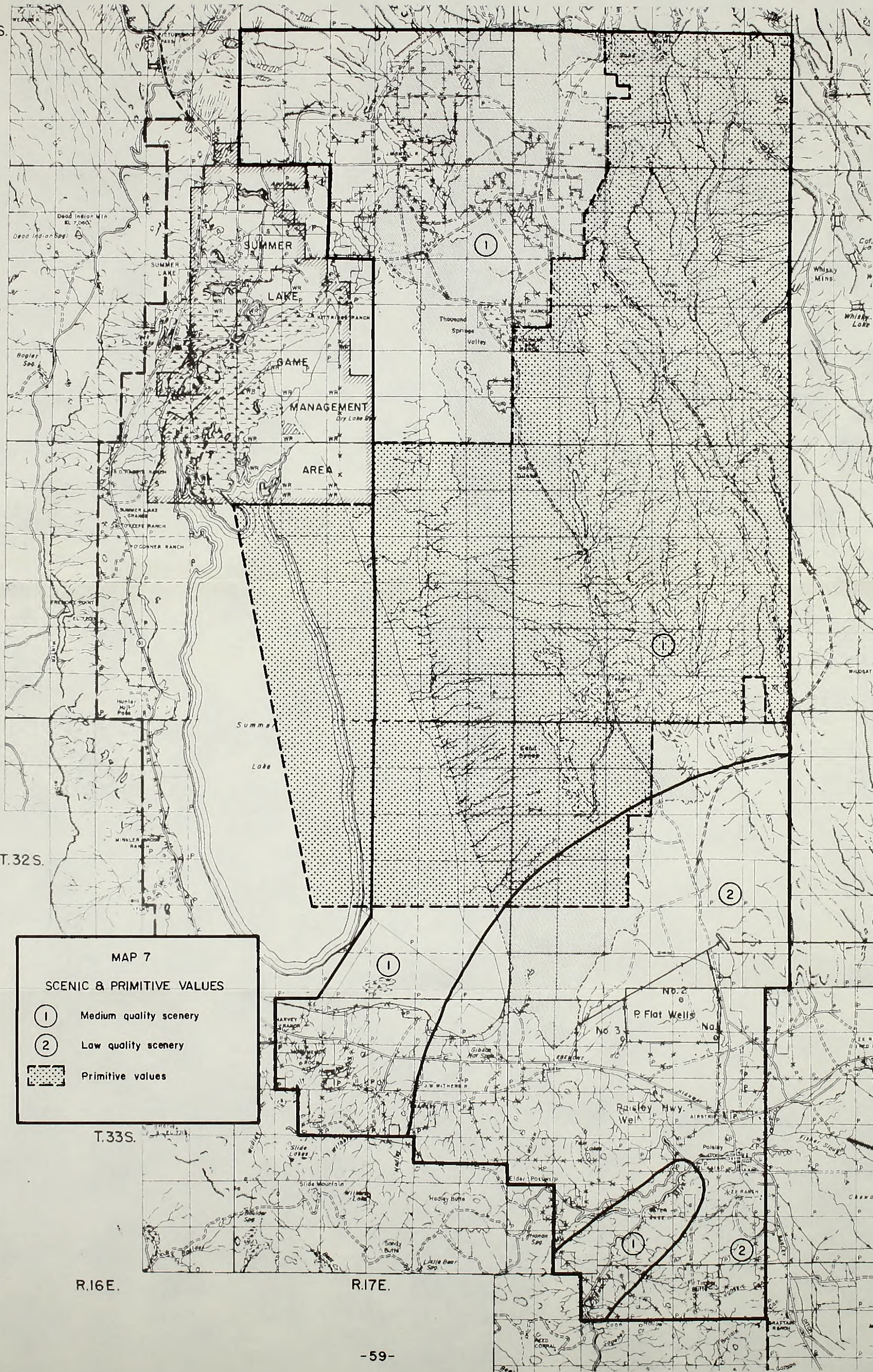
Summer Lake is a 40 square mile shallow lake adjacent to the western portion of the analysis area. It is a dominant scenic feature to the casual observer traveling the highway adjacent to the area. The still waters of the lake reflect the colors and forms of the analysis area and add contrasting textural qualities to the predominantly angular dimensions of the surrounding topography. Throughout most of the year, Summer Lake is surrounded by a white band of alkaline salts. This band of white adds another dimension of contrast to the otherwise drab lake basin colors.

The foothills in the southern portion of the area of anaylsis are the most colorful part of the areas landscape. The variety of color comes from the vegetation, especially in the fall when the aspen turn color. Some color is also added by the light colored chalky hills in the extreme southwest corner of the analysis area. The foothills are rolling and less formidable than the blocky plateaus.

The Chewaucan River flows through the southeast corner of the area. This river is the major moving water in the area of analysis and it rumbles through the foothills that are dissected by tributary draws to the river. During high water, rapids are common along this stretch of the river and it is probably the most scenic segment because of the combination of rapids, location in a canyon, and colorful vegetation along the banks and tributary draws.

Small shallow lakes and reservoirs are scattered throughout the EAR area and add subtle contrasts of color to all the physiographic regions.

The quality of visual resources (scenery) is inventoried according to criteria set forth in BLM manual 6111. The scenery is evaluated using a point system for each scenery component (land form, color, water, and vegetation). The components are given a score of one, if the component is lacking or adds nothing to the scenery, and goes as high as four if the component adds a lot to the scenery. Two other factors, uniqueness and man made intrusions are also given a score. Uniqueness is scored from one (if it is common) to six (if it is very unique), and man made intrusions are scored from two (if no intrusions exist) to minus four (if the intrusions obliterate the natural scenery). The scenery components, plus the uniqueness and intrusions are then summarized and given an A, B, or C rating; an "A" being high quality, "B" being moderate quality, and "C"being low quality. Most of the area of analysis is considered to have moderate scenic values (B rating) in accordance with the above inventory system. The rest of the area is rated at C quality (Refer to Map 7).


T.29S.
T.30S.
T.31S.
T.32S.
T.33S.
R.16E.
R.17E.
SUMMER
LAKE
GAME
MANAGEMENT
AREA
Summer Lake
Thousand Springs Valley
Whisky Mtns
Whisky Lake
Dead Indian Mtn
Dead Indian Spg
Bogley Spg
Hunter Spg
Gibbs Hot Spgs
P. Flat Wells
No. 2
No. 3
No. 1
Paisley Hwy. Well
Paisley
Slide Mountain
Slide Lakes
Hadley Butte
Sandy Butte
Little Bear Spg
Elder Pasture
Elder Slough
MAP 7
SCENIC & PRIMITIVE VALUES
1 Medium quality scenery
2 Low quality scenery
Primitive values

b. Man-made Features

Except for the small town of Paisley, most man-made features on the landscape are farm and ranch buildings with their associated features such as fenced fields and pastures. The scattered farms and ranches along the north and south edges of the Summer Lake Basin, are harmonious with the natural landscape in that they provide a subordinate rural setting compatible with the natural setting of the analysis area. There are a few roads in the area and these are confined to the north and south fringes. Only a couple of jeep trails exist in the eastern portion of the basin and plateau area. These trails are essentially inconspicuous to the casual observer. The small town of Paisley also fits into the rural setting and is not a significant scenic intrusion because of its location.

13. Education-Scientific-Historical

The Summer Lake Hot Springs on the south edge of Summer Lake is an unusual geologic phenomenon. The occurrence of hot springs is common in the west and indicates ground water coming into contact with an underground heat source. To geologists, a hot spring provides certain clues to the subterranean features of the area. Hot springs are usually associated with fault zones, also providing clues to the possibility of natural catastrophic events, such as earthquakes. There are no hot springs on B.L.M. lands within the area of analysis.

The Diablo Mountain area containing 97,000 acres north of Paisley, Oregon, and east of Summer Lake, has been identified by the Bureau of Land Management as being roadless and having potential for primitive area designation.

About 74,000 acres or 45% of the analysis area has been identified as having primitive values and meeting the minimum criteria of the Wilderness Act of 1964, (refer to Map 7). B.L.M. primitive area criteria specify that potential primitive areas:

(a) Contain natural, wild, and undeveloped lands in a setting essentially removed from the effects of civilization.

(b) Has outstanding opportunities for solitude or a primitive and unconfined type of recreation.

(c) Is of sufficient size as to make practicable its preservation and use in an unimpaired condition.

(d) May also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

In September of 1973, a evaluation team of B.L.M. employees and members of the Lakeview District Livestock Advisory Baord took a one day field trip to rate the Diablo Mountain area for its primitive area qualities. The average rating for the following qualities was determined:

(a) Scenic - moderate
(b) Archaeological - low
(c) Geological - low
(d) Off-Road Vehicle - low
(e) Primitive - moderate
(f) Historical - low.

No decision has been made as to whether the Diablo Mountain Area will be designated as a primitive area. If designated as a primitive area, the Diablo Mountain area would be managed to preserve, protect, and enhance areas of scenic splendor, natural wonder, scientific interest, primitive environment, and other natural values for the enjoyment and use of present and future generations.

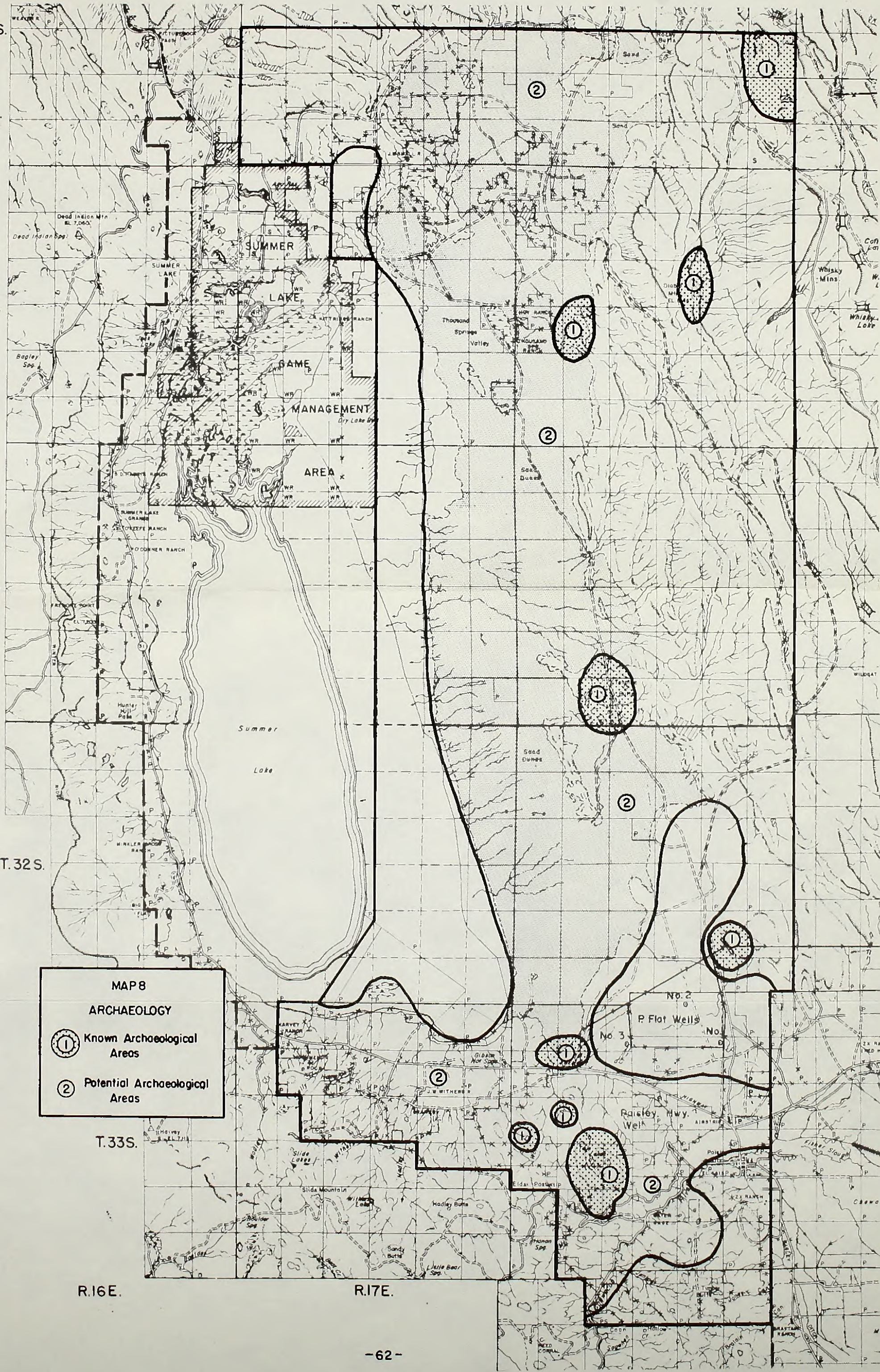
There are no known historical sites within the analysis area. It was the opinion of the late Rueb Long, Co-Author of "The Oregon Desert", that the existing trail between the plateau and the eastern shore of Summer Lake is the historic trail between the military post at the Dalles, Oregon, and San Francisco, California. Research has not confirmed or eliminated this opinion, because documentation seems to be non-existant. Until further evidence is found, this trail will not be considered an historical trail.

14. Archaeology

The Summer Lake area contains many archaeological sites. The human prehistory of the region spans a possible 14,000 years of time. For discussion purposes, the area is divided into three physiographic units (See Map 1.) Known and potential archaeological site areas are shown on Map 8. Known areas on Map 8 indicate general rather than specific site locations.

Predictions of archaeological sites in the Summer Lake area are based upon previous archaeological research (literature search), site reconnaissance within the KGRA, identification of site areas by informants (and institutions), and ethnographic descriptions of the Northern Paiute, who inhabited southeastern Oregon in historic times.

Archaeological research in southeastern Oregon started in 1938 by Dr. L.S. Cressman, of the University of Oregon. Several cave sites, one of which is located in the southeast portion of the EAR area, were excavated. Cressman postulated that man had inhabited southeastern Oregon at a fairly early date. The cave within the EAR area was inhabited 6000 years ago or earlier.


T.29S.
T.30S.
T.31S.
T.32S.
T.33S.
R.16E.
R.17E.
SUMMER LAKE GAME MANAGEMENT AREA
Summer Lake
Sand Dunes
Thousand Springs Valley
Dead Indian Mtn
Dead Indian Spg
Bagley Spg
Whisky Mtns
Whisky Lake
Hunter Hill Pass
Paisley Hwy. Well
P. Flat Wells
No. 2
No. 3
No. 1
Slide Mountain
Hadley Butte
Sandy Butte
Little Bear Spg
Boulder Spg
Fisher Slough
MAP 8
ARCHAEOLOGY
Known Archaeological Areas
Potential Archaeological Areas

No further research was conducted in southeastern Oregon until the 1960's. Several small site reconnaissance projects along with research projects in Fort Rock Valley and Warner Valley were conducted between 1960 and 1975. While not within the immediate Summer Lake area, these research areas are in a similar environment. All are part of the Great Basin Culture Area. It is extremely likely that further research in the Summer Lake Basin will produce results similar to these studies.

The prehistory in southeastern Oregon, including Summer Lake, indicates that area was inhabited about 14,000 years ago by people who existed by hunting and gathering. Habitation was continuous or at least sporadic up to historic times.

During the historic period, after 1850, southeastern Oregon was inhabited by the Northern Paiute who spoke a type Shoshonean language. The Paiutes were a nomadic people whose subsistance was based upon the hunting of game and gathering of vegetal foods.

The KGRA portion of the EAR area was examined for sites. Most of the KGRA is within the foothills physiographic unit. A total of four sites were located on lands which are controlled by BLM. These sites appear to be small temporary hunting camps. One site is tentatively dated between 4500-2500 years ago while the others date between 2500-500 years ago.

A small portion of the KGRA is within the basin physiographic unit. One site is located along a stream bank in an area of sand dunes. The site appears to be a temporary occupation site, dated between 1500-500 years ago. It was likely used on a temporary seasonal basis.

The Museum of Natural History, at the University of Oregon, has record of two sites within the EAR area. It was estimated by museum personnel that between 20-30 sites per square mile might be found in the basin.

The Oregon State Historic Preservation Officer had record of several prehistoric and historic sites in the region, none of which are in the EAR area.

People who are interested in the study of area prehistory, reported the presence of archaeological sties in the EAR area. Exact locations of these sites were not known.

The National Register of historic sites and places does not list any sites in the EAR area. One National Register site, Picture Rock Pass, is located just outside the northwest corner of the EAR area.

One site within the EAR area, the cave which Cressman excavated, is being evaluated for nomination to the National Register of Historic Sites and Places.

The Summer Lake area is known to have been subjected to unauthorized collection of artifacts. This has likely reduced or destroyed the scientific value of many sites.

One would expect archaeological sites in the Summer Lake area to range in time from 14,000 years ago up to the historic period. Sites could include caves, rockshelters, winter villages, temporary campsites, hunting campsites, hunting blinds, stone rings, stone walls, rock cairns, petroglyphs, pictographs, stone quarrys, stone tool manufacture sites, and burials. The presence of sites would be indicated by stone debris, house pit depressions, changes in soil composition, presence of aritfacts, fire cracked rocks, fire pits, bone or shell, and stone structures.

Sites within the basin are most likely to be found at springs, along streams, marshes, lakeshores, old terraces, sand dune areas, along rimrock, and in caves.

Sites within the foothill and low plateau are most likely to be found at springs, along streams, small sink lakes, along rimrock, in caves, and near game trails.

A complete inventory and evaluation of archaeological sites will be made in all areas that are subject to surface disturbing activitiy caused by geothermal leasing.

References:

Aikens, C. Melvin 1970. Hogup Cave. University of Utah Antropological Papers No. 93.

Bedwell, Stephen F. 1970. Prehistory and Environment of the Pluvial Fort Rock Lake Area of South Central Oregon. Ph.D. Dissertation, Department of Anthropology, University of Oregon.

Clewlow, C. William 1967. "Time and Space Relations of Some Great Basin Projectile Point Types", paper no. 10, in Papers in Great Basin Archaeology, University of California Archaeological Survey Reports 70, 1967.

Cole, David L. 1975. Survey For Archaeological Sites in Warner Valley, report to Bureau of Land Mangement, Museum of Natural History, University of Oregon, Eugene, February 13, 1975.

Cole, David L. 1975. Survey For Archaeological Sites in the Fort Rock Valley report to the Bureau of Land Management, Museum of Natural History, University of Oregon, Feb. 3, 1975.

Cressman, L.S. 1942. Archaeological Researches in the Northern Great Basin. Carnegie Institution of Washington Publications 538. Washington, D.C.

_____, Howell Williams, Alex D. Krieger 1940. Early Man in Oregon. Archaeological studies in the northern Great Basin. University of Oregon monographs, Studies in Anthropology No. 3, Eugene, August, 1940.

Fagan, John L. 1974. Altithermal Occupation of Spring Sites in the Northern Great Basin. University of Oregon, Anthropological Paper No. 6, Eugene, 1974.

Kelly, Isabel T. 1932. Ethnography of the Surprise Valley Paiute. University of California, Publications in American Archaeology and Ethnography. University of California Press, Berkeley, California, 1932.

Mack, Joanne M. 1975. Cultural Resource Survey in the Southern Warner Valley, Oregon. Final report, BLM purchase order no. 3691-PH5356, Department of Anthropology, University of Oregon, Eugene, 1975.

O'Connell, J.F. 1967. "Elko Eared/Elko Corner-Notched Projectile Points as Time Markers In The Great Basin", paper no. 9, in Papers on Great Basin Archaeology, University of California Archaeological Survey Reports 70, 1967.

_____ and Paul S. Hayward. 1972. "Altithermal and Medithermal Human Adaptation in Surprise Valley, Northeast California", in Great Basin Cultural Ecology: A Symposium, Desert Research Institue, Reno and Las Vegas, Nevada.

Pettigrew, Richard M. 1975. Cultural Resource Survey in the Alvord Basin, Southeastern Oregon, University of Oregon Press, Eugene, Dec. 1975.

Scott, Lolla 1966. Karnee: A Paiute Native. University of Nevada Press, 1966.

Stewart, Omar C. 1939. "The Northern Paiute Bands", University of California Anthropological Records, Vol. 2, No. 3, 1939.

Weide, Margaret L. 1966. Archaeological Site Survey Warner Valley-Hart Mountain Area, Summer 1966. Report, December 1, 1966.

_____ 1967. Archaeological Site Survey Warner Valley-Hart Mountain Area, Oregon, Summer 1967. Report, Department of Anthropology, University of California, Los Angeles. October, 1967.

_____ 1968. Archaeological Site Survey Warner Valley-Hart Mountain Area, Oregon, Summer 1968. Report, Department of Anthropology, California State College, Long Beach. November 15, 1968.

_____ 1968. Cultural Ecology of Lakeside Adaptation in the Western Great Basin Ph.D. Dissertation, Department of Anthropology, University of California, Los Angeles.

_____ North Warner Subsistence Network: A Prehistoric Band Territory. Nevada Archaeological Survey Research Paper No. 5, Reno.

_____ and David L. Weide. "Site Survey of the Warner Valley-Hart Mountain Area, Southeastern Oregon,' in The Nevada Archaeological Survey Reporter, No. 12, pp. 4-5, University of Nevada, Reno.

Wood, James 1974. Archaeological Site Survey Of Potential Geothermal Lease Areas. Bureau of Land Management, District Office, Susanville, California. 1974.

15. Social Welfare

a. Economic Characteristics of the Study Area

The study area is located in Lake County, Oregon. Lake County, which is one of the largest counties in Oregon, has a land area of 8,231 square miles. The county's 1974 population was 6,450 people, an increase of 1.7 percent over 1970. The bulk (over 50 percent) of the population resides in the Goose Lake Valley. Employment in the county is shown on Table 10.

Table 10

Lake County Employment

	Number Employed	Percent
Agriculture	621	21
Self-employed	290	10
Lumber & Wood Manufacturing	380	13
Other manufacturing	30	1
Contract Construction	20	1
Transportation and Utilities	120	4
Retail Trade	330	11
Finance, Insurance, Real Estate	80	3
Service and Miscellaneous	200	7
Government	680	23
Unemployed	240	8
Total	2990	

The government is the largest employer followed by agriculture and wood manufacturing. Agriculture and government account for almost half of the employment in the county, and are the major economic contributors to county residents. The wood manufacturing industry also contributes a considerable amount of employment.

The study area contains two major population and economic areas. Paisley (Fig. 10), the largest, has a 1971 population of 260, and Summer Lake has a population of less than 20. Paisley is incorporated while Summer Lake is unincorporated. Paisley's economy is based upon agriculture, wood manufacturing, and government. Agriculture and wood manufacturing are the major economic contributors in the Paisley area. Summer Lake consists of a small concentration of retail outlets and a small group of government employees.

Few services are available in Paisley and Summer Lake. The community of Paisley has a school which serves the area. According to the school district, the facility has adequate staff and space for expansion. Utilities are provided by Surprise Valley Electric Co-op and Beaver State Telephone Company. Paisley's municipal sewage system was designed for a population of 500 people, and a limited amount of expansion can be handled.

Fig. 10 - The town of Paisley with the Fremont Sawmill in the foreground.

b. Existing Economic Uses of Geothermal Energy

The geothermal resource is not being extensively used at this time. Summer Lake Hot Springs is developed into a recreation site with several campsites and a heated pool. The BLM has one warm water livestock well in the area.

c. Local Regulatory Structure

Lake County is governed by a three member Board of County Commissioners. The county planning commission prepared a land use plan and zoning ordinance which was adopted in 1972.

The majority of the study area is zoned A-2 (General Rural Zone) to maintain an openness and rural character. All of the National Resource Land falls into this category. The private land south of Summer Lake is zoned as A-1 (Exclusive Farm Zone) to maintain this area's agricultural production. Geothermal steam was not mentioned in the county's land use plan, and there is no mention made of geothermal steam in the zoning ordinance. Geothermal exploration and development would be a conditional use, and any company doing this type of work may need a conditional use permit from the county planning commission.

16. Attitudes and Expectations

People within the EAR area have been exposed to only one use of geothermal energy. Summer Lake Hot Springs bathhouse, the one use, has been heated by hot water for close to 60 years.

Private companies have leased the geothermal resources on the bulk of the land at the south end of Summer Lake. Some of these companies have also done some geophysical surveys in the area.

Most of the residents favor the leasing of federal lands. Nonresidents have expressed no attitudes. (See Intensity of Public Interest Section for comments on the lease program).

C. Analysis of Proposed Action and Alternatives

1. Impacts of the Proposed Action

a. Non-Living Components

(1) Geology

Exploration and development would have a very minor impact upon geology, amounting simply to the drill holes left in the ground after drilling. An additional impact possible on foothills is that of landslides caused by road and drill pad construction on steep slopes.

Several components of the geology may be impacted during the operation stage by both waste disposal and production. The components are subsidence, seismicity, rock temperatures, and hot springs.

Subsidence may occur in the basin as the geothermal fluids are removed from the ground during production. The probability of subsidence occurring in this area is very low because of the rock types in the area.

Seismicity may be affected by both waste disposal (re-injection of geothermal fluids) and production (removal of geothermal fluids). Removal of the geothermal fluids might have the effect of decreasing the number, and increasing the severity of local earthquakes. Reinjection of the geothermal fluids may have the effect of increasing the number and decreasing the severity of local earthquakes.

The rock temperatures may gradually be reduced by the production of geothermal power. The temperature reduction rate is unknown. The temperature reduction rate may be so slow that it is immeasureable, or it may be very fast. The result of the rock temperature dropping too fast would be to terminate the use by the geothermal developer prematurely. This may also reduce local hot spring and hot well temperatures.

Hot springs may be effected by production (removal of geothermal fluids) and reinjection (replacing geothermal fluids). Existing hot springs or wells may become larger or smaller, new hot springs may start, or old hot springs or wells may disappear.

(2) Air

Particulate matter, (dust) may be dispersed during all of the stages of implementation. Concentrations in the basin may exceed the daily state air quality standards during certain times of the year. The highest concentrations will probably occur during the summer when the soils are driest.

The only significant contribution of noxious gases would be from drilling and production testing operations. The noxious gas most likely encountered would be hydrogen sulfide of concentrations similar to that found in hot springs. This concentration may be very near the state air quality standards and may exceed the standard during production testing in the development stage, and during maintenance, waste disposal, and production in the operational stage. Concentrations may be increased during winter months by inversion layers within the basin, but probably not to toxic levels. The toxic effect of hydrogen sulfide is not cumulative. The impact to an individual in the area would be smelling a rotten egg odor.

Temperature may be impacted by production and possibly by waste disposal. The impact would be to increase the air temeprature by 1 to 2 degrees F in the immediate vicinity of the operation.

Air movement patterns may be impacted by production and possibly by waste disposal. How the air movement patterns would be impacted by the venting of large quantities of steam is unknown.

Non-ionizing radiation would be impacted by the production of electricity. The impact would be interference with radio transmission and reception by the 60 cycle frequency of the generators and transmission lines. This impact would be localized around the geothermal power plant and along the transmission lines.

(3) Land Use

Several exploratory activities would have a minor impact on land use while other exploration techniques may permanently alter land use. Off-road vehicular travel and additional road and trail construction would open areas previously closed to motorized travel. Additional physical access can result in more recreational use of previously inaccessible areas, thus altering existing land use patterns. The use of numerous existing roads

for exploratory purposes would not negatively impact existing land use. In general, the exploration is for a short duration, and would not have a long term impact.

Road and trail construction during the exploratory stage could temporarily disrupt existing land use by destroying vegetation, compacting the soil and adding to erosion. Noise from seismic blasting and shallow hole drilling may be a nuisance if done near population centers or farmsteads. Drilling activity may cause temporary scenic disturbance to the public lands along Highway 31.

The development stage requires several wells and possibly the construction of one or more electric power generation plants. In general, 16 to 20 producing wells are required per power plant. Generating plants are centrally located to minimize pipeline length. Power plant spacing is about one plant per 640 acres throughout a producing field. If a field is developed, existing land uses on 640 acres per power plant would be interrupted and the primary use would be changed to electric generation. This impact would be greater in irrigated cropland and urban areas because high value land is removed from production or use. Noise from drilling and construction may last for long periods of time. The noise levels of muffled wells have been described as slightly less than that of an unmuffled diesel truck. Decibel readings for machines with mufflers read from 70 to 125 decibels. Continued exposure to anything over 90 decibels (decibels measure loudness not pitch of sound) can cause permanent ear damage. These loud noise levels would definitely be annoying to adjoining land users.

The construction of power transmission lines may further impact land use. Transmission lines would impact areas completely removed from the immediate site. If crossing cropland, cultivation and irrigation would become difficult. Visual impacts may be considerable, depending upon line location and line size. By the time the operation phase is reached, most of the major land use impacts have occurred. Other operations such as drilling additional wells may occur during this phase.

(4) Water and Soil

Surface disturbance may effect each specific physiographic unit differently, depending on the extent and kind of disturbance. The basin is

generally flat with little to no relief. Exploration and development in the dry portions should have minimal effect on soil erosion and sedimentation of surface waters except in the Dune areas where wind erosion would increase with increased activity. Disturbance in the wet areas by seismic surveys could increase sedimentation of surface water through vehicle activity and drill site preparation. Exploration sites in these wet areas would require a drill pad which may increase sedimentation. Quality of surface water in the basin is presently low and may not be significantly impacted.

Slopes on the low plateaus and foothills range from 0 to greater than 60%. The relationship between slope, soil types, and vegetative cover is very important to soil stabilization. Soils on both physiographic units are very susceptible to erosion if the vegetation cover is removed or disturbed. Erosion potential exists even from a minimum disturbance such as a drill site. Road or building construction on these soils may increase erosion and runoff significantly and may cause offsite damage to water resources.

A few small areas supporting a pine type exist within the Summer Lake area, soils on these types are more stable. Road construction or individual drill sites would not increase erosion or sediment load significantly. However, if a geothermal generating development was completed in either physiographic unit, the combination of activity involved may have a high impact. There may be enough soil disturbance and soil compaction associated with its development that ground water recharge could be reduced. Stream or spring flow may or may not be impacted.

Within the foothill unit a few upland meadows exist, exploration or development in or directly above these meadows would be damaging. If a shallow water table is present, any surface disturbance would increase runoff and erosion. An increase in erosion could lower the water table and result in decreased discharge from the spring and/or streams fed by these meadows.

In all stages of implementation, ground water may be impacted. Blowouts during exploratory drilling or during production stages may occur, introducing to the ground water supply toxic or undersirable substances. Accidental spillage from waste ponds may occur, affecting both the shallow water tables

and the regional water table. After rehabilitation of a site, seepage from waste ponds could have an effect on both surface and ground water for an indefinite period.

What effects geothermal development would have on the hydrologic cycle is largely unknown, however, water vapor would probably be added to the atmosphere. Geothermal activity may use anywhere from 3.7 acre ft./yr of water for exploration and development to 3,000 acre ft./yr for the operation of one power plant's cooling towers. This water may come from the geothermal field or wherever that amount of water is available. Twenty to 100 percent of the geothermal fluids may be reinjected, depending upon the type of geothermal field. If the geothermal fluids are found to be of good quality, they may provide a new water source for the Basin.

Vehicle travel, associated with all stages of implementation, during wet soil conditions may adversely effect some areas. Travel during this period would cause increased soil compaction, disturb surface vegetation and damage roads. In some cases, gullies may result.

b. Living Components

Impacts on living components of the environment from an action, such as this are difficult to accurately predict. Because of the great number of unknowns, the relative importance of potential impacts depends on several variables. Definite site location, degree of development and timing of developments are paramount among these. The following impacts would be limited to general problems or conditions that could occur within each stage of implementation.

(1) Terrestrial Vegetation

Most stages of geothermal resource leasing would have some degree of impact on native vegetation. Exploration could result in crushing or removing vegetation. Impacts to vegetation would be similar in the three units, however, the impact to animal species using the vegetation may vary.

The foothill unit supports vegetation that is valuable for wildlife, livestock, and watershed protection. Disturbance from exploration or development could decrease forage production and increase soil loss. There is a variety of vegetative types in the foothills, the low sagebrush types would respond to rehabilitation slower than big sagebrush types.

In the basin, removal of vegetation would have less impact upon grazing and wildlife in the saltgrass -

greasewood communities. This habitat is not critical for any known species, and these plants can re-establish themselves by sprouting and/or rhizomes in a short period.

Impacts to the low plateau vegetation would be similar to the foothill area, however, it would require more time to reestablish. Vegetation on this area is of less importance to animal species.

Impacts of development and operation would be similar to those of exploration. In addition, major vegetation changes would be expected on any site in the basin where artesian water is encountered and allowed to flow over the surface. Desirable forage species can be expected to come in in these cases.

Closeout of a geothermal operation could have both adverse and beneficial impacts to vegetation. Additional plant damage could occur. Vegetation could be restored on certain sites, the success depending on the individual site. In general, introduced species would not be used in the basin, except on deeper more productive soils. They would be used on select sites in both the foothill and low plateau areas.

(2) Wildlife

Potential adverse impacts to wildlife during normal exploration activities are expected to be minor. Increased activity and disturbance in deer winter ranges, antelope kidding grounds, raptor nesting sites, or other critical animal use areas may prove detrimental to the affected species. However, this will be temporary and lasting impacts should not be significant. Greatest concern is the increased access resulting from road and trail construction, particularly in the deer winter range areas. Future use of these roads by the public could lead to increased harassment of animals during critical periods of their life cycle.

Road construction in or adjacent to the Chewaucan River or its tributaries would result in physical damage to the stream beds and adjacent riparian habitat in the immediate site. In addition, construction activities on the steep slopes of the drainage could cause offsite damage to lower stream areas. Increased turbidity and resultant sedimentation of lower stream beds could result in a reduction of acquatic insects and plants, loss of spawning areas, and eventually a decline in fish populations.

If deep well exploration takes place in similar sites, the disturbance will be greater and result in an expected loss of 2-3 acres of habitat for each well site.

The increased disturbance, activity, and noise levels associated with development and operation could prove detrimental to many species, especially during the breeding season or in critical wintering areas. The full significance of this is not known at present because many species adapt to changing conditions and increased human activity, while others tolerate little change. Raptors for example, have abandoned nests because of the presence of man. The impact may be temporary or permanent depending upon the tolerance level of the individual species. It could result in a change of wildlife species utilizing a specific site.

In the immediate area being developed, forage and cover would be removed, resulting in localized loss of habitat for terrestrial species. This could result in a moderate amount of acreage being disturbed. It may prove to be a lasting adverse impact if the site is in a sagegrouse strutting ground, antelope kidding ground, critical deer winter range, raptor nesting sites, or other critical animal use areas. The severity of the impacts is dependent upon the number of sites, amount, and location of land involved.

In this area it is felt that any loss of important deer winter habitat would have an adverse impact on the wintering population.

Impacts to waterfowl are expected to be minimal with the following exceptions which are not normally expected to occur when lands are leased under the provisions of the Geothermal Steam Act.

(a) The disposal of, or accidental discharge of water or waste effluents of toxic or poor quality into higher water quality areas such as Ana River or the Summer Lake marshes could prove detrimental to this resource. If of significant quantity it could change the chemical, physical, or thermal properties of existing water thereby altering the existing aquatic environment. These toxic wastes may destroy aquatic animal life (fish, etc.) and vegetation. Significant changes or reduction in aquatic vegetation would be reflected in reduced waterfowl use and production.

(b) Although improbable, the possibility exists that heavy utilization of ground water during the production phase could result in lowering the water table or ground subsidence. The total impact of this would be difficult to assess, but obviously any reduction in the water supply to the management area or loss of springs would be detrimental to wildlife.

The above mentioned impacts would also apply to the aquatic resource of the Chewaucan River.

Should wastes associated with drilling or production prove to be toxic, it would present a hazard to animal life. If, however, waste water was of good quality it would be beneficial, and enhance waterfowl and other aquatic habitat.

Above ground transmission lines associated with production could pose a hazard to migrating waterfowl, and if not properly designed result in raptor electrocution.

Construction of pipelines in big game migration routes could prove to be a barrier to their seasonal movements.

The close-out operations should prove beneficial to most animals. Human activity, disturbance and high noise levels associated with producting wells would be removed. Many of the disturbed sites and roads can be reseeded and the latter put to rest, thereby partially replacing lost forage and cover and reducing access. In the more homogeneous portions of the area these habitat changes could alter the wildlife species composition, providing some wildlife diversity in the area.

The threatened and endangered species listed, with the exception of the Northern Bald Eagle and the Snowy Plover, are not usually found in the EAR area. The actual impacts of geothermal development on their welfare is unknown, however, impacts as specified for waterfowl and raptors would be applicable to these species.

(3) Livestock

Drill sites, power plant construction, and off-road vehicle use may disturb livestock in areas where animals normally concentrate, such as water sources

meadows, and grass seedings. Emission of waste and sumps for mud and waste water may be hazardous to livestock. Pipelines and equipment may interfere with livestock movement. Loss of forage production would take place if disturbed areas are not reseeded. If development occurred within the intensive grazing management area, loss of forage could be significant. If it occurs near the center of the playa or on the southeast or east portions of the study area, impacts would be insignificant or very minor.

Impacts upon wild horses are not being considered because it is anticipated that they will not occupy any of the analysis area in the future.

(4) Ecological Interrelationships

Plant succession would be altered on all disturbed sites. Little significant impact is anticipated for most plant communities because impacts would be very localized.

Successional changes would be left to natural processes. Most of the disturbed sites would revegetate, although species may differ from the original flora. Introduced species resulting from rehabilitation would be present on these sites where they are adapted. Other sites may be dominated, at least temporarily, by annual and perennial species able to survive the altered environment. Regeneration of the vegetation on timber sites may require many years to regain its original status.

Food relationships would be altered on localized areas by loss of vegetation and subsequent animal production. The loss of use areas critical for a species to complete its life cycle would obviously be detrimental to that species. An example is the destruction or encroachment upon a segment of critical deer winter range. As previously stated, significance of these impacts depends upon the exact location and amount of land involved.

Most impacts such as increased activity, noise, pollution of existing water, etc. relating to the development and operational stages have been discussed previously. All of these factors may alter animal habitat relationships either directly or indirectly.

c. Human Values

(1) Landscape Character & Aesthetics

All phases of geothermal development may have impacts on the landscape. During the exploration and development phases new roads and trails would add lines of contrast to all landscape types. New roads and trails would be most harmonious within the basin and least harmonious upon open slopes in the plateau and foothills. The impact on the landscape would last longer with a high standard road or trail. A low standard road or trail would have the best chance of revegetating and eliminating contrasting scars. Topography within the plateaus and foothills would break up the contrasting road scars by screening portions behind hills or vegetation. Wellheads, plants, pipelines, and transmission lines would become long-term intrusions upon natural landscape features in these areas. These structures and facilities would have lower visual impacts in the basin where similar structures exist and would have greatest impact in areas, such as the plateaus and foothills where there are no existing structures. The close out phase of geothermal development would remove inharmonious features from all landscape regions and rehabilitation procedures would reduce contrasts of form, line, color, and texture qualities of the landscape.

The degree of impact that a certain action would have on the landscape is directly related to the scenic quality of the area. The same action would have a greater impact on an area of high scenic value than it would on an area of low scenic value.

The odor of hydrogen sulfide gas (rotten egg odor) may permeate the air during the exploration, development, and operations phases and have an impact on the experiences and pleasures of both the residents and visitors to the area. The impact of the gases would be dependent on the amount and density of the gas and its location in relation to populations.

The noise may also have an impact on the experiences and pleasures of both residents and visitors.

(2) Man-Made Features

The construction of well drilling rigs, well equipment, and power plants would add structures to a landscape that is rural in character. Large tall bright reflecting structures would be inconsistant

with the low profile and subtle tones of most rural dwellings and out buildings of the basin. A large complex or concentration of structures would also be inconsistant with the existing rural structures.

d. Socio-Cultural Interests

(1) Educational-Scientific-Historical

During geothermal exploration, surface disturbance would be minor, but beneficial impacts may be high, owing to the additional knowledge of the geology and hydrology gained through geologic mapping, geophysical exploration, geochemical surveys, drilling, and production.

Hot springs may be affected by production (removal of geothermal fluids) and reinjection (replacing geothermal fluids). Existing hot springs or wells may become larger or smaller, new hot springs may start, or old hot springs or wells may disappear. After the 1968 earthquake, Cox Ranch Hot Springs in Warner Valley increased its flow, however, other hot springs and geysers in the area did not change. If flow rates do increase because of geothermal development, it is likely that the change would be beneficial. Decreased flow rates would have adverse impacts.

All phases of geothermal development except a few phases of exploration would have impacts on any primitive values within the analysis area. Large scale construction and development near primitive areas would impact the "setting essentially removed from the effects of civilization" within the primitive area.

There is no known impact on historical sites.

(2) Archaeology

Positive impacts may result from an archaeological reconnaissance and/or salvage work performed on areas which have had little or no archaeological research to date. The resulting increase in knowledge may outweigh the effects of site disturbance.

Negative impacts during the stages of geothermal development would be both direct and indirect.

Direct impacts would result from surface disturbance during off road vehicle travel, road construction, drill pad construction, construction of production facilities, and construction of transmission

facilities. The ground disturbance would destroy the sequence of cultural materials within a site, destroying its scientific value. Some sites are completely exposed on the surface and clearing or leveling an area would completely remove and destroy these sites. Excavations made during construction projects may expose unknown sites. If care is not taken to insure that the significance of such a site is evaluated and appropriate precautions taken before work continues, significant sites could be completely destroyed. Chemical destruction of organic material in sites may occur if waste drill fluids or water escapes from holding tanks and saturates sites.

Indirect impacts may occur during and after geothermal development. New or improved roads would increase access to sites and the number of people. The tourist attraction of geothermal plants may attract people into areas containing sites. The increased access and number of people in site areas may increase unauthorized collection of artifacts. The effect is cumulative and could result in eventual destruction of sites. Improper collection of artifacts is a major cause of site destruction.

The cummulative impact of archaeological site destruction is the permanent loss of part of the human prehistory record.

(3) Social Welfare

Several general observations can be made concerning probable economic impacts. Nearby communities would benefit in the form of increased expenditures from workers employed during geothermal development and in the form of an increased tax base. These same communities would be required to provide additional services for employees. The magnitude of these impacts would obviously vary, depending upon the type of developments and the number of persons involved.

The probable impacts of geothermal development on social welfare are difficult to assess at this time. Exploration drilling would probably require one rig for a 6 month to one year period and at least 20 people would be needed during this period. The development phase would probably occur over a 2 to 10 year period. Additional drilling crews and construction workers would be required for development. The number of workers required during development is a direct function of the number of plants

eventually built, the number of wells eventually drilled, and the amount of transmission facilities required.

The impacts on social welfare can best be described by identifying a hypothetical situation. If, for example, a large geothermal field is developed near Paisley or Summer Lake, the probable impacts would be great. Fast growth would strain housing and place burdens on other community services. If a small field is developed, the impacts would be less. The additional people required for a small development could be incorporated into the existing communities.

If the electrical power generated by the geothermal development is used near the plant site, the region could conceivably experience considerable economic growth in the future. If the power is transported out of the area, few impacts beyond the development phase would occur.

These examples illustrate extreme situations and any discussion of possible impacts is speculative at this time. Development cannot occur without some strain on communities and on the people who reside in these communities. The level of impacts would range from slight to severe up to and through the development phase. When the field is developed and producing, impacts associated with growth should diminish and demand for social services should stabilize.

2. Impacts of the Alternatives

a. No Leasing

One alternative is to decline to lease the land. This alternative would involve an administrative decision by the B.L.M. not to lease for geothermal resource development any of the federal land within the Summer Lake Basin geothermal area. The environmental impacts of the alternative are as follows:

(1) A decision not to lease would conserve the resources in the area for use by future generations.

(2) A decision not to lease would eliminate all anticipated impacts of leasing.

(3) A decision not to lease could seriously hamper efficient development of the resource on adjacent private land that is presently being leased.

(4) A decision not to lease could encourage energy producers to turn to other energy sources to meet the nation's growing demands. Most of the alternative energy sources have greater adverse impacts upon the total environment than geothermal resources (See the Programatic EIS for geothermal leasing).

(5) A decision not to lease would have an adverse impact on the attitudes and expectations of the majority of interested Oregonians.

D. Possible Mitigating or Enhancing Measures

Potential known or anticipated environmental problems have been identified in this analysis. Many of the impacts can be mitigated through enforcement of federal, state, and local laws; and the geothermal regulations.

Applicable environmental stipulations found in the lease form and geothermal regulations are found in the next selection.

Other measures such as no leasing of areas with resource conflicts or no surface occupancy are included in the following mitigating recommendations.

1. Non-Living Components

Rock temperature reduction is an inevitable impact of geothermal energy production and cannot be mitigated. If subsidence occurs in the irrigated basins to a degree that it has an adverse impact upon farming, reinjection of water that would not contaminate ground water supplies or other measures may be required. If re-injection does not prevent subsidence, geothermal production may be required to cease. Because the impact of geothermal operations upon seismicity and hot springs is unknown, no mitigating measures can be developed. If operations produce an adverse impact upon these components of geologic structure, mitigating measures should be developed at that time.

Require dust preventative measures such as surfacing or watering of trails, drill pads, roads, and construction sites when the dust content of the air exceeds State and Federal air quality standards. Federal and State requirements should mitigate most of the impact of operations upon the noxious gas content of the air. If air inversions cause the problem of noxious gases to become serious, it may have to be mitigated by the addition of air pollution control devices. Because the impacts of operations upon air temperature, air movement patterns, and non-ionizing radiation are unknown, no mitigating measures can be developed. If operations produce an adverse impact upon these components of the air quality, mitigating measures should be developed at that time.

Since entry onto the lands with equipment would increase the potential for erosion, the following measures applicable to the Summer Lake Basin may be required.

Existing roads and trails should be fully utilized before additional road work can be done. Permanent roads should be gravelled or paved to reduce erosion. Off road vehicle travel is acceptable during the May to October dry period, but should be prohibited when the soils are wet. Roads placed in areas

with rocky shallow soils should be constructed by placing a pad of soil over the rocks rather than cutting below the original ground surface. All roads, drill sites, and plant areas should be rehabilitated and revegetated at the time of abandonment.

No drilling or development work in the drainages above or in the meadows should be allowed.

Roads should be properly designed and constructed to minimize erosion and waste ponds should be properly sealed to prevent leakage.

Mitigating measures for soil erosion, vegetation disturbance, etc. should mitigate the impacts upon land use.

2. Living Components

The natural vegetation should be undisturbed as much as possible within the foothill and low plateau areas. Removal of vegetation in the basin area is not critical except on the dune areas. Actual operations should not occur on dunes if possible.

If roads are no longer needed, they should be shaped and drained and seeded to adaptable species.

On the foothill area, species beneficial to wildlife should be seeded on disturbed areas.

The best mitigating measure in areas of important wildlife habitat is not to lease the specific parcel of land or not allow surface occupancy. No surface occupancy would eliminate all drill sites, plants, and other facilities on the lands, however, angle drilling from off site locations would be allowed. Specific areas that may be included in the above categories are as follows:

(a) a no surface occupancy strip ½ mile wide established adjacent to the east boundary of the Summer Lake Management area and the Summer Lake water body.

(b) to adequately protect important deer winter range and the aquatic resources of the Chewaucan drainage no leasing allowed within the deer winter range in the South portion of the EAR area, as outlined on Map 6.

A lesser degree of mitigation for critical deer winter range can be obtained by restricting exploration during the period of December 1 through May 1. If exploration is successful, mitigation of development and production can be achieved by modifications of the development plan.

No surface occupancy should be allowed within 200 yards of any live stream, lake, or reservoir.

Access roads should be limited to the minimum necessary. Roads and trails not necessary for plant operation should be shaped, drained and seeded with species adapted to the area.

All disturbed soil areas should be seeded to vegetation species adapted to the area which are beneficial to wildlife, within one year of completion or termination of the particular operation involved.

Transmission lines should be designed to prevent raptor electrocution and when possible install perches to improve raptor habitat. No surface disturbance should take place on or adjacent to special animal use areas (sagegrouse strutting within 2 miles, antelope kidding grounds within 1 mile, raptor nesting sites within ½ mile, fawning areas, etc.

Pipelines and other barriers constructed in wildlife migration routes should be designed to allow free movement of animals.

Mitigating measures pertaining to water quality and subsequent effects on aquatic organisms are covered in applicable lease stipulations and state water quality laws.

To protect livestock, no surface occupancy should be allowed within 200 yards of the existing stock water wells at Paisley flat.

3. Human Values and Socio-Cultural Interests

Visual Resource Management Classes were developed for the EAR Area prior to preparation of this document in accordance with draft Manual 6150. Final guidelines were adopted in November of 1975. These guidelines are not quality ratings, but suggested management procedures. The quality rating areas, as described under Existing Environment, are zoned into foreground and background from major traveled roads and highways. Areas that cannot be seen from these routes are identified as "seldom seen." The combination of the quality rating and the zoning results in classifying the area into general scenic management classes (Refer to Map 9), i.e., areas that are along major travel routes and have a "B" or "C" rating are Class II areas. Those areas which are not often seen and rated as "B" or "C" are Class III or IV. The combination of scenic quality (B rating) and the amount of traffic dictate a Class II management objective area for the Chewaucan River Canyon and the western edge of the anaysis area. The rest of the area is considered Class III.

The classes are used as guides to manage the visual resources and determine mitigating measures. Changes in the landscape

character should be in accordance with the guidelines described under each class designation (Refer to Legend, Map 9). Actions that cannot conform to these guidelines may create residual or unmitigated impacts to Class II areas.

Changes in the basic elements may be evident in the areas of Class III scenery, but the changes should be complimentary to the existing landscape.

Permanent installations should be constructed to blend into the surrounding landscape to minimize the visual impact.

Noise levels should not exceed 125 decibels at 25 feet.

Whenever gaseous emissions reach the State of Oregon's minimum levels for air quality, the escaping gases should be reduced.

There are no measures to mitigate the impacts of geothermal development within primitive areas. Construction and development near a designated primitive area may be designed to match existing man-made structures and be of the scale and size to minimize visual impacts and intrusions.

Mitigating measures for impacts upon archaeological sites may consist of not leasing, non-occupancy, or salvage under the provisions of federal laws and geothermal lease stipulations. In some cases, archaeological salvage may not be desirable.

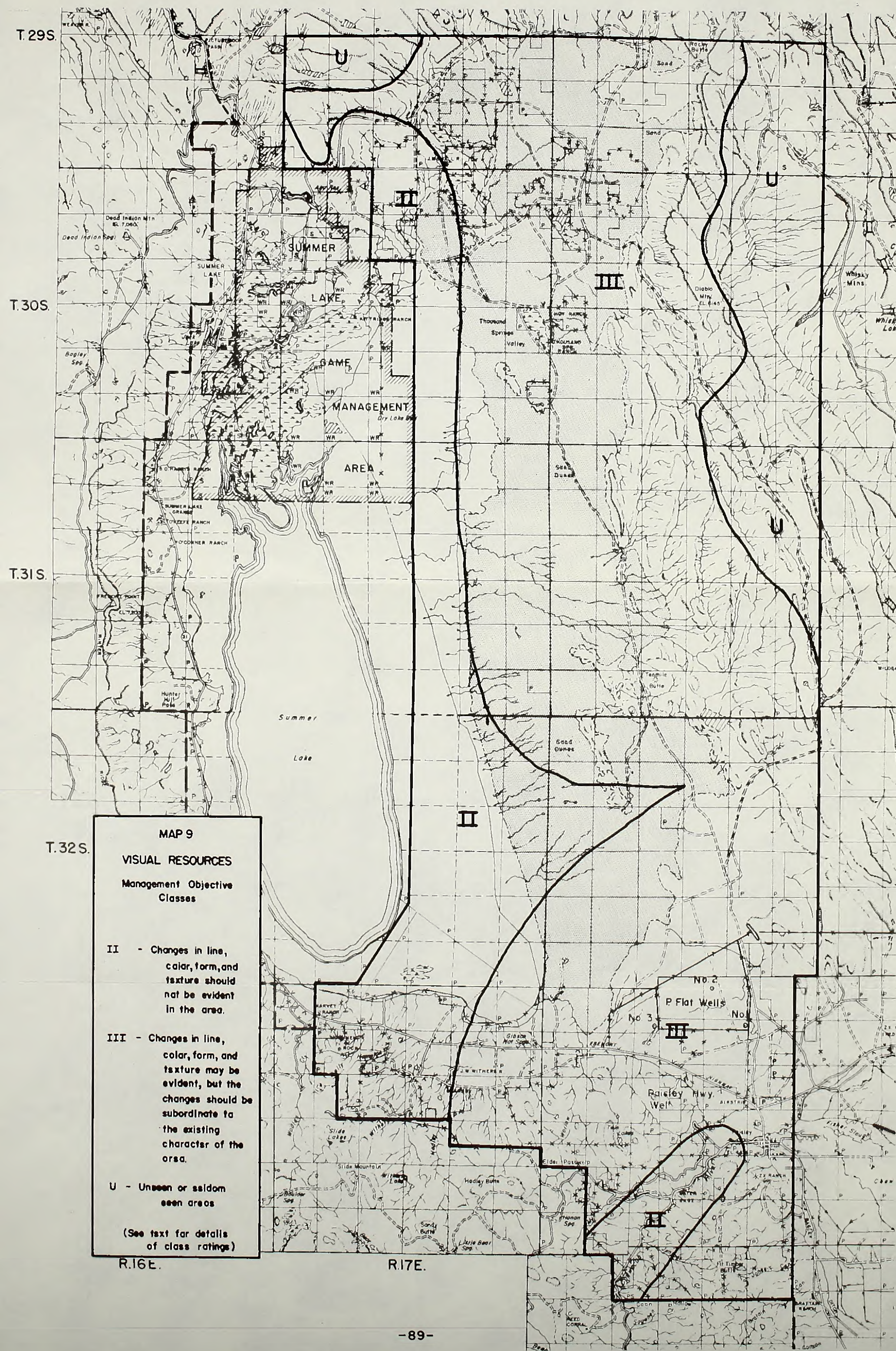
Areas containing potential National Register quality sites should be deleted from leasing. Intensive surveys for archaeological values should be done in areas where potential National Register quality sites are identified and surface disturbances would take place.

In addition, roads and projects should be carefully planned to avoid creating easy access to sites. Information regarding protection of archaeological resources should be distributed in areas of increased public access. Periodic, random checks should be made of projects and site areas to insure compliance with lease stipulations by the lessee.

When excessive vandalism of sites occur, access restrictions may be necessary.

Care should also be taken to avoid contamination of site by waste fluids from geothermal operations.

Social impacts may be mitigated by obtaining a conditional use permit from the local planning commission.


T.29S.
T.30S.
T.31S.
T.32S.
R.16E.
R.17E.
SUMMER
LAKE
GAME
MANAGEMENT
AREA
Summer
Lake
Dead Indian Mtn
Dead Indian Spg
Bagley Spg
Thousand Springs Valley
Diablo Mtn
Whisky Mtns
Sand Dunes
Tenmile Butte
Hunter Hill Pole
Slide Lake
Slide Mountain
Hedley Butte
Sandy Butte
Little Bear Spg
Gibson Hot Spg
Elder Pasture
P Flat Wells
No. 2
No. 3
No. 1
Bailey Hwy. Well
Fisher Slough
U
II
III
MAP 9
VISUAL RESOURCES
Management Objective Classes
II - Changes in line, color, form, and texture should not be evident in the area.
III - Changes in line, color, form, and texture may be evident, but the changes should be subordinate to the existing character of the area.
U - Unseen or seldom seen areas
(See text for details of class ratings)

E. Recommendations for Mitigation

The geothermal lease form, Part 270 and 3200 of the Code of Federal Regulations and Geothermal Resources Operating Orders contain provisions for mitigating environmental impacts. Sections of these documents that are appropriate to the Summer Lake Basin area of study are reproduced on the following pages.

Lease stipulations that contain measures related to the sites and not specifically mentioned in the above documents are on at the end of this section.

GEOTHERMAL RESOURCES LEASE FORM

This lease is made pursuant to the Geothermal Steam Act of 1970 (84 Stat. 1566; U.S.C. 1001-1025) (hereinafter called "the Act") to be effective on _____(hereinafter called the "effective date"). It is subject to all the provisions of the Act and to all the terms, conditions, and requirements of:

(a) all regulations promulgated by the Secretary of the Interior (hereinafter called "the Secretary") in existence upon the effective date, specifically including, but not limited to, 43 CFR Parts 3000 and 3200 and 30 CFR Parts 270 and 271,

(b) all geothermal resources operational orders (hereinafter called "GRO orders") issued pursuant thereto, all of which are incorporated herein and by reference made a part hereof,

Section 8

(1) The lessee shall conduct all operations under this lease in a workmanlike manner and in accordance with all applicable statues, regulations, and GRO orders, and all other appropriate directives of the lessor to prevent bodily injury, danger to life or health, or property damage, and to avoid the waste of resources, and shall comply with all requirements which are set forth in 43 CFR Group 3200, including, but not limited to, Subpart 3204, or which may be prescribed by the lessor pursuant to the regulations, and with the special stipulations which are attached to the lease, all of which are specifically incorporated into this lease.

Section 14

(1) The lessee shall take all mitigating actions required by the lessor to prevent:

(a) soil erosion or damage to crops or other vegetative cover on Federal or non-Federal lands in the vicinity;

(b) the pollution of land, air, or water;

(c) land subsidence, seismic activity, or noise emissions;

(d) damage to aesthetic and recreational values;

(e) damage to fish or wildlife or their habitats;

(f) damage to or removal of improvements owned by the United States or other parties; or

(g) damage to or destruction or loss of fossils, historic, or prehistoric ruins, or artifacts.

(2) Prior to the termination of bond liability or at any other time when required and to the extent deemed necessary by the lessor, the lessee shall reclaim all surface disturbances as required, remove or cover all debris or solid waste, and, so far as possible, repair the off site and on site damage caused by his activity or activities incidental thereto, and return access roads or trails and the leased lands to an acceptable condition including the removal of structures, if required.

(3) The Supervisor or the Authorized Officer shall prescribe the steps to be taken by lessee to protect the surface and the environment and for the restoration of the leased lands and other lands affected by operations on the leased lands and improvements thereon, whether or not the improvements are owned by the United States.

(4) Timber or mineral materials may be obtained only on terms and conditions imposed by the Authorized Officer.

Section 15

(1) The lessee shall use all reasonable precautions to prevent waste of natural resources and energy, including geothermal resources, or of any minerals, and to prevent the communication of water or brine zones any oil, gas, fresh water, or other gas or water bearing formations or zones which would threaten destruction or damage to such deposits.

(2) The lessee shall monitor noise, air, and water quality conditions in accordance with any orders of the Supervisor.

Section 18

The Lessee shall immediately bring to the attention of the Authroized Officer any antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered as a result of operations under this lease, and shall leave such discoveries intact. Failure to comply with any of the terms and conditions imposed by the Authorized Officer with regard to the preservation of antiquities may constitute a violation to the Antiquities Act (16 U.S.C. 431-433). Prior to operations, the Lessee shall furnish to the Authorized Office a certified statement that either no archaeological values exist or that they may exist on the leased lands to the best of the Lessee's knowledge and belief and that

they migh be impaired by geothermal operations. If the Lessee furnishes a statement that archaeological values may exist where the land is to be disturbed or occupied, the Lessee will engage a qualified archaeologist, acceptable to the Authorized Officer, to survey and salvage, in advance of any operations, such archaeological values on the lands involved. The responsibility for the cost for the certificate, survey, and salvage will be borne by the Lessee, and such salvaged property shall remain the property of the Lessor or the surface owner.

Part 270 of The Code of Federal Regulations

270.11 General Functions.

The Supervisor is authorized and directed to carry out the provisions of this part. He will require compliance with the terms of geothermal leases with the regulations in this part and the applicable regulations in 43 CFR Group 3200, and with the applicable statutes. He shall act on all applications, requests, and notices required in this part. In executing his functions under this part, the Supervisor shall ensure that all operations, within the area of operations, will conform to the best practice and are conducted in such manner as to protect the deposits of the leased lands and to result in the maximum ultimate recovery of geothermal resources, with minimum waste, and are consistent with the principles of the use of the land for other purposes and of the protection of the environment. Inasmuch as conditions in one area may vary widely from conditions in another area, the regulations in this part are intended to be general in nature. Detailed procedures hereunder in any particular area will be covered by GRO orders. The requirements to be set forth in GRO orders relating to surface resources or uses will be coordinated with the appropriate land management agency. The Supervisor may issue oral orders to govern lease operations, but such orders shall be confirmed in writing by the Supervisor as promptly as possible. The Supervisor may issue other orders and rules to govern the development and method of production of a deposit, field, or area. Prior to the issuance of GRO orders and other orders and rules and the approval of any plan of operations, the Supervisor shall, consult with, and receive comments from appropriate Federal and State agencies, lessees, operators, or interested parties. Before permitting other operations on the leased land, the Supervisor shall determine if the lease is in good standing, whether the lessee is authorized to conduct operations, has filed an acceptable bond, and has an approved plan of operations.

270.15 Well Spacing And Well Casing.

The Supervisor shall approve proposed well-spacing and well-casing programs or prescribe such modifications to the programs as he determines necessary for proper development, giving consideration to such factors as:

(a) Topographic characteristics of the area;

(b) hydrologic, geologic, and reservoir characteristics of the field;

(c) the number of wells that can be economically drilled to provide the necessary volume of geothermal resources for the intended use;

(d) protection of correlative rights;

(e) minimizing well interference;

(f) unreasonable interference with multiple use of lands; and

(g) protection of the environment, including ground water quality.

270.30 Lease Terms, Regulations, Waste, Damage, And Safety.

(a) The lessee shall comply with the lease terms, lease stipulations, applicable laws and regulations and any amendments thereof, GRO orders, and other written or oral orders of the Supervisor. All oral orders (to be confirmed in writng as provided in 270.11) are effective when issued unless otherwise specified.

(b) The lessee shall take all reasonable precautions to prevent:

(1) Waste;

(2) damage to any natural resource including trees and other vegetation, fish and wildlife and their habitat;

(3) injury or damage to persons, real or personal property; and

(4) any environmental pollution or damage.

(c) Any significant effect on the environment created by the lessee's operations or failure to comply with environmental standards shall be reported to the Supervisor within 24 hours and confirmed in writing within 30 days.

270.34 Plan Of Operation.

Prior to commencing any operations on the leased lands or on any lands covered by a unit or cooperative agreement, the lessee shall submit in triplicate and obtain the approval of the Supervisor and the appropriate land management agency of a plan of operation for the area. Such plan shall include:

(a) The proposed location of each well including a layout showing the position of the mud tanks, reserve pits, cooling towers, pipe racks, etc.;

(b) Existing and planned access and lateral roads;

(c) Location and source of water supply and road building material;

(d) Location of campsites, airstrips, and other supporting facilities;

(e) Other areas of potential surface disturbance;

(f) The topographic features of the land and the drainage patterns;

(g) Methods for disposing of waste material;

(h) A narrative statement describing the proposed measures to be taken for protection of the environment, including, but not limited to, the prevention or control of

(1) fires,

(2) soil erosion,

(3) pollution of surface and ground water,

(4) damage to fish and wildlife or other natural resources,

(5) air and noise pollution, and

(6) hazards to public health and safety during lease activities;

(i) All pertinent information or data which the Supervisor may require to support the plan of operations for the utilization of geothermal resources and the protection of the environment;

(j) Provisions for monitoring deemed necessary by the Supervisor to ensure compliance with these regulations for the operations under the plan; and

(k) A requirement for the collection of data concerning the existing air and water quality, noise, seismic and land subsidence activities, and ecological system of the leased lands covering a period of at least one year prior to the submission of a plan for production. The informations required for paragraphs (a) through (f) of this section may be shown on a map or maps available from State or Federal sources.

270.41 Pollution.

The lessee shall comply with all Federal and State standards with respect to the control of all forms of air, land, water, and noise pollution, including, but not limited to, the control of erosion and the disposal of liquid, solid, and gaseous wastes. The Supervisor may, in his discretion, establish additional and more stringent standards, and if he does so, the lessee shall comply with those standards. Plans for disposal of well effluents must take into account effects on surface and subsurface waters, plants, fish, and wildlife, and their habitats, atmosphere, or any other effects which may cause or contribute to pollution, and such plans must be approved by the Supervisor before action is taken under them.

270.42 Noise Abatement.

The lessee shall minimize noise during exploration, development, and production activities. Welfare of the operating personnel and the public must not be affected as a consequence of the noise created by the expanding gases. The method and degree of noise abatement shall be as approved by the Supervisor.

270.43 Land Subsidence And Seismic Activity.

In the event subsidence or seismic activity results from the production of geothermal resources, as determined by monitoring activities by the lessee or a government body, the lessee shall take such action as required by the lease or by the Supervisor.

270.44 Pits And Sumps.

The lessee shall provide and use pits and sumps of adequate capacity and design to retain all materials and fluids necessary to drilling, production, or other operations unless otherwise specified by the Supervisor. In no event shall the contents of a pit or sump be allowed to:

(a) Contaminate streams, artificial canals or waterways, ground waters, lakes, or rivers;

(b) Adversely affect environment, persons, plants, fish and wildlife and their habitats; or

(c) Damage the aesthetic values of the property or adjacent properties. When no longer needed, pits and sumps are to be filled and covered and the premises restored to a near natural state, as prescribed by the Supervisor.

270.45 Well Abandonment.

The lessee shall promptly plug and abandon any well on the leased land that is not used or useful. No well shall be abandoned until its lack of capacity for further profitable production of geothermal resources has been demonstrated to the satisfaction of the Supervisor. Before abandoning a producible well, the lessee shall submit to the Supervisor a statement of reasons for abandonment and his detailed plans for carrying on the necessary work. The detailed plans shall provide for the preservation of fresh water aquifers and for the prevention of intrusion into such aquifers of saline or polluted waters. A producible well may be abandoned only after receipt of written approval by the Supervisor. No well shall be plugged and abandoned until the manner and method of plugging have been approved or prescribed by the Supervisor. Equipment shall be removed, and premises at the well site shall be restored as near as reasonably possible to its original condition immediately after plugging operations are completed on any well except as otherwise authorized by the Supervisor. Drilling equipment shall not be removed from any suspended drilling well without taking adequate measures to close the well and protect the subsurface resources.

270.48 Departure From Orders.

The Supervisor may prescribe or approve either in writing or orally, with prompt written confirmation, variances from the requirements of GRO orders and other orders issued pursuant to these regulations, when such variances are necessary for the proper control of a well, conservation of natural resources, protection of human health and safety, property, or the environment. The Supervisor shall inform appropriate Federal and State agencies, of any action taken under this section.

270.76 Annual Report Of Compliance With Environmental Protection Requirements.

The lessee shall submit annually a report giving a full account of the actions taken to comply with the appropriate Federal and State regulations or requirements of the Supervisor pertaining to the protection of the surface and subsurface environment. This report shall include but is not limited to such matters as:

(a) Noise abatement;
(b) Water quality;
(c) Air quality;
(d) Erosion control;
(e) Subsidence and seismic activity;
(f) Rehabilitation activities;
(g) Waste disposal; and
(h) Environmental effects on flora and fauna.

Part 3200 Of The Code Of Federal Regulations

3203.6 Plan Of Operation.

A lessee will be required to submit a plan of operation pursuant to 30 CFR 270.34, prior to entry upon the leased lands for any purpose other than casual use as that term is defined in 3209.0-5 (d) of this chapter. Operations will not be permitted on the lands until the plan of operation has been approved.

3204.1 General.

A lessee shall comply with and be bound by the following general terms and conditions, the specific requirements contained in the lease stipulations and any GRO orders that may be issued pursuant to 30 CFR 270.11. Assuring compliance with the requirements of this section is the responsibility of the Supervisor as to the lands within the area of operations and is the responsibility of the appropriate land management agency as to the remaining lands in the lease.

(b) Public Access.

(1) The lessee shall permit free and unrestricted public access to and upon the leased lands for all lawful and proper purposes

except in areas where such access would unduly interfere with operations under the lease or would constitute a hazard to health and safety. Restrictions on access will not be allowed without prior approval.

(2) During construction, the lessee shall regulate public access and vehicular traffic to protect the public, wildlife, and livestock from hazards associated with the project. For this purpose, the lessee shall provide warnings, fencing, flag men, barricades, and other safety measures as appropriate.

(c) Pollution Abatement. The lessee shall comply with all Federal and State standards and all applicable local standards with respect to the control of all forms of air, land, water, and noise pollution, including, but not limited to, the control of erosion and the disposal of liquid, solid, and gaseous wastes. The Supervisor may, in his discretion, establish additional and more stringent standards, and, if he does so, the lessee shall comply with those standards. The lessee, in addition to any other action required by those standards, shall take the following specific actions:

(1) Pesticides and Herbicides. The lessee shall comply with all rules issued by the Department of the Interior and the Environmental Protection Agency pertaining to the use of poisonous substances on public lands.

(2) Water Pollution. The lessee shall conduct lease operations and maintenance in accordance with Federal and State water quality standards and public health and safety standards, and applicable local water quality standards and public health and safety standards. Toxic materials shall not be released into any surface waters or underground waters. Reinjection of waste geothermal fluids into geothermal or other suitable aquifers will be permitted upon approval of the lessee's plan of operation submitted pursuant to 30 CFR 270.34.

(3) Air Pollution. The lessee shall control emissions from operations in accordance with Federal and State air quality standards, and applicable local air quality standards.

(4) Erosion Control. The lessee shall minimize disturbance to vegetation, drainage channels, and streambanks. The lessee shall employ such soil and resource conservation and protection measures on the leased lands as the Supervisor deems necessary.

(5) Noise Control. The lessee shall control noise emissions from operations, in accordance with Federal and State noise emission standards, and applicable local noise emmission standards.

(d) Sanitation and Waste Disposal. The lessee shall remove or dispose of all waste material generated in connection with the exploration,

development, production, and transportation operations in a manner set forth in the approved plan of operation submitted pursuant to 30 CFR 270.34.

(e) Land Subsidence, Seismic Activity. The lessee shall take precautions necessary to minimize land subsidence or seismic activity which could result from production of geothermal resources and the disposal of waste fluid where such activity could damage or curtail the use of the geothermal resources or other resources, or other uses of the land and take such measures as stipulated to:

(1) monitor operations for land subsidence and for seismic activity; and

(2) maintain, and when requested, make available to the lessor, records of all monitoring activities.

(f) Aesthetics. The lessee shall take aesthetics into account in the planning, design, and construction of facilities on the leased premises.

(g) Fish and Wildlife. The lessee shall employ such measures as are deemed necessary to protect fish and wildlife and their habitat.

(h) Antiquities and Historical Sites. The lessee shall conduct activities on discovered, known, or suspected archaeological, paleontological, or historical sites in accordance with lease terms or specific instructions.

(I) Restoration. The lessee shall provide for the restoration of all disturbed lands in an approved manner.

(j) The lessee shall submit annual reports to the authorized officer on compliance with the requirements of paragraphs (b)-(i) of this section and report within 24 hours, and if the report is oral, shall confirm the report in writing within 30 days, any significant environmental damage suffered by the lands subject to his lease. However, if, after drilling operations have begun, the lessee is required to submit a similar report under 30 CFR 270.30 and 270.76, he may fulfill the requirement of this subsection by submitting to the authorized officer a copy of that report.

3204.2 Waste Prevention.

All leases shall be subject to the condition that the lessee will, in conducting his exploration, development, and producing operations, use all reasonable precautions to prevent waste of geothermal resources and other natural resources found or developed in the leased lands.

Adverse environmental impacts from geothermal-related activity shall be prevented or mitigated through enforcement of applicable Federal, State, and local standards, and the application of existing technology. Inability to meet these environmental standards or continued violation of environmental standards due to operations of the lessee, after notification, may be construed as grounds for the Supervisor to order a suspension of operations.

The lessee shall be responsible for the monitoring of readily identifiable localized environmental impacts associated with specific activities that are under the control of the lessee. Monitoring of environmental impacts may be conducted by the use of aerial surveys, inspections, periodic samplings, continuous recordings, or by such other means or methods as required by the Supervisor. Due to the differing natural environmental conditions among geothermal areas, the extent and frequency of such monitoring activities will be determined by the Supervisor on an individual basis. In the event the Supervisor determines that the degree and adequacy of existing environmental protection regulations in certain areas are insufficient, the Supervisor may establish additional and more stringent requirements by the issuance of field orders or by modifying existing orders.

(1) Aesthetics. The lessee shall reduce visual impact, where feasible, by the careful selection of sites for operations and facilities on leased lands. The design and construction of facilities shall be conducted in a manner such that the facilities will blend into the natural environmental setting of the area by the appropriate use of landscaping, vegetation, compatible color schemes, and minimum profiles. Native plants or other compatible vegetation shall be used, where possible, for landscaping and revegetation.

(2) Land Use and Reclamation. Operating plans shall be designed so that operations will result in the least disturbance of land, water, and vegetation. Existing roads shall be used where suitable. Entry upon certain environmentally fragile land areas, as designated by the surface management agency, may be either seasonally restricted or restricted to special vehicles or transportation methods which will minimize disturbance to the surface or other resources as specified by the Supervisor and surface management agency.

Operating plans shall provide for the reclamation and revegetation of all disturbed lands in a manner approved by the Supervisor and

the appropriate surface management agency. Land reclamation may include preparation and seeding with prescribed wildlife food and plant cover or improved and acceptable substitutes thereof which will equal or enhance the food values for indigenous wildlife species and domesticated animals. Temporary fencing for such reclaimed areas may be required to facilitate restoration thereof.

The lessee shall at all times maintain the leased lands in a safe and orderly condition and shall perform the operations in a workmanlike manner. The lessee shall remove or store all supplies, equipment, and scrap in a timely and orderly fashion.

Operations under a geothermal lease shall not unreasonably interfere with or endanger operations under any other lease, license, claim, permit, or other authorized use on the same lands.

(3) Public Access. The public shall have free and unrestricted access to geothermal leased lands, excepting however, where restrictions are necessary to protect public health and safety or where such public access would unduly interfere with the lessee's operations or the security thereof. The lessee shall provide warning signs, fencing, flagmen, barricades or other safety measures deemed necessary by the Supervisor to protect the public, wildlife, and livestock from hazardous geothermal or related activities.

(4) Recreation. Recreational values shall be adequately protected through through planning and designing of site development to minimize the aesthetic degradation of the particular recreation area. The lessee shall generally be restricted from surface locations for drilling and other lease operations within 61 metres (200 ft) of established recreation sites and access routes thereto. However, the lessee may relocate a recreational site and/or access routes thereto when approved by the Supervisor with the concurrence of the land management agency.

(5) Slope Stability and Erosion Control. Operations shall be conducted in such a manner so as to minimize erosion and disturbance to natural drainage. The lessee shall provide adequate erosion and drainage control to prevent sediments from disurbed sites from entering water courses for soil and natural resource conservation protection.

Mitigating measures to lessen environmental damage may include reseeding of disturbed soils, chemical stabilization, and dust and erosion control on well sites, roads, and construction areas.

All operating plans shall give proper consideration to the potential hazards of slope instability. Where potentially unstable ground conditions exist, design of proposed roads, drill sites, and surface facilities shall be approved by and constructed under the supervision of a qualified engineer or engineering geologist satisfactory to the Supervisor.

(6) Biota. The lessee shall conduct all operations in such a manner as to afford reasonable protection of fish, wildlife, and natural habitat. The lessee shall take such measures as are necessary for the conservation of endangered and threatened species of flora and fauna as set forth in applicable executive orders, regulations, and State or Federal legislation such as the Endangered Species Act of 1973 and the Migratory Bird Act of 1966. When such species would be adversely affected by the lessee's operations on the leased lands, the lessee shall implement those measures necessary to minimize or eliminate such adverse effects and to protect the flora and fauna as specified by the Supervisor in accordance with recommendations by appropriate Federal and State Agencies. Such measures may be in addition to provisions set forth in the lease or accompanying stipulations.

(7) Cultural Resources Preservation. The lessee shall exercise due diligence in the conduct of his operations to protect and preserve significant archaeological, historical, cultural, paleontological, and unique geologic sites. The lessee shall not disturb any known cemetery or burial ground of any group or culture.

Previously unknown sites uncovered by the lessee shall be immediately reported to the Supervisor, and operations on the particular site shall cease until said site can be assessed for its archaeological value and preservation. Necessary controls and remedial actions for the protection and preservation of cultural resources shall be issued on an individual site basis by the Supervisor as warranted.

The preservation, restoration, maintenance, and nomination of all resources for purposes of the National Register of Historic Places shall be in accordance with the provisions of Executive Order 11593 (36 FR 8921) entitled, "Protection and Enhancement of the Cultural Environment," or any amendments thereto.

(8) Subsidence and Seismicity. Surveying of the land surface prior to and during geothermal resources production will be required for determining any changes in elevation of the leased lands. Lessee shall make such resurveys as required by the Supervisor to ascertain if subsidence is occuring. Production data, pressures, reinjection rates, and volumes shall be accurately recorded and filed monthly with the Supervisor as provided in 30 CFR 270.37. In the event subsidence activity results from the production of geothermal resources, as determined by surveys by the lessee or a governmental body, the lessee shall take such mitigating actions as are required by the lease terms and by the Supervisor.

If subsidence is determined by the Supervisor to present a significant hazard to operations or adjoining land use, then the Supervisor may require remedial action including, but not limited to, reduced production rates, increased injection of waste to other fluids, or a suspension of production.

(c) Reservoir Data. Initial reservoir pressure and temperature shall be reported to the Supervisor in duplicate on Well Completion or Recompletion Report (Form 9-330C) for all completed wells within 30 days after the completion of measurements or tests conducted for the purpose of obtaining such data. Initial production test data including steamwater ratio, surface pressure, and temperature, quality, and quantity of well effluent shall also be filed with the Supervisor on Form 9-330C within 30 days after a well is completed.

(d) Seismicity. The installation of seismographs or other like instruments in producing geothermal areas for the purpose of detecting potential seismic activity may be initiated from time to time by appropriate public agencies. Lessees shall cooperate with the appropriate public agencies in this regard. The lessee and the appropriate public agency should take care not to unreasonably interfere with or endanger each other's respective operations. The Supervisor shall coordinate such detection programs between the appropriate public agency conducting the program and the lessee.

Where induced seismicity caused by the production of geothermal fluids is determined to exist by the Supervisor, then the Supervisor may require the lessee to install such monitoring devices as necessary to adequately quanitify the effects thereof. If induced seismicity is determined to represent a significant hazard, the Supervisor may require remedial actions including, but not limited to, reduced production rates, increased injection of waste or other fluids, or suspension of production.

(9) Pollution, Waste Disposal, and Fire Prevention. The lessee shall comply with all applicable Federal and State standards with respect to the control of all forms of air, land, water, and noise pollution, including the control of erosion and the disposal of liquid, solid, and gaseous wastes. The Supervisor may, at his discretion, establish addition and more stringent standards. Plans for disposal of well effluents must be approved by the Supervisor before any implementation action is undertaken. Immediate corrective action shall be taken in all cases where pollution has occurred.

The lessee shall timely remove or dispose of all waste including human waste, trash, refuse, and extraction and processing waste generated in connection with the lessee's operations in a manner acceptable to the Supervisor.

The lessee shall provide safeguards to minimize potential accidental fires and shall instruct field personnel in fire-prevention methods. The lessee shall maintain firefighting equipment in working order at strategic locations on the leased lands.

(a) Pollution Prevention. In the conduct of all geothermal operations, the lessee shall not contaminate any natural waters and shall minimize adverse effects on the environment.

(1) Liquid Disposal. Liquid well effluent or the liquid residue thereof containing substances, including heat, which may be harmful or injurious and cannot otherwise be disposed of in conformance with Federal, State, and regional standards, shall be injected into the geothermal resources zone or such other formation as is approved by the Supervisor.

Toxic drilling fluids shall be disposed of in a manner approved by the Supervisor and in conformance with applicable Federal, State, and regional standards.

(2) Solid Waste Disposal. Drill cuttings, sand, precipitates, and other solids shall be disposed of as directed by the Supervisor either on location or at other approved disposal sites. Containers for mud additives for chemicals and other solid waste materials shall be disposed of in a manner and place approved by the Supervisor.

(3) Air Quality. Noncondensible gases such as carbon dioxide, ammonia, and hydrogen sulfide may be vented or ejected into the atmosphere, provided, however, that the volume and the measured concentration of such vented gas or gases shall not exceed applicable Federal, State, or regional air pollution standards. Copies of each permit issued by the appropriate air pollution control agency and the reports required thereunder shall be submitted to the Supervisor.

(4) Pits and Sumps. Pits and sumps shall be lined with impervious material and purged of environmentally harmful chemicals and precipitates before backfilling. In no event shall the contents of a pit or sump be allowed to contaminate streams, lakes, and ground waters. Pits and sumps shall be constructed in a manner and in such locations so as to minimize damage to the natural environment and aesthetic values of the lease or adjacent property. When no longer used or useful, pits and sumps shall be backfilled and the premises restored to as near a natural state as reasonably possible. Temporary fencing of unattended pits and sumps to protect wildlife, livestock, and the public may be required by the Supervisor and the surface management agency.

(5) Production Facilities Maintenance. Production facilities shall be operated and maintained at all times in a manner necessary to prevent pollution. The lessee's field personnel shall be instructed in the proper maintenance and operations of production facilities for the prevention of pollution.

(b) Inspection and Reports. Lessees shall comply with the following pollution inspection and reporting requirements.

(1) Pollution Inspections. Drilling and production facilities shall be inspected daily by the lessee. Appropriate preventative maintenance shall be performed as necessary to prevent failures and malfunctions which could lead to pollution. Wells and areas not under production shall be inspected by the lessee at intervals prescribed by the Supervisor. Necessary repairs or maintenance shall be made as required.

(2) Pollution Reports. All pollution incidents shall be reported orally within 18 hours to the appropriate Geothermal District Supervisor and shall be followed within 30 days thereof by a written report stating the cause and corrective action taken.

(10) Water Quality. The primary responsibility for water quality and pollution control has been delegated to the States where such have standards approved by the Environmental Protection Agency. Such State standards must meet basic Federal requirements prohibiting the deterioration of waters whose existing quality is higher than established water quality standards. The lessee shall comply with the State water quality control organization's standards in such States as have federally-approved standards. The Supervisor, at his discretion, may establish additional and more stringent standards.

The lessee shall file, in duplicate, a detailed water analysis report for all completed geothermal wells within 30 days after completion and annually thereafter or as otherwise specified by the Supervisor. Unless otherwise prescribed by the Supervisor, such analyses shall include a determination of arsenic, boron, radioactive content, and radioactivity of the produced fluids. In the event that a health hazard exists, the Supervisor shall require appropriate health and safety precautions, periodic monitoring, or the suspension of production.

(11) Noise Abatement. The lessee shall minimize noise during exploration, development, and production activities. The method and degree of noise abatement shall be as approved by the Supervisor.

The lessee shall conduct noise level measurements during exploration, development, and production operations to determine the potential objectionability to nearby residents as well as the potential health and safety danger due to noise emissions.

Noise level measurements and accompanying data shall be filed with the Supervisor. Such data shall provide the basis for operational and noise control decisions by the Supervisor and shall be based on an assessment of the noise relative to Federal or State criteria including adjustments for the area involved, meteorological conditions, and the time of day of the noise occurrence.

The lessee shall comply with Federal occupational noise exposure levels applicable to geothermal activity under the Occupational Safety and Health Act of 1970 as set forth in 29 CFR 1910.95, which are incorporated herein by reference, or with State standards for protection of personnel where such State standards are more restrictive than Federal standards.

SPECIAL STIPULATIONS

Lease stipulations 1, 2, and 3 are recommended to be included in all leases, and stipulations 4 and 5 are recommended to be included in those leases where they are relevant.

(1) Prior to any operations under this lease, the Lessee will engage a qualified archaeologist, acceptable to the Authorized Officer, to make an archaeological survey of the land to be disturbed or occupied. A certified statement, signed by the qualified archaeologist, setting out the steps taken in the survey and the findings thereof as to the existence of antiquities or other objects of historic or scientific interest, shall be submitted to the Authorized Officer. If the statement indicates the existence of such objects which might be disturbed by operations under this lease, the Lessee shall take such mitigating actions as may be required by the Authorized Officer, including archaeological salvage, or protective measures, or avoidance of the site, to protect and preserve such objects.

(2) The Lessee will apply to the Authorized Officer for a tramroad Right-of-Way Permit pursuant to 43 CFR 2811 over lands and roads owned or controlled by the BLM, for the purpose of obtaining access to the leased area.

(3) The Lessee shall contact the Authorized Officer and Supervisor prior to development of a plant of operation to be apprised of practices which should be followed or avoided in field development, including but not limited to such matters as road standards, road crossing, gates, cattleguards, fencing, erosion control, surface rehabilitation, reservoirs, wells, and springs.

(4) Operations within 600 feet of any surface waters, including but not limited to springs, streams, or seeps will be permitted only if specifically approved in writing by the Authorized Officer and the Supervisor.

(5) The Lessee shall not occupy or use the surface of designate area. The Lessee, however, is authorized to employ directional drilling to the geothermal resources provided that such drilling will not disturb the surface of the restricted land.

F. Residual Impacts

The residual impacts are similar to the anticipated impacts, except most of them are either eliminated or less severe. The impacts are caused by the increased number of people in the area and their various surface disturbing activities.

These residual impacts are both beneficial and adverse to:

1. wildlife and their habitat
2. soils
3. hydrology and geothermal resources
4. land use
5. air
6. vegetation
7. landscape
8. social welfare and the community
9. archaeology
10. and knowledge of most of the above resources.

G. Relationship Between Short-Term Use and Long-Term Productivity

The existing use of the land is for livestock grazing, mineral prospecting, wildlife, recreation, archaeological study, and watershed. The proposed action, geothermal leasing followed by development, may remove some of the land from production for some of the existing uses. Uses such as livestock grazing, may be able to co-exist with the geothermal activities, and may even have their productivity increased by the geothermal activities, such as increasing year-long water. Uses such as archaeological study may not be able to co-exist with the geothermal activities.

Geothermal development would utilize the geothermal resources to help meet out nation's growing energy needs. Geothermal leasing and development would commit the land and its resources for a period of 20 to 50 years. When the production capacity of the geothermal field is depleted, the leases would be terminated, the plant removed, and the land restored to near its original condition. The land could then be returned to near the original productivity for some uses.

H. Irreversible and Irretrievable Commitments

1. Removal of thermal energy and water from the geothermal field. These resources are renewable, but not within the life span of a specific project.

2. Compaction may result in land subsidence by the removal of geothermal fluids.

3. Roads and plant sites may not be returned to the original landscape.

4. The soil that is eroded cannot be returned to the original condition.

5. The plants and animals which would be removed may not be replaced by the same species.

6. Archaeological sites are a fragile resource. If disturbed or destroyed by the proposed action the scientific information in the specific site cannot be replaced.

I. Persons, Groups and Governmental Agencies Consulted

During October, 1975, letters were sent out to several persons and groups inviting comments on the Summer Lake Basin EAR. In addition, a statewide news release was issued in November for the same purpose.

Federal Agencies -

U.S. Geological Survey
Menlo Park, California

Fish & Wildlife Service
Division of River Basin Studies
Portland, Oregon

U.S. Forest Service
Portland, Oregon

Fremont Forest Supervisor
Lakeview, Oregon

Bonneville Power Administration
Portland, Oregon

Soil Conservation Service
Klamath Falls, Oregon

National Park Service
Seattle, Washington

Environmental Protection Agency
Seattle, Washington

Bureau of Land Management
Branch of Energy & Minerals
Denver, Colorado

Soil Conservation Service
Portland, Oregon

Winema Forest Supervisor
Klamath Falls, Oregon

U.S. Bureau of Reclamation
Klamath Falls, Oregon

Bureau of Reclamation
Boise, Idaho

State Agencies -

Department of Environmental Quality
Klamath Falls, Oregon

County Extension Service
Lakeview, Oregon

State Clearing House
Salem, Oregon

Oregon Dept. of Geology & Minerals
Portland, Oregon

Governor of Oregon
Salem, Oregon

Oregon Dept. of Fish and Wildlife
Portland, Oregon

Fish Commission of Oregon
Portland, Oregon

Department of Enviromental Quality
Portland, Oregon

State Engineer
Salem, Oregon

State Soil and Water Cons. Comm.
Salem, Oregon

State Water Resource Board
Salem, Oregon

Oregon Dept. of Fish and Wildlife
Hines, Oregon

Summer Lake Management Area
Summer Lake, Oregon

Division of State Land
Salem, Oregon

Assistant to the Governor
Salem, Oregon

Local Agencies -

Lake County Commissioners
Lakeview, Oregon

Lake County Planning Commission
Lakeview, Oregon

Lake County Chamber of Commerce
Lakeview, Oregon

Paisley Town Council
Paisley, Oregon

Groups and Individuals-

Oregon Environmental Council
Portland, Oregon

Oregon Wildlife Federation
Portland, Oregon

Wilderness Society
Denver, Colorado

Mt. Hood Forest Study Group
Portland, Oregon

Associated Students - Univ. of Oregon
Eugene, Oregon

Environmental Studies Center
University of Oregon
Eugene, Oregon

Dept. of Biology
Portland State University
Portland, Oregon

Oregon Student Public Interest Research Group
Portland, Oregon

Survival Center
Eugene, Oregon

Oregon High Desert Study Group
Eugene, Oregon

Wilderness Society
Eugene, Oregon

Oregon Museum of Natural History
Eugene, Oregon

P.U.R.E.
Bend, Oregon

Northwest Environmental Defense Center
Portland, Oregon

Sierra Club
Eugene, Oregon

Oregon Historical Society
Portland, Oregon

Audubon Society of Oregon
Portland, Oregon

Oregon Ecological Society
Portland, Oregon

Dept. of Fisheries & Wildlife
O.S.U.
Corvallis, Oregon

Isaak Walton League
Klamath Falls, Oregon

Dept. of Environmental Services
Portland General Electric
Portland, Oregon

Andy Kerr
Corvallis, Oregon

David Hatcher
Corvallis, Oregon

Sierra Club
Klamath Falls, Oregon

Oregon Institute of Technology
Klamath Falls, Oregon

Pacific Power and Light
Portland, Oregon

Steven deKeijker
Corvallis, Oregon

Peter K.Hubbard
Corvallis, Oregon

Mary Jane Newton
Bend, Oregon

Deanna Crispin
Pendleton, Oregon

J. Intensity of Public Interest

There is only minor public interest in geothermal development of the Summer Lake Basin. Most persons in the area don't known what development entails and have a wait-and-see attitude.

The local governments and informed public have a favorable attitude toward geothermal development, however, they are not optimistic that anything will happen in the near future.

The public input solicited by the B.L.M. prior to starting the E.A.R. indicates that most people are not concerned about geothermal leasing in the Summer Lake Basin. The few people that were concerned, were primarily concerned about the impact upon wildlife by geothermal development.

K. Participating Staff

This EAR was prepared by B.L.M. personnel in the Lakeview District with technical assistance and information supplied by the following:

Larry Bright - Oregon Department of Fish and Wildlife
David Cole - Univ. of Oregon Museum of National History
Duane Crane - U.S. Soil Conservation Service
Howard Daggett - Lake County Watermaster
Maitlan Goodman - Lake County School District 11 (Paisley)
Paul Hartwig - Oregon State Historic Preservation Office
William H. Lee - U.S. Geological Survey
Thomas Newman - Portland State University
Robert Percy - Oregon Dept. of Environmental Quality
William M. Riley - U.S. Geological Survey
Richard Thompson - B.L.M. Electronic Technician
C.E. Young - Paisley Mayor

The B.L.M. interdisciplinary team was as follows:

Christopher Broili - Geologist
William Cannon - Archaeologist
Edwin Depaoli - High Desert Area Manager
Larry Doughty - Wildlife Biologist
Marvin Hammersmark - Range/Watershed Specialist
Dennis Hill - Recreation Specialist
Melvin Schlagel - Realty Specialist

L. Summary Conclusion

It is unlikely that work beyond the exploration stage will occur on most of the area which has geothermal lease applications. Exploration has the least environmental impact of the stages of geothermal development. Therefore, most of the area will not have residual impacts, changes in short-term use or long-term productivity, or any irreversible and irretrievable commitment of resources. The public interest will likely only be aroused if activity beyond the exploration stage takes place.

The area in which geothermal development occurs will be removed from production for some resources for an indefinite period of time. This area will experience residual impacts, changes in short-term use and long-term productivity, irreversible and irretrievable commitment of resources, and an increase in public interest.

Should geothermal development take place, another environmental assessment will be needed to examine the impacts on the site of development.

APPENDIXES

half mile of the generation plant. The number of wells used to service a plant is dependent on the temperature of the wells (a temperature of 325-350 F at the generator is needed) and the characteristics of the geothermal reservoir. Generally, from 16 to 20 producing wells are used per power plant.

At Cerro Prieto, 18 wells (3 are standby) will service a 75 MW generating plant. They are drilled on a 10 acre spacing (one well per 10 acres). A 40 acre well spacing is being used at the Geysers initially, but future infill drilling to 20 acre spacing is planned in order to maintain steam production to plant capacity.

(3) Production Testing - To determine the sustained flow characteristics of a well, and to clean out the hole, each new well is vented to the atmosphere for a period of time. At the Geysers, enough experience has been gained as to the characteristics of the reservoir that this is no longer necessary there. Elsewhere it is an established practice.

Steam, water, and noise accompany production testing. The water is generally directed into the reserve pit and is contained. The steam is released into the atmosphere.

Noncondensible gases (carbon dioxide, methane, hydrogen, nitrogen, argon, carbon monoxide, hydrogen sulfide, radon, ammonia) and vapors (boric acid and mercury) are often contained in the steam. These vapors and gases make up generally less than 3% of the total steam fraction.

When present in excessive amounts, some of these gases and vapors are toxic.

Gas	Toxicity Levels
Ammonia	50 ppm
Boric acid	None established
Carbon dioxide	5,000 ppm
Carbon monoxide	100 ppm
Hydrogen sulfide	20 ppm
Mercury	12.2 ppb
Methane	10,000 ppm

Where present in unacceptable amounts, monitoring devices and special precautions may be necessary as a safety measure.

Additionally, very small amounts of hydrogen sulfide (as small as .025 ppm) can be detected by smell. This "rotten egg"

odor, common in hot spring areas, can be an aesthetic problem.

High noise levels accompany production testing. Because of this, muffling devices are generally installed. At the Geysers measurements of noise from a muffled testing well indicates a noise level slightly less than that of an unmuffled diesel truck.

Noise levels from other geothermal fields, both vapor dominated and water dominated, may not be a similar magnitude.

(4) Blowouts - In the four geothermal areas in the world (Geysers, USA; Lardarello, Italy; Wairakei, New Zealand; Cerro Prieto, Mexico) which have undergone commercial development, blowouts have occurred in approximately 1-3% of the wells drilled. These blowouts were mostly in the exploratory or early stages of development drilling, with few mishaps in later stages as experience was gained and local drilling techniques perfected. Although some of these blowouts were temporarily spectacular, none have resulted in any significant or lasting environmental damage.

At Lardarello, Italy, the oldest commercial geothermal field in the world, they are routinely handled as a noisy, difficult, part of regular operations. They are not considered as serious mishaps that could cause pollution or have other adverse effects.

(C) Geothermal Pipelines

Pipelines 10 to 30 inches in diameter will be used to transmit steam or hot water from the production wells to the power plants. The pipes are typically insulated with fiberglass or asbestos to minimize heat loss. Expansion loops or joints are placed at frequent intervals either vertically or horizontally to provide for the extreme expansion and contraction of the pipes upon production startup (heating up) and shutdown (cooling down).

Under present technology, pipelines are constructed above ground to provide for expansion and contraction and to enhance maintenance and detection of leaks. Underground installation is thus far uneconomical and may also present some safety hazards.

The lines form a radiating pattern on the surface, connecting wells with the power plant. They may be painted to blend with the surroundings.

(D) Plant Construction

Generating plants are centrally located to minimize the length of the steam or water pipes from the servicing wells. The largest plants in current use consist of two 55 MW generators housed together so that production is 110 MW per power plant. Power plant spacing is about one plant per 640 acres throughout the productive area.

At the Geysers, the average 110 MW plant building is about 100 x 200 feet and three stories high. The adjacent colling towers are about a third larger than the generating plant building. The entire generating plant cooling tower complex occupies an area of about five acres.

(E) Transmission Lines

Power generated from the plant is transmitted via conventional power lines to the area of use. The size and location of the lines is dependent upon the power output and destination.

The lines will tend to be large, considering that 1 MW of plant capacity will service the power needs of about 1,000 people. To express this another way, one 110 MW power plant could supply the power needs of the City of Reno.

(F) Rehabilitation

Rehabilitation will be possible on disturbed areas not needed for continued production, commensurate with terrain, climate and significance of the damage.

(1) Road Development - Roads needed for maintenance and further development will not be rehabilitated. Temporary roads and trails can be scarified and revegetated, if desirable.

(2) Drill Site Development - After well completion, an area approximately 30 ft. x 30 ft. directly surrounding the well head will be needed for operation. An additional graded area about 50 x 100 feet may be needed for moving in a drilling rig to correct any problems which may develop during production. The reserve pit (sump) is generally dried out, covered with dirt, and graded. It and the remaining area of the drill site can be rehabilitated and revegetated.

(3) Plant Construction - The area disturbed in constructing the generating plant and cooling towers can be rehabilitated and revegetated. The buildings may be painted to blend with the

surroundings. Some cooling towers are architecturally attractive and, if desired, may be intentionally painted to contrast with the surroundings to heighten the visual experience.

(4) Geothermal Pipelines - Geothermal pipelines may be painted to blend with the surroundings and any areas not needed for access may be revegetated. At Lardarello, Italy, steam lines cross grainfields and vineyards with essentially no loss of land productivity.

(5) Transmission Lines - Surface disturbance accompanying electrical transmission line construction may be rehabilitated with the exception of needed maintenance roads.

OPERATION

The operation phase starts upon reaching commercial power production. Exploration and development are typically carried on in other parts of the geothermal field simultaneously with the operational activities.

The operation stage may be divided into the following discrete operations:

(A) New drill sites
(B) Maintenance
(C) Waste disposal
(D) Production

(A) New Drill Sites

Geothermal fields are long lived resources. The Lardarello field has been in production since 1904 and the Geysers since 1958. The Geysers is estimated to have a minimum productive life of 30 more years. Nonetheless, production slowly diminishes the heat flow and additional wells must be drilled and completed to keep the generating plant operating at full capacity.

Additional wells may also be required to replace wells that have become inoperative and, if the waste waters are disposed of by injection, injection wells may be drilled.

The technique and effect of these wells would be the same as for development wells. On a major producing field, it can be expected that one or two drilling rigs would be operating continuously throughout the life of the field drilling additional or replacement wells.

(B) Maintenance

Repair, maintenance, and monitoring of an operating field will require the periodic use of access roads to service the equipment. Existing wells will require occasional repair work or cleanout. The amount of this remedial work will depend upon the production characteristics of the field; severe scaling and corrosion would require frequent remedial work. Normally one medium-sized drill rig would be required full-time for each 20-30 wells (one 110 MW power plant).

(C) Waste Disposal

The work force (both construction and maintenance) for geothermal power plants will usually be housed in the nearest town rather

than creating a new town at the site. Thus, waste materials connected with human habitation will typically be handled in the local community.

At the plant site itself, sanitary facilities for workers will be provided. Solid wastes will either be disposed of in a dump developed at the site or trucked to the nearest established dump site.

The most significant waste disposal problem relates to handling the excess geothermal fluids. In vapor dominated systems, as at the Geysers, about 75-80% of the water from the spent steam is consumed in the cooling towers, leaving 20-25% to be disposed of. In water dominated systems, such as Cerro Prieto, the reverse is true with 80% or more of the total well production requiring disposal.

Disposal techniques vary, depending on the quality and quantities involved. Any or a combination of the following techniques may be employed:

(1) Evaporation ponds - Waste water at Cerro Prieto is piped to evaporation ponds. Where water quality is satisfactory, such ponds may provide new aquatic habitat. Where water quality is toxic, special measures may be required to protect the ground-water supply, livestock, and wildlife.

(2) Natural drainage systems - At Wairakei, New Zealand, waste water is discharged into a large river. High quality water disposed of in this manner provides additional resources for agriculture, wildlife and other uses. Low quality water may require extensive treatment before it is suitable for release into natural drainages.

(3) By-product development - In some instances it may be economical to extract useful minerals or gases from the geothermal fluids. This could result in increasing the waste water quality so as to make it available for other purposes. Desalinization may also be feasible in some areas, providing by-product fresh water for other uses.

(4) Re-injection - At the Geysers, excess water is re-injected into nonproductive zones of the geothermal field. Successful re-injection is dependent on the quality of the waste water and the geologic characteristics of the geothermal field. Typical considerations would include: whether plugging and scaling problems will prevent the reservoir from accepting the fluid; whether fresh water aquifers can be adequately protected from contamination by hot saline waste water; and whether the subsurface rock structure will adequately hold the re-injected fluids.

(D) Production

Production from a geothermal field will generally require 2-5 people per plant to inspect, adjust and service the wells, making the rounds about once each day on the existing road network.

Sustained production will have several effects:

(1) Temperature drop - The field will gradually realize diminishing temperatures as the energy is utilized.

(2) Water utilization - Cooling towers will consume about 40-45 acre feet of water per year for each megawatt of plant capacity. Each 110 MW plant would thus consume about 5,000 acre feet of water per year. The water may come either from steam condensate, waste geothermal water, or from any other water source. This water consumption might be reduced by use of some technique other than conventional cooling towers. One such scheme, called the "night stream cooling system" would theoretically use only 42% as much water.

(3) Subsidence - As large volumes of water are pumped from a geothermal reservoir, some subsidence of the ground surface may occur. In many cases subsidence may have no serious land use or environmental consequences. In some situations, such as developed agricultural land under gravity irrigation, minor surface subsidence could have a significant impact. Continuous monitoring might be necessary to detect whether subsidence was occurring. In some instances, re-injection of the waste water might correct subsidence problems.

(4) Seismic activity - Geothermal areas are typically associated with seismic activity. Such activity is generally of small magnitude (usually less than 4.5 on the Richter scale). Fluid pressure changes from both production and re-injection may tend to increase earthquake frequency, though the relationship is not well known. To date, such earthquakes have been small and there is some evidence to suggest that this minor seismic activity tends to relieve regional stresses and diminishes the likelihood of large earthquakes. Earthquakes sometimes modify geyser activity and may effect other geothermal features such as hot springs.

CLOSE-OUT

Close-out or final abandonment takes place when energy production ceases to be economic. To date, no developed geothermal field has reached this stage. In a sense, geothermal reservoirs may be somewhat renewable resources in that after a long period of rest, the fluids may become reheated to temperatures that are again useable.

Two discrete operations are expected to take place during close-out:

(A) Removal of improvements
(B) Restoration of surface

(A) Removal of Improvements

The removal of improvements from a geothermal field involves:

(1) Surface improvements - Removal of all structures constructed during field development and operations will be accomplished. Solid waste remaining may either be disposed of in a dump developed at the site or trucked to the nearest established dump.

(2) Wells - The bottom of the hole is plugged with cement and the surface casing will also be plugged with about 20 feet of cement. The casing will be cut off below the surface and a steel plate welded over the hole. A vertical steep pipe and marker will be welded to the plate. The concrete lined excavation surrounding the hole (called the "cellar") will be pushed in and the location may be graded and revegetated. The marker will remain above ground to provide identification.

(3) Transmission lines - Any of the electrical transmission lines no longer in use will be removed.

(B) Restoration of the Surface

Surface restoration will typically be a gradual process, taking place throughout the life of the field and culminating with the final abandonment. Access roads can be ripped up, landscaped and revegetated. Power lines can be landscaped and revegetated. Well and plant locations can similarly be treated but, because of their large size, complete landscaping to approximate the original surface in steep terrain will not be feasible except in unusual circumstances.

Environmental Controls

Geothermal energy development is subject to a wide variety of environmental controls under the authorities of two agencies--Geological Survey and BLM. Such environmental controls are covered in the regulations of both agencies (GS - 30 CFR 270; BLM - 43 CFR 3200) and are part of the exploration form (3200-9) and lease form (3200-21). Additional controls in the form of special stipulations, geothermal resources operational orders (GRO orders), and approved operational plans may also be used. Bonding is required to assure compliance.

Basically, the two agencies consult throughout the leasing program and agree on any needed special stipulations. For all actions up to and including issuance of a lease, the BLM is the responsible agency. For all operational activities undertaken after a lease has been issued, the Geological Survey is the responsible agency.

Opportunities to attach special environmental controls occur at several points:

(A) Notice of Intent To Conduct Geothermal Resource Explorations - (Form 3200-9) - This form is filed for exploration activities not connected with a lease. The BLM District Manager has 30 days to either approve or disapprove the permit. Special stipulations may be added if needed. The Geological Survey will advise of any recommended stipulations to protect subsurface resource values. A $5,000 compliance bond is required.

(B) Proposed Plan - Prior to the issuance of a lease, the applicant must file a proposed plant detailing his proposed methods for diligent exploration. Environmental protection measures proposed are included. The proposed plan may alert the District Manager to special problems that should be covered by special stipulations in the lease. The Geological Survey will also review these plans and may furnish additional comments or information which may be useful for environmental considerations.

However, these proposed plans are filed so early in the process that they will generally be based on little knowledge of the available geothermal resource and, hence, will usually undergo major changes as new exploration data is gathered. They will tend to be written in broad general terms commensurate with the limited data available. Therefore, they cannot be entirely relied upon in anticipating environmental effects.

The chief value of the proposed plan is to commit the applicant to a program of diligent exploration. Reliable environmental judgements can be made later when an actual plan of operation is filed.

(C) Leases - Lessees are committed to a variety of environmental controls by regulation and the standard lease (Form 3200-21) contains stipulations on protection of the environment and antiquities.

Additionally, special stipulations may be added if necessary. The Geological Survey will provide advice as to recommended special stipulations to protect the subsurface environment and as to the effect of any proposed BLM special stipulations on geothermal development.

Two bonds are required: a $10,000 bond to insure lease compliance, and a $5,000 bond to indemnify any damages to persons or property. A $150,000 nationwide bond or $50,000 Statewide bond may be substituted.

(D) Geothermal Resources Operational Order (GRO Order) - The Geological issues GRO orders which set forth the requirements and procedures to be followed within a particular region or area. This allows flexibility to address conditions which vary widely from area to area. The BLM District will be consulted by Geological Survey to develop any needed surface resource protection requirements.

(E) Plan of Operation - Before any operations may commence on a lease, the lessee must submit a detailed plan of operation and gain approval of it. Both the Geological Survey and the BLM must approve it.

In practice, these plans will tend to be incremental with new phases of the plan based on information gained in the preceding phase. They will be detailed enough to allow a sound environmental assessment prior to approval.

Energy Considerations

U.S. energy demand is expected to continue increasing at a rate of 3-5% per year. To keep pace, we shall either have to import more fuel (imports are currently about 4%) or develop more domestic sources. Former President Nixon stated that our policy goal is to become independent in energy resources by 1980.

All forms of energy supplement one another in the total energy picture. Should geothermal energy be used to produce electricity, other forms of energy (coal, oil, gas) would be freed for use elsewhere.

Estimates of our geothermal potential vary widely but suggest that by the year 2000 such energy may supply 5-14% of our use. This is a signicant amount considering that hydroelectric power currently supplies only about 5% of the total.

Geothermal energy offers less environmental impact than conventional energy sources. Essentially all of the impact, with the exception of power lines, is confined to a small site. Other power forms have multiple impacts: power dams flood large acreages; coal, oil, gas, and nuclear sources are mined in one place, transported to another place where power is generated and then transmitted via power lines to the area of use.

In the short range, geothermal sources stand a far better likelihood of substantial contributions to the energy pool than do such exotic sources as solar energy, breeder and fusion reactors, fuel cells, etc.

Economic Considerations

There are several ways to view the economic implications of geothermal development:

(A) Direct revenues
(B) Indirect revenues
(C) Direct expenditures
(D) Indirect expenditures

(A) Direct Revenues

Lease rentals and royalties are distributed as follows:

95% - U.S. Government
5% - State Governments

(1) Rentals - Each lease brings in $1/acre per year annual rental (minimum) which increases on a graduated basis after the fifth year. Advance rentals filed during the first three months of filing in Nevada total 1.7 million dollars.

(2) Royalties - When production is reached, royalties of 10-15% of the value of the steam are assessed. Royalties up to 5% are also paid on by-product minerals, including commercial demineralized water.

At the Geysers, a royalty of 10% of the steam value is paid to private landowners. The royalty averages about $250,000 per year per 100 MW plant. With 400 MW capacity, the royalty is about 1 million dollars per year from a production area about two miles wide by seven miles long.

(3) Bonus Bids - On competitive lease sales, bonus bids are an additional source of revenue. In the first federal lease sale held in California on January 22, 1974, twenty leasing units were bid on with 57 bids totalling $12-½ million. The highest bid for a single leasing unit was $3,200,000, which amounts to $1,367.50 per acre for the 2,340 acre unit.

(B) Indirect Revenues

Taxation by State and local subdivisions accounts for an additional increment of revenue. Taxes paid to Sonoma Co. from the Geysers approximate $1 million per year for the current 400 MW capacity.

Dr. Robert W. Rex, President of Republic Geothermal Inc., in remarks to the Sub-Committee on Energy, Committee on Science and Astronautics, U.S. House of Reporesentatives, on September 18, 1973, said in part "...Every 1000 megawatts of geothermal development on Federal lands yield about $1 billion of public revenue; 73% to the Federal government, 11% to State governments which have income taxes...and 18% to County governments.

(C) Direct Expenditures

Development of a 110 MW plant costs $15-17.5 million at the Geysers. Individual wells cost about $150,000-$200,000 each.

(D) Indirect Expenditures

The local business community will be affected by geothermal development, both by increased business and by having to provide additional services.

During exploration drilling, two drilling rigs might be used for 1-2 years. Employees would consist of about 40 people directly involved in drilling, with 10-20 additional service people intermittently involved.

Development would advance in 55-110 MW increments in an orderly fashion over a period of 2-10 years. Drill crews for 2-3 rigs would number 40-60, and 20-30 additional people would be involved in plant construction. All of the above personnel would be temporary.

Once the field is operating on stream, about five (5) permanent employees are needed for field production plus five (5) more for each 110 MW plant. One drilling rig would be needed full time, adding 20 more permanent employees to the area.

Thus, for several years, a local community would be burdened with providing necessary school and service facilities for between 40 and 90 additional temporary families. Thereafter, 30 or more families would become permanent residents, also requiring services.

In the short run, communities near a geothermal development would be financially strained. However, such development is capital intensive and in a few years the increased tax base should be much greater than community expenditure on a per capita basis of a dditional residents.

Other Considerations

This technical report is addressed principally to electrical power generation from vapor dominated and hot water geothermal systems. There

are other uses and other geothermal systems that might be involved.

(A) Uses - The heat from geothermal fields may be used for space heating, greenhouse heating, vegetable dehydration and a myraid of other uses for which a heat source is required. Water also might be used for a variety of purposes. The impacts of these uses would be less than the impacts of power generation.

(B) Systems - The hot water and steam systems offer the best chance of commercial use in the near future. For long range consideration two other systems may, with developing technology, become useful.

(1) Hot Dry Rock Systems - Basically similar in origin to the water or steam systems, but lack water to form a convection cell. Such areas may be susceptible to fracturing and introduction of water to develop steam for power generation. Exploration of what is believed to be a hot dry rock geothermal area is currently being carried out on National Resource lands near Marysville, Montana by Battelle Northwest Institute under a National Science Foundation grant.

(2) Geopressurized Reservoir Systems - Consist of hot brines under great pressure in marine sediments along the Gulf Coast. They are thought to represent an accumulation of heat due to the normal heat flow being trapped by an insulating layer of undercompacted clay. The resource is large, but years will be required to develop the technology for commercial use.

Stipulations

To be effective, stipulations must be feasible, understandable, germane (related to a specific problem), not redundant, and enforceable.

(A) General Stipulations - The regulations and the standard lease form contain stipulations that cover most general environmental problems. They require among other things, that the lessee shall comply with all Federal and State pollution standards (air, land, water, and noise) and that the lessee shall take all mitigating actions required by the lessor to protect the environment and to restore any lands affected by the operation.

(B) Special Lease Stipulations - Care must be taken to avoid using special stipulations that reiterate general stipulations already covered. Special stipulations should relate to specific lease conditions that will have a significant operational or economic impact on the lessee. Generally, these will involve:

(1) Restrictions on surface occupancy.

(2) Restrictions on time of year when operations will be permitted.

More detailed stipulations can best be developed during the operational stage.

(C) Plan of Operation Stipulations - Detailed stipulations such as erosion control, road and drill site locations and standards, surface facilities, restoration requirements, etc. are developed when the plan of operation is being reviewed. The plan provides the detailed information on operations, location, and methods, that allows the development of specific, enforceable stipulations tailored to that plan.

(D) Technical Problems With Stipulations - Some stipulations that would appear to provide improved surface protection may face economic or technical restrictions that are not initially apparent.

For example, directional drilling would lessen surface damage. However, it can add from $20,000 to $100,000 extra cost per hole (depending on the angle). Also, directional work in hot holes presents special problems in getting surveys to accurately locate the bottom of the hole as most survey systems involve photographic film which is severely affected by the heat.

In addition, directional drilling may pose a significantly greater safety hazard. The extreme temperature differences from drilling to producing conditions (often 400° F or more) may create unsafe stress on casing. Stuck drill pipe is much more common in directional

drilling. In hot holes, the greatest danger of blowouts occurs when mud temperatures exceed the boiling point-depth curve. Any excess down time without circulation, such as a stuck drill pipe, greatly increases the chances of a serious blowout due to the mud boiling off and blowing out of the hole.

Developing stipulations with technologic or economic implications must be closely coordinated with the Geological Survey to assure that such stipulations are sound.

Acknowledgments

Most of this report was prepared by:

Robert T. Webb
Supervisory Mining Engineer
Nevada State Office
Bureau of Land Management

With the assistance and suggestions of:

Dennis Simontacchi
Geothermal Specialist
Winnemucca District, BLM

L. Vernon Stephens
Geologist
Conservation Division, U.S. Geological Survey

Orrin Gilbert
Assistant Geothermal Engineer
Conservation Division, U.S. Geological Survey

Bruce Hellier
District Geothermal Engineer
Conservation Division, U. S. Geological Survey

Hillary A. Oden
Acting Geothermal Supervisor
Conservation Division, U.S. Geological Survey

September 3, 1974
Date

Christopher J. Broili
Christopher J. Broili
Geologist
Lakeview District Office
Bureau of Land Management

APPENDIX II

Animals of Probable Occurrence Within the Summer Lake Basin E.A.R. Area

Fish

Chewaucan River

Rainbow trout - *Salmo gairdneri*
Brook trout - *Salvelinus fontinalis*
Brown trout - *Salmo trutta*
Speckled dace - *Rhinichthys osculus*
Brown bullhead - *Ictalurus nebulosus*
Tui chub - *Gila bicolor*

Ana River

California rainbow trout - *Salmo gairdneri*
Tui chub - *Gila bicolor*

Amphibians

Order - Anura

Great Basin spadefoot toad - *Scaphiopus intermontanus*
Western toad - *Bufo boreas*
Pacific treefrog - *Hyla regilla*
Leopard frog - *Rana pipiens*
Spotted frog - *R. pretiosa*

Reptiles

Order - Squamata

Short-horned lizard - *Phrynosoma douglassi*
Desert horned lizard - *P. platyrhinos*
Great Basin skink - *Eumeces skiltonianus utahensis*
Great Basin whiptail - *Cnemidophorus tigris tigris*
Collared lizard - *Crotaphytus collaris*
Leopard lizard - *C. wislizenii*
Sagebrush lizard - *Sceloporus graciosus*
Western fence lizard - *Sceloporus occidentalis*
Side-blotched lizard - *Uta stansburiana*
Rubber boa - *Charina bottae*
Racer - *Coluber constrictor*
Striped whipsnake - *Masticophis taeniatus*
Western ground snake - *Sonora semiannulata*
Gopher snake - *Pituophis melanoleucus*

Common garter snake - Thamnophis sirtalis
Western terrestrial garter snake - T. elegans
Night snake - Hypsiglena torquata
Western rattlesnake - Crotalus viridus

Mammals

Order - Insectivora

Water shrew - Sorex palustris
Merriam's shrew - S. merriami
Vagrant shrew - S. vagrans
Trowbridge's shrew - S. trowbridgii
Broad-handed mole - Scapanus latimanus

Order - Chiroptera

Townsend's big-eared bat - Plecotus townsendii
Pallid bat - Antrozous pallidus
Silver-haired bat - Lasionycteris noctivagans
Hoary bat - Nycteris cinereus
Big brown bat - Eptesicus fuscus
Fringed myotis - Myotis thysanodes
Long-eared myotis - M. evotis
Long-legged myotis - M. volans
California myotis - M. californicus
Small-footed myotis - M. subulatus
Yuma myotis - M. yumanensis
Little brown myotis - M. lucifugus

Order - Lagomorpha

Pygmy rabbit - Sylvilagus idahoensis
Nuttall's cottontail - S. nuttallii
Snowshoe rabbit - Lepus americanus
White-tailed jackrabbit - L. townsendii
Black-tailed jackrabbit - L. californicus

Order - Rodentia

California ground squirrel - Spermophilus beecheyi
Townsend's ground squirrel - S. townsendii
Belding's (Oregon) ground squirrel - S. beldingi
White-tailed antelope squirrel - Ammospermophilus leucurus
Golden-mantled ground squirrel - Spermophilus lateralis
Least chipmunk - Eutamias minimus
Yellow-pine chipmunk - E. amoenus
Porcupine - Erethizon dorsatum
Beaver - Castor canadensis
Yellow-bellied marmot - Marmota flaviventris

Townsend's pocket gopher - Thomomys townsendii
Northern pocket gopher - T. talpoides
Great Basin pocket mouse - Perognathus parvus
Ord's kangaroo rat - Dipodomys ordii
Chisel-toothed kangaroo rat - D. microps
Dark kangaroo mouse - Microdipodops megacephalus
Western harvest mouse - Reithrodontomys megalotis
Northern grasshopper mouse - Onychomys leucogaster
Bushy-tailed wood rat - Neotoma cinerea
Desert wood rat - N. lepida
Canyon mouse - Peromyscus crinitus
Pinyon mouse - P. truei
Deer mouse - P. maniculatus
Sagebrush vole - Lagurus curtatus
Long-tailed vole - Microtus longicaudus
Montane vole - M. montanus
Muskrat - Ondatra zibethicus
House mouse - Mus musculus
Norway rat - Rattus norvegicus
Western jumping mouse - Zapus princeps

Order - Carnivora

Bobcat - Lynx rufus
Mountain lion - Felis concolor
Coyote - Canis latrans
Kit fox - Vulpes macrotis (very rare if present)
Raccoon - Procyon lotor
Spotted skunk - Spilogale putorius
Striped Skunk - Mephitis mephitis
Mink - Mustela vison
Badger - Taxidea taxis
Long-tailed weasel - Mustela frenata

Order - Artiodactyia

Pronghorn - Antilocapra americana
Rocky Mountain mule deer - Odocoileus hemionus hemionus

Birds

	Sp	S	F	W	N
LOONS, GREBES					
Common Loon	u	u	u		
Horned Grebe	u	u	u		
Eared Grebe	c	c	c	u	*
Western Grebe	c	c	c		*
Pied-billed Grebe	c	c	c	u	*
PELICANS, CORMORANTS					
White Pelican	c	c	u		*
Double-crested Cormorant	u	r	u		
HERONS, BITTERNS, IBIS					
Great Blue Heron	c	c	c	c	*
Green Heron	u				
Common Egret	u		u		
Snowy Egret	u	u			
Black-crowned Night Heron	c	c	c	u	*
American Bittern	c	c	c	u	*
Least Bittern			u		
White-faced Ibis	r	r	r		*
SWANS, GEESE, DUCKS					
Whistling Swan	c		c	a	
Canada Goose	c	c	c	c	*
Cackling Canada	u		u	u	
Lesser Canada			r		
White-fronted Goose	u		u		
Snow Goose	a		a		
Blue Goose	u		u		
Ross' Goose	u		u		
Mallard	c	c	c	c	*
Gadwall	c	c	c	c	*
Pintail	c	c	c	c	*

SYMBOLS:

Sp - March-May
S - June - August
F - September-November
W - December-February
N - Nests locally*
a - abundant
c - common
u - uncommon
r - rare
o - occassional

This list was developed from checklists published by the Oregon Dept. of Fish & Wildlife for Summer Lake Wildlife Area, and U. S. Fish and Wildlife Service for Hart Mountain National Antelope Refuge

	Sp	S	F	W	N
Green-winged Teal	c	c	c	c	*
Blue-winged Teal	u	u	u		*
Cinnamon Teal	a	a	u		*
European Widgeon	r		r		
American Widgeon	a	c	c	c	*
Shoveler	c	c	c	c	*
Wood Duck	r		r		
Redhead	c	c	c	u	*
Ring-necked Duck	u		u		
Canvasback	c	u	c	u	*
Greater Scaup	r		r		
Lesser Scaup	r	r	c		*
Common Goldeneye	c		c		
Barrow's Goldeneye	u		u		
Bufflehead	c		c	c	
Oldsquaw	u		u		
White-winged Scoter			r		
Surf Scoter			r		
Common Scoter			r		
Ruddy Duck	c	c	u		*
Hooded Merganser	u		u		
Common Merganser	u	u	u	u	
VULTURES, HAWKS, EAGLES					
Turkey Vulture	c	c	c		
Goshawk	u	u	u	u	
Sharp-shinned Hawk	u	u	u	u	
Cooper's Hawk	u	u	u	u	
Red-tailed Hawk	c	c	u	u	
Swainson's Hawk	c	c	u	u	*
Rough-legged Hawk	u	u	u	c	*
Ferruginous Hawk	u	u	u		
Golden Eagle	u	u	u	u	
Bald Eagle (Northern)	u	u	u	u	
Marsh Hawk	a	a	a	c	*
Osprey	r	r	r		
Prairie Falcon	u	u	u	u	
Peregrine Falcon	r	r	r	r	
Sparrow Hawk	u	u	u	u	*
GROUSE, QUAIL, PHEASANT					
Sage Grouse	u	u	u	u	*
California Quail	a	a	a	a	*
Ring-necked Pheasant	c	c	c	c	*
Chukar Partridge	u	u	u	u	
Turkey				r	
Mountain Quail	o	o	o	o	

	Sp	S	F	W	N
CRANES, RAILS, COOTS					
Sandhill Crane	c	c	c		*
Virginia Rail	c	c	c	u	*
Sora Rail	r	r	r		
American Coot	c	c	a	u	*
SHORE BIRDS					
Snowy Plover	c	c			*
Killdeer	a	a	a	u	*
Common Snipe	c	c	c		*
Long-billed Curlew	c	c	c		*
Spotted Sandpiper	u	u	u		
Solitary Sandpiper	u		u		
Western Willet	u	u	u		*
Greater Yellowlegs	u		u		
Pectoral Sandpiper	u		u		
Least Sandpiper	c		c		
Red-backed Sandpiper	u		u		
Long-billed Dowitcher	c		c		
Western Sandpiper	c		c		
American Avocet	a	a	a		*
Black-necked Stilt	c	c	u		*
Marbled Godwit	r		r		
Wilson's Phalarope	c	c	u		*
Northern Phalarope	u		u		
GULLS, TERNS					
California Gull	a	a	c		*
Ring-billed Gull	a	a	c		*
Bonaparte's Gull	u		u		
Forster's Tern	a	a	c		*
Caspian Tern	u	u	u		*
Black Tern	c	c	u		*

	Sp	S	F	W	N
PIGEONS, DOVES					
Band-tailed Pigeon	r				
Mourning Dove	a	c	a	u	o
OWLS					
Barn Owl	u	u	u	u	*
Great Horned Owl	c	c	c	c	*
Burrowing Owl	u	u			
Long-eared Owl	u	u	u		*
Short-eared Owl	c	c	c		*
Saw-whet Owl	o	o	o	o	
Pygmy Owl	o	o	o	o	*
GOATSUCKERS					
Poor-will	o	c	c		
Common Nighthawk	o	c	c		*
SWIFTS					
Black Swift	o	o	o		
White-throated Swift	o	o	o		*
HUMMINGBIRDS					
Black-chinned Hummingbird	o	u	u		
Broad-tailed Hummingbird	o	o	o		
Rufous Hummingbird	o	u	u		
Calliope Hummingbird	o	u	u		
KINGFISHERS					
Belted Kingfisher	u	u	u	u	
WOODPECKERS					
Yellow-shafted Flicker	r	r			
Red-shafted Flicker	u	c	c	u	*
Pileated Woodpecker		o	o		
Lewis' Woodpecker	o	u	u		
Yellow-bellied Sapsucker		u	u		
Williamson's Sapsucker		u	u		
Hairy Woodpecker		u	u		
Downy Woodpecker		o	o		

	Sp	S	F	W	N
White-headed Woodpecker		o	o		
FLYCATCHERS					
Eastern Kingbird		o	o		
Western Kingbird	u	c	c		*
Ash-throated Flycatcher	u	c	c		
Say's Phoebe	u	c	c		*
Traill's Flycatcher		u	u		
Hammond's Flycatcher		c	c		
Dusky Flycatcher		c	c		
Gray Flycatcher		u	u		
Western Flycatcher		u	u		
Olive-sided Flycatcher		c	c		
Western Wood Pewee		c	c		
LARKS					
Horned Lark	a	a	a	a	*
SWALLOWS					
Violet-green Swallow	u	u	u		*
Tree Swallow		u	u		*
Roughwinged Swallow	o	o			
Barn Swallow	u	c	c		*
Cliff Swallow	a	a	c		*
Bank Swallow	u	u			*
CROWS, JAYS					
Gray Jay		u	u		
Steller's Jay	o	u	u	o	
Scrub Jay		u	u		
Black-billed Magpie	c	c	c	c	*
Common Raven	c	c	c	c	*
Common Crow	u	c	c	o	
Pinon Jay	o	o	o		
Clark's Nutcracker		u	u		
CHICKADEES					
Black-capped Chickadee		c	c		
Mountain Chickadee		c	c		
Bushtit		u	u		

	Sp	S	F	W	N
NUTHATCH					
White-breasted Nuthatch		c	c		
Red-breated Nuthatch		u	u		
Pygmy Nuthatch		u	u		
CREEPERS					
Brown Creeper		u	u		
DIPPER					
Dipper		o	o		
WRENS					
House Wren		u	u		
Winter Wren		u	u		
Long-billed Marsh Wren	u	c	c		*
Canon Wren		c	c		
Rock Wren	c	c	c	c	*
THRASHERS					
Sage Thrasher	o	u	u		*
Brown Thrasher			r		
THRUSHES					
Robin	c	c	c	c	*
Varied Thrush		u	u		
Hermit Thrush		u	u		
Veery		u	u		
Western Bluebird		o	o		
Mountain Bluebird		c	c	o	
Townsend's Solitaire		c	c		
KINGLETS					
Golden-crowned Kinglet		c	c		
Ruby-crowned Kinglet		c	c		
PIPIT					
Water Pipit		u	u		

	Sp	S	F	W	N
WAXWINGS					
Bohemian Waxwing				o	
Cedar Waxwing		u	u		
SHRIKES					
Northern Shrike				o	
Loggerhead Shrike	c	c	c	c	*
STARLING					
Starling	c	c	c	c	*
VIREOS					
Solitary Vireo		u	u		
Warbling Vireo		u	u		
WARBLERS					
Myrtle Warbler	u		u		
Orange-crowned Warbler		u	u		
Nashville Warbler		u	u		
Yellow Warbler		u	u		
Audubon's Warbler	u	u	u		
Black-throated Gray Warbler		u	u		
Townsend's Warbler		u	u		
Hermit Warbler		o	o		
Macgillivray's Warbler		u	u		
Yellowthroat		u	u		
Yellow-breasted Chat		c	c		
Wilson's Warbler		u	u		
American Redstart	u	u	u		
WEAVER FINCH					
House Sparrow	c	c	c	c	*
MEADOWLARK, BLACKBIRDS, ORIOLES					
Western Meadowlark	c	c	c	c	*
Yellow-headed Blackbird	u	c	c		*
Redwinged Blackbird	u	c	c		
Bullock's Oriole		c	c		*
Brewer's Blackbird	u	c	c		*
Brown-headed Cowbird	u	c	c		*
Tricolored Blackbird	u	u			

	Sp	S	F	W	N
TANAGER					
Western Tanager	u	c	c		
GROSBEAKS, SPARROWS, FINCHES					
Black-headed Grosbeak		u	u		
Lozuli Bunting		u	u		
Evening Grosbeak		c	c		
Cassin's Finch		u	u		
House Finch	u	u	u	u	*
Pine Grosbeak		u	u		
Common Redpoll				u	
Pine Siskin	u	u	u		
American Goldfinch	o	c	c		
Lesser Goldfinch		u	u		
Red Crossbill		o	o		
Green-tailed Towhee		u	u		
Rufuous-sided Towhee	u	c	c	u	
Savannah Sparrow	c	c	u	u	*
Vesper Sparrow		u	u		
Lark Sparrow		c	c		*
Sage Sparrow	o	c	c		*
Slate-colored Junco	o			o	
Oregon Junco	c	u	c		*
Chipping Sparrow		u	u		
Brewer's Sparrow		c	c		
White-crowned Sparrow		c	c		
Golden-crowned Sparrow		o	o	o	
Fox Sparrow		u	u		
Lincoln Sparrow		u	u		
Song Sparrow		u	u		
Snow Bunting	u			o	

Plant List by Occurrence

Major Species According To Physiographic Unit

TREES

Basin	Foothills	Plateaus	Genus	Species	Common Name
	x		Pinus	ponderosa	Ponderosa Pine
	x		Populus	tremuloides	Aspen
	x		Juniperus	occidentalis	Western Juniper
	x		Prunus	virginiana	Chokecherry
	x		Cercocarpus	ledifolius	Curl Leaf Mountain Mahogany

SHRUBS

x		x	Atriplex	confortifolia	Shadscale
x	x	x	Artemisia	tridentada	Sagebrush
x	x	x	Grayia	spinosa	Hopsage
x		x	Artemisia	spinescens	Bud sage
	x	x	Chrysothamnus	vicidiflorous	Low Rabbitbrush
x	x	x	Chrysothamnus	nauseosus	Rubber Rabbitbrush
	x	x	Artemisia	arbuscula	Low Sage
	x		Purshia	tridentata	Bitterbrush
x		x	Sarcobatus	vermiculatus	Greasewood
	x		Salix	spp	Willow
	x		Rosa	woodsi	Wild Rose
	x		Ribes	spp	Currant
	x		Symphoricarpos	spp	Snowberry
	x		Amelanchier	ainifolia	Serviceberry

GRASSES

x		x	Disticalis	stricta	Saltgrass
x	x	x	Elymus	cinereus	Great Basin Wildrye
x	x	x	Bromus	tectorum	Cheatgrass
x	x	x	Sitanion	hystrix	Squirreltail
x	x	x	Poa	secunda	Sandberg Bluegrass
x	x	x	Oryzopsis	Hymenoides	Indian Rice Grass
	x	x	Agropyron	spicatum	Bluebunch Wheatgrass
	x		Festuca	idahoensis	Idaho Fescue
	x		Stipa	spp	Needlegrass
x	x		Juncus	spp	Rush
x	x		Carex	spp	Sedge
		x	Sporobolus	cryptandrus	Sand Dropseed
x	x		Agropyron	cristatum	Crested Wheat

FORBS

x		x	Salsola	kali	Russian Thistle
	x		Rumex	spp	Dock
	x		Iva	axillaris	Poverty Weed
x		x	Lepidium	perfoliatum	Pepperweed
	x	x	Phlox	spp	Phlox
	x		Lupinus	spp	Lupine
	x	x	Eriogonum	spp	Buckwheat
	x		Taraxacum	spp	Dandelion
	x		Balsamorhiza	sagittata	Balsam root
	x		Senecio	serra	Groundsel
	x		Wyethia	spp	Mules Ear
	x	x	Delphinium	spp	Larkspur
	x		Achillea	lanulosa	Western Yarrow
	x		Allium	spp	Wild Onion
	x		Cirsium	spp	Star Thistle
	x		Perideridia	spp	Yampa
	x	x	Zigadenus	spp	Death Camas
	x		Antennaria	spp	Pussy Toes
x			Suaeda	spp	Inkweed

ENVIRONMENTAL ANALYSIS WORKSHEET

MARKS: Environmental Impacts of the Proposed Action:

0 - No Impact M - Medium Impact x - Unknown + - Beneficial Impact
L - Low Impact H - High Impact - - Adverse Impact

STAGES OF IMPLEMENTATION	EXPLORATION					DEVELOPMENT						OPERATION				CLOSE-OUT		
DESCRETE OPERATIONS	Airborne	Off-Road Vehicle Travel	Road & Trail Construction	Drilling	Rehabilitation	Road Construction	Drill Site Development	Geothermal Pipelines	Plant Construction	Electric Transmission Lines	Rehabilitation	New Drill Sites	Use of Existing Facilities	Waste Disposal	Production	Removal of Surface Equipment	Surface Reclam. & Restoration	REMARKS
C. WATER																		
Sediment Load	0	-L	-L	-L	+L	-L	-L	0	-L	0	+L	-L	0	0	0	0	-L	X refers to unknown chemical
Hydrologic Cycle	0	0	0	x	0	-L	0	0	-L	0	0	0	0	-L	±M	0	0	quality of geothermal fluids
Dissolved Solids	0	0	0	x	0	0	x	0	0	0	0	x	0	x	x	+L	0	
Toxic Chemicals	0	0	0	x	0	0	x	0	0	0	0	-L	0	-L	-L	x	0	
Temperature	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	0	0	
Dissolved Oxygen	0	0	0	0	0	0	0	0	0	0	0	0	0	x	0	0	+L	
Radiological Contam.	0	0	0	0	0	0	0	0	0	0	0	0	0	x	0	x	0	
pH	0	0	0	0	0	0	0	0	0	0	0	0	0	x	0	x	0	
. LIVING COMPONENTS A. PLANTS (AQUATIC)																		
All	0	0	0	0	0	-L	-L	0	0	0	0	0	0	x	0	0	+L	
B. PLANTS (TERRESTRIAL)																		
All	0	-L	-L	-L	+L	-L	-L	-L	-L	0	+L	-L	0	x	0	-L	+M	

REMARKS: Environmental Impacts of the Proposed Action:

0 - No Impact M - Medium Impact x - Unknown + - Beneficial Impact
L - Low Impact H - High Impact - - Adverse Impact

STAGES OF IMPLEMENTATION	EXPLORATION					DEVELOPMENT						OPERATION				CLOSE-OUT		
DESCRETE OPERATIONS	Airborne	Off-Road Vehicle Travel	Road & Trail Construction	Drilling	Rehabilitation	Road Construction	Drill Site Development	Geothermal Pipelines	Plant Construction	Electric Transmission Lines	Rehabilitation	New Drill Sites	Mtce. of Existing Facilities	Waste Disposal	Production	Removal of Surface Equipment	Surface Reclam. & Restoration	REMARKS
I. NON-LIVING COMPONENTS																		
A. AIR																		
Air Movement Patterns.	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x	0		
Temperature	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	0		
Particulate Matter	0	-L	-L	-L	0	-L	-L	-L	-M	-L	+L	-L	0	0	0	-L	+M	Total surrounding area
Noxious Gases	0	-L	-L	-L	0	0	-L	0	0	0	0	-L	x	x	x	0		
Non-ionizing Radiation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	0		
B. LAND																		
Soil Depth	0	0	-L	-L	+L	-L	-L	0	-L	-L	+L	-L	0	0	0	+L	0	
Soil Erosion	0	-M	-M	-L	+M	-M	-L	-L	-L	-L	+L	-L	0	0	0	+L	+M	
Soil Structure	0	-L	-L	0	0	-L	-L	0	-L	-L	+L	-L	0	0	0	+L	0	
Geologic Structure	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	0	0	
Land Use Compatibility	0	0	-L	-L	+L	-L	0	-L	-L	-L	+L	0	0	x	x	x	x	
Soil Pollutant Properties	0	0	0	x	0	0	x	0	0	0	0	x	x	-L	x	0	0	
Land Use Suitability	0	0	-L	-L	+L	-L	-L	-L	-L	-L	+L	0	0	x	x	x	x	

ENVIRONMENTAL ANALYSIS WORKSHEET

REMARKS: Environmental Impacts of the Proposed Action:

0 - No Impact M - Medium Impact x - Unknown + - Beneficial Impact
L - Low Impact H - High Impact - - Adverse Impact

STAGES OF IMPLEMENTATION	EXPLORATION					DEVELOPMENT						OPERATION				CLOSE-OUT		
DESCRETE OPERATIONS	Airborne	Off-Road Vehicle Travel	Road & Trail Construction	Drilling	Rehabilitation	Road Construction	Drill Site Development	Geothermal Pipelines	Plant Construction	Electric Transmission Lines	Rehabilitation	New Drill Sites	Mtce. of Existing Facilities	Waste Disposal	Production	Removal of Surface Equipment	Surface Reclam. & Restoration	REMARKS
C. ANIMALS (AQUATIC)																		
All	0	-L	-L	-L	+L	-L	-L	0	0	0	+L	-L	0	x	0	0	0	
D. ANIMALS (TERRESTRIAL)																		
All Domestic & Wildlife	0	-L	-L	-L	+L	-L	-M	0	-L	x	+L	-L	0	x	x	0	+M	Depends upon exact location
III. ECOLOGICAL INTERRELATIONSHIPS																		
A. ECOLOGICAL PROCESSES																		
Succession	0	-L	-L	-L	x	-L	-L	0	-L	0	x	-L	0	x	0	0	x	
Food Relationships	0	0	-L	0	0	-L	-L	0	-L	0	x	-L	0	x	0	0	+L	
Community Relationships	0	0	-L	0	0	-L	-L	0	-L	0	x	-L	0	x	x	0	0	

ENVIRONMENTAL ANALYSIS WORKSHEET

REMARKS: Environmental Impacts of the Proposed Action:

0 - No Impact M - Medium Impact x - Unknown + - Beneficial Impact
L - Low Impact H - High Impact - - Adverse Impact

STAGES OF IMPLEMENTATION	EXPLORATION					DEVELOPMENT						OPERATION				CLOSE-OUT		
DESCRETE OPERATIONS	Airborne	Off-Road Vehicle Travel	Road & Trail Construction	Drilling	Rehabilitation	Road Construction	Drill Site Development	Geothermal Pipelines	Plant Construction	Electric Transmission Lines	Rehabilitation	New Drill Sites	Mtce. of Existing Facilities	Waste Disposal	Production	Removal of Surface Equipment	Surface Reclam. & Restoration	REMARKS
IV. HUMAN VALUES																		
A. LANDSCAPE CHARACTER																		
Harmonious	0	-L	-M	-L	+L	-M	-M	-M	-M	-M	0	-L	x	x	x	+H	+L	
Accentuating	0	x	x	x	x	0	0	0	0	-M	0	0	0	0	0	0	0	
B. SOCIOCULTURAL INTERESTS																		
Education/ Scientific	0	0	±M	±M	0	±M	±M	0	±M	-M	0	±M	0	0	±M	+H	+H	
Social Welfare	0	0	+L	+L	+L	+L	+M	+L	+M	+M	+L	+L	+L	0	+L	0	+L	
Attitudes & Expectations	0	0	0	+L	0	x	x	x	x	x	x	0	0	0	0	0	0	
Local Regulatory Struct.	0	0	0	0	0	x	x	x	x	x	x	0	0	0	0	0	0	
Cultural Values	0	x	±L	±L	0	±L	±M	±L	±M	x	0	±M	0	x	0	0	x	