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DOE/ID/01764--T1

RESOURCE USE

A Summary of the Assessments of Geothermal Resource Use Limitations

of

BRUNEAU KGRA,
CASTLE CREEK KGRA,
CRANE CREEK KGRA,
MOUNTAIN HOME KGRA,
VULCAN KGRA

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DISCLAIMER

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INTRODUCTION

Under the auspices of the Geothermal Overview Project of the Department of Energy (DOE), EG&G Idaho, Inc. has undertaken a comprehensive preplanning environmental program related to known geothermal resource areas (KGRA's) in the Snake River Basin and adjacent lands. As a first phase of this program, the task of compilation and evaluation of existing environmental data in five KGRA's (identified in Fig. 1) was subcontracted to regional universities and consulting agencies (see Appendix A). Program elements included air quality, meteorology, hydrology, water quality, soils, geology, subsidence, seismicity, terrestrial and aquatic ecology, demography, socioeconomics, historic and archaeological sites. The present report "Resource Use", summarizes the special concerns identified in the reports prepared on the preceding program elements and those brought out in the January 1979 workshop. Current commitments of land, water, and geothermal resources are described and how these commitments might affect further geothermal development outlined. This report brings together the identified concerns of and limitations to present geothermal development, as well as recommendations for further study essential to completion of the first phase of the Snake River Basin geothermal projects within the five specific KGRA's.

As indicated in Contract No. EW-78-S-07-1764, Appendix A, the study entitled "Resource Use" was intended to accomplish the following:

> "Data provided for resource use should be evaluated on a regional basis and should include the areas encompassed by the other program elements. This will involve coordinating this program element with the contractors (BYU, Lewis and Associates, and Geotechniques).

If available, data should be provided on current and planned commitments of resources (at least land, water and geothermal) that might affect or be affected by geothermal development in each KGRA." (p. 2)

In a subsequent meeting (10/20/78) between the University of Idaho team and DOE/EG&G representatives, the objectives of the study were discussed in terms of the following questions:

1. Could an environmental impact be determined, say, 10 years after development based on the information that is available now?
2. Are there commitments existing or forecast that would prohibit geothermal development; e.g. historic areas, trails, closed groundwater areas, etc.?
3. Are there special land ownership patterns or reservations that would affect geothermal development?

As an attachment to the contract (Table I), a listing of Possible and Maximum potential geothermal development was provided, distributed by the five KGRA's, as follows:

POTENTIAL DEVELOPMENT

	Possible	Maximum
Vulcan	20 A. greenhouse fish farm (100,000 lb/yr) 20 A. tree farm	20 MW power plant 60 A. greenhouse 40 A. tree farm fish farm (400,000 lb/yr)
Castle Creek	space heating (Grandview) 20 A. greenhouse fish farm (100,000 lb/yr) feed lot (10,000 head)	space heating 80 A. greenhouse fish farms (400,000 lb/yr) feed lots (30,000 head) refrigeration (1 T.)

POTENTIAL DEVELOPMENT* (cont.)

	Possible	Maximum
Bruneau	space heating (Bruneau) 20 A. greenhouse fish farm (100,000 lb/yr) feed lot (10,000 head)	space heating 60 A. greenhouse fish farms (400,000 lb/yr) feed lots (20,000 head)
Mountain Home	20 A. greenhouse fish farm (100,000 lb/yr) feed lot (10,000 head)	space heating** 80 A. greenhouse fish farms (400,000 lb/yr) feed lots (30,000 head) refrigeration (1 T.) potato processing (100 A.)
Weiser (Crane Creek)	20 A. Greenhouse fish farm (100,000 lb/yr) Feed lot (10,000 head)	space heating (Weiser) 20 MW power plant 60 A. greenhouse feed lots (30,000 head) fish farms (400,000 lb/yr) potato processing (100 A.) manure processing (5 A.)

* These development estimates are based solely on what is currently known about the characteristics of the geothermal resource in each KGRA.

** If in conjunction with industry buildup and air base.

NOTE: Approximate land requirements:

Fish farm	40 A. for 100,000 lb/yr
Feed lot	7 A. for 10,000 head
Refrigeration	1 A. for 1 T.

It is obvious that the required information base for the variety of possible developments would not be identical. Furthermore, generalized statements concerning the adequacy of information would not only depend upon what kind of development was contemplated, but would necessitate a more comprehensive review of the specific requirements (size), location, and relationships to the other existing or contemplated developments. Such background information on potential developments is available only in generalities as presented above, and was not responded to by the various subcontractors in their reports.

It would appear that in the presentation of the data and evaluation of the adequacy of that data of the various elements studied by the subcontractors that the tendency was to consider only that major development of the geothermal resources was contemplated. In reality, development is likely to include many minor uses as well as possible major programs.

Because the basic information provided in the subcontract reports was presented essentially on the basis of assumed major developments, it is not possible to make a very detailed evaluation of the resource use limitations of a full range of potential development. The information developed in the reports is important to the resource manager and prospective developer, however, in that it does indicate the kinds of limitations that can now be identified.

The information is presented in three ways in this report: (1) a brief summary of the characteristics of each KGRA; (2) a brief summary of the results of each study element; and (3) as a part of (2), a table detailing the key findings of each study element.

Even though we find it not possible to detail the relationship of these subcontract reports to a full range of developmental alternatives, it is our conclusion that it is important that an indication, as a minimum, be presented. As a result, a matrix presentation has been developed (Table 1). It must be stressed, however, that the presentation of Table 1 is qualitative only. For each and every suggested possible development site a detailed matrix could be prepared. Such information is neither available nor capable of being implemented within the scope of this contract.

As a matter of interest to the subject of this report, excerpts from a report by WAPORA, Inc. concerning environmental regulations concerning the subject of geothermal exploration development and use are presented in Appendix B. The appendix discusses briefly pertinent federal and Idaho regulations.

Table 1: Information Adequacy and Potential Resource Use Problems of Geothermal Development.★

ENVIRONMENTAL ASSESSMENT ELEMENTS

GEOTHERMAL RESOURCE USES		GEOLOGY (See Table 2)	SEISMICITY (See Table 3)	SUBSIDENCE (See Table 4)	METEOROLOGY & CLIMATE (See Table 5)	AIR QUALITY	SOILS / LAND USE (See Table 6)	HYDROLOGY (See Table 7)	WATER QUALITY (See Table7)	ECOLOGY (See Table 8)	HERITAGE RESOURCES (See Table 9)	SOCIO-ECONOMIC (See Table 10)
GREENHOUSES	1□	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Not adequate	Not adequate	Adequate	Not adequate	Adequate
	2□	Minimal	Minimal	Minimal	Destructive winds in some areas.	Minimal	Land use & erosion problems.	Water rights problems.	Flouride problem. Return flow quality concern.	Minimal	Potential problems.	Minimal
TREE FARMING	1	Adequate	Adequate	Adequate	Questionable	Adequate	Adequate	Not adequate	Not adequate	Adequate	Not adequate	Adequate
	2	Minimal	Minimal	Minimal	Destructive winds & microclimate change.	Minimal	Land use & erosion problems.	Water rights problems.	Flouride problem. Return flow quality concern.	Minimal	Potential problems.	Minimal
FISH FARMING	1	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Not adequate	Not adequate	Adequate	Not adequate	Adequate
	2	Minimal	Minimal	Minimal	Minimal	Minimal	Land use & erosion problems.	Water rights problems.	Flouride problem. Return flow quality concern.	Minimal	Potential problems.	Minimal
FEED LOTS	1	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Not adequate	Not adequate	Adequate	Not adequate	Adequate
	2	Minimal	Minimal	Minimal	Minimal	Minor local problems.	Land use & erosion problems.	Water rights problems.	Flouride problem. Return flow quality concern.	Potential habitat conflicts.	Potential problems.	Minimal
SPACE HEATING	1	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Not adequate	Not adequate	Adequate	Not adequate	Adequate
	2	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Water rights problems.	Flouride problem. Return flow quality concern.	Minimal	Potential problems.	Minimal
REFRIGERATION	1	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Not adequate	Not adequate	Adequate	Not adequate	Adequate
	2	Minimal	Minimal	Minimal	Microclimate change.	Minimal	Minimal	Water rights problems.	Flouride problem. Return flow quality concern.	Minor problems.	Potential problems.	Minimal
POTATO PROCESSING	1	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Not adequate	Not adequate	Adequate	Not adequate	Limitations
	2	Minimal	Minimal	Minimal	Microclimate change	Minimal	Land use & erosion problems.	Water rights problems.	Flouride problem. Return flow quality concern.	Minor local problems.	Potential problems.	Potential problems (Especially during construction).
POWER PLANTS	1	Questionable	Questionable	Questionable	Adequate	Questionable	Adequate	Not adequate	Not adequate	Adequate	Not adequate	Limitations
	2	Major exploration problems.	Possible problems.	Possible problems.	Microclimate change.	Possible problems.	Land use & erosion problems.	Water rights & recharge problems.	Flouride problem. Return flow quality concern.	Local habitat problems (Especially during construction).	Potential problems.	Potential problems (Especially during construction).

□ Row 1 attempts to answer the three questions of data adequacy posed in the introduction from a regional perspective.

□ Row 2 attempts to identify potential problems of the development of the geothermal resource for specific uses.

★ The questions posed are not whether an economic possibility exists for development; rather, would a reasonable resource manager be concerned about potential environmental consequences.

PART I: OVERVIEW BY KGRA

BRUNEAU KGRA

CASTLE CREEK KGRA

CRANE CREEK KGRA

MOUNTAIN HOME KGRA

VULCAN KGRA

BRUNEAU KGRA
CASTLE CREEK KGRA
CRANE CREEK KGRA
MOUNTAIN HOME KGRA
VULCAN KGRA OVERVIEW BY KGRA

PART I:

This section contains a brief overview of the physical, socioeconomic, and heritage resources of each KGRA summarized from the draft reports submitted to EG&G by subcontractors for this project. Included under the subheading of Physical Environment are geology, topography, and ecology with brief mention of climate, hydrology, and soils. Under Socioeconomic and Heritage Resources are demographic and economic data, land use and ownership, and known prehistoric and historic features.

The purpose of this section is to familiarize the reader with the known natural and human elements of the environment of each KGRA relevant to geothermal resource development. Much is not known about some of these elements. The information gaps are listed in Part II of this report. This very brief overview summarizes hundreds of pages of data from the original reports to which the reader is directed for additional detail. Bibliographic citations are not made since all information was derived from the original reports which are listed in the reference section of this report.

BRUNEAU KGRA

Physical Environment

The eight square mile Bruneau KGRA is located in the wide, flat Bruneau Valley and surrounding plateau at the mouth of the Bruneau River canyon in Owyhee County (Fig. 1). It lies just north of the fault zone forming the southern edge of the Snake River graben (Fig. 7). To the south of the fault zone are Miocene silicic volcanic rocks which form the Owyhee Plateau and underlie the KGRA. These may be correlative with the Idavada volcanics to the north of the Snake River graben (see Mountain Home). Rocks exposed within the KGRA consist of interbedded laval flows and lacustrine and fluviatile sedimentary deposits of the Idaho Group dating from the lower Pliocene age. Freshwater gastropod and plant fossils as well as camel, rhinoceros, beaver and rodent skeletal remains occur in the late Pliocene Chalk Hills Formataion. Upper Pleistocene terrace gravels are exposed along the margins of the Bruneau Valley and alluvial deposits form the valley flood plain.

The area is in a semiarid desert characterized by 7-8" average annual precipitation (Fig. 2), long hot summers and short cold winters with very little snow. The Bruneau River with an average annual discharge of 146,214 cfs-days (at Hot Springs within the KGRA) is the only permanent stream in the area. The topography consists of the hilly plateau surface; steep, highly dissected breaklands; and wide valley flood plain. Slopes are 0-2% in the valley and 2-20% on the adjacent plateau surface and slopes. Total relief is about 400 feet and mean elevation approximately 2,710 feet, msl.

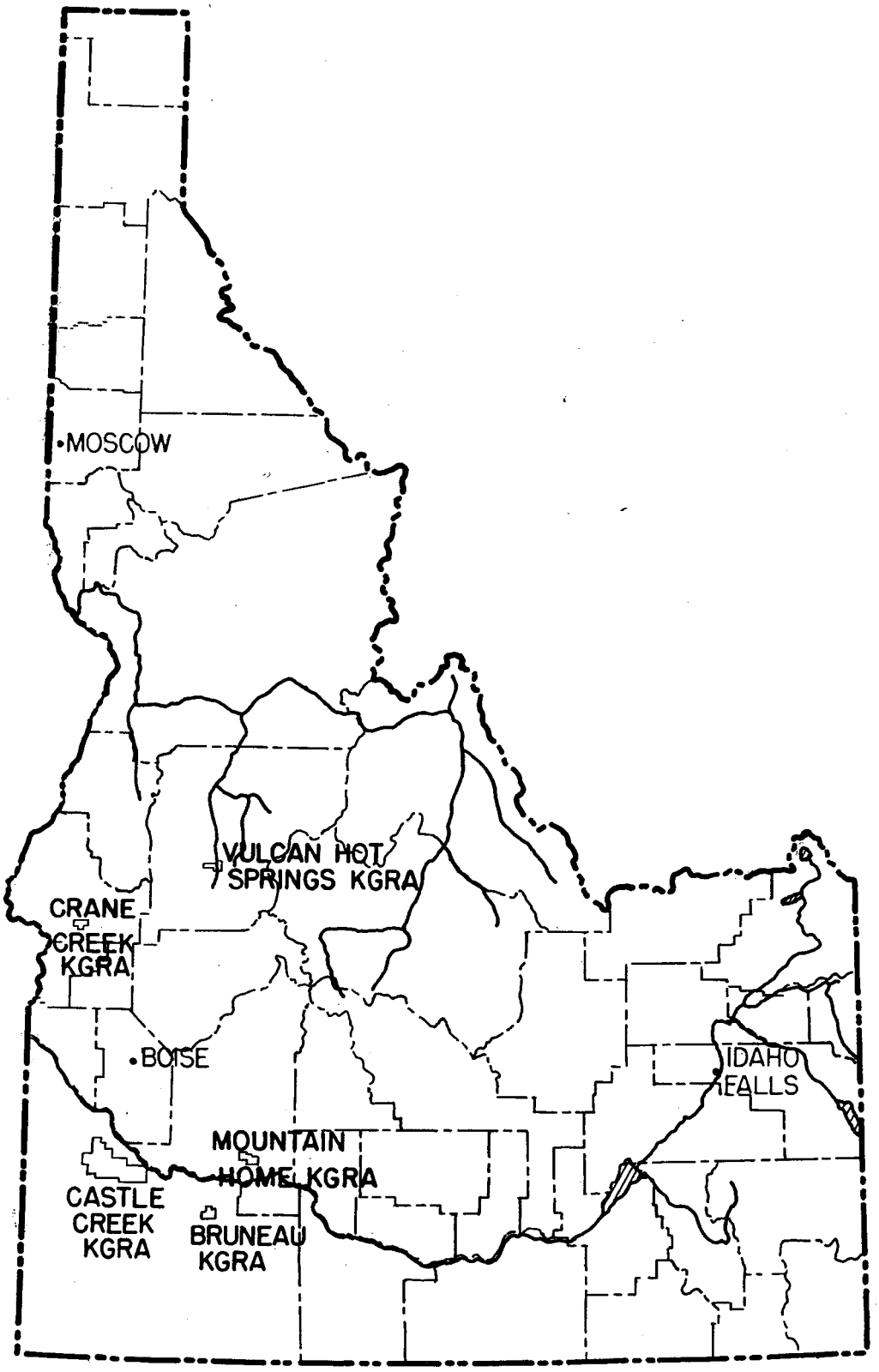

Figure 1. Western Snake River Plain KGRA.

Soils are calcareous, shallow and gravelly on the plateau and slopes; and coarse loamy, well-to-poorly drained in the valley. The plateau is in the Tall Sagebrush habitat wich covers much of Owyhee County. Eagles and other raptors utilize the canyon walls for nesting and roosting and sagebrush habitat for hunting. This area lies on the eastern edge of the Birds of Prey Natural Area impact zone. Extensive riparian vegetation in the valley provides important game and non-game habitat and is an outstanding feature of this area.

Socioeconomic and Heritage Resources

The total population of Owyhee County is 7,900* restricted almost entirely to the northern part of the county along highway 78. The city of Bruneau (Pop. 100) is the nearest population center to the KGRA. A population increase of 23% took place in the county between 1970 and 1976, 66% of which was in-migration Population forecasts based on existing economic conditions project a modest 1% increase through the year 2000 with migration outward beginning by 1980. The county unemployment rate in 1977 was 4.6%. Per capita income was low for Idaho at $3,232 in 1976 reflecting a depressed agricultural economy for that year. Agriculture accounts for a high 26% of the total earnings.

The Bruneau schools serve 580 students (some coming from Grandview), showing a recent decline, with a student/teacher ratio of 21.5. There is only one doctor permanently located in the county and no hospital facilities. Crime rate is low with greatest increases in larceny and burglary.

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* 1976 census

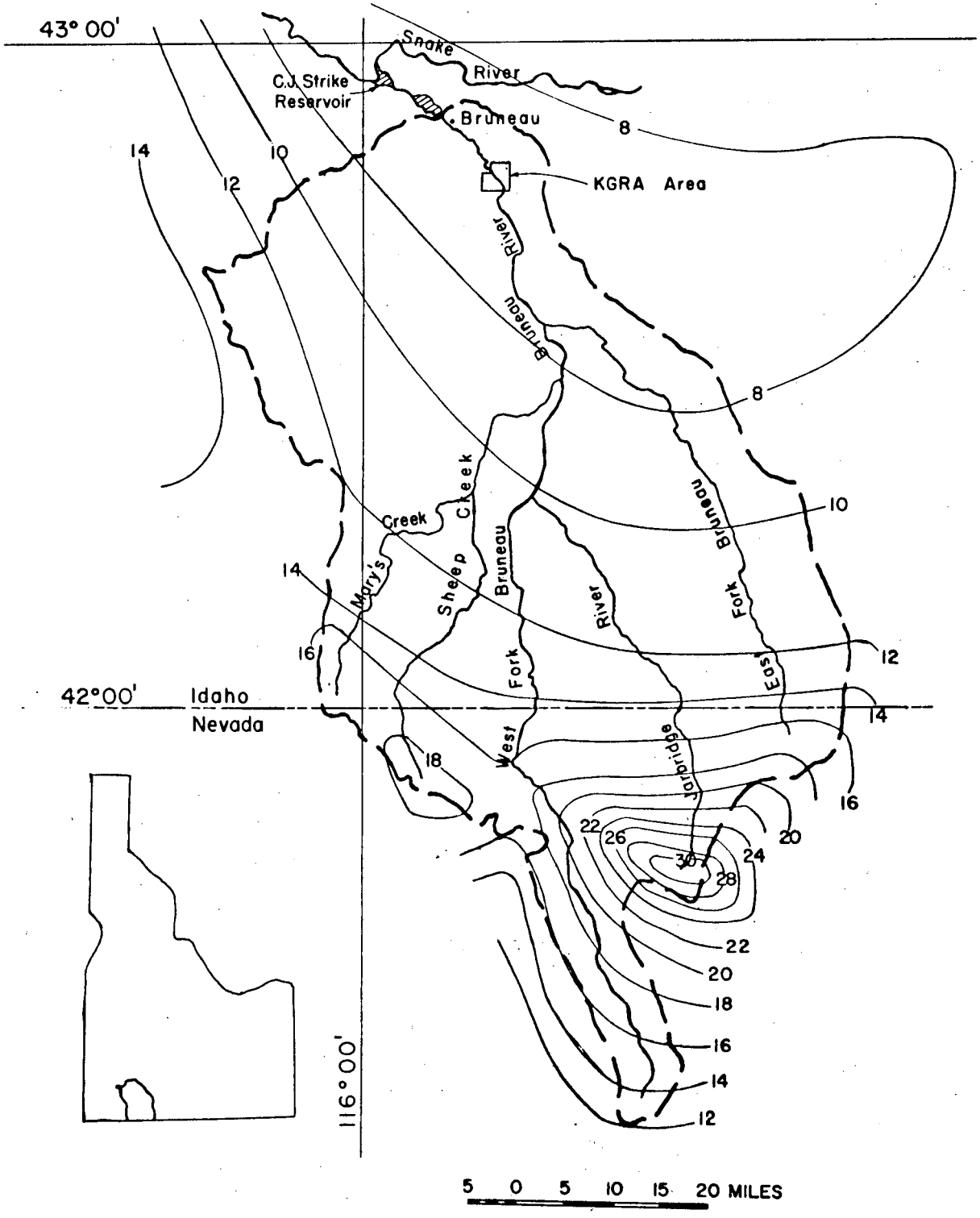


Figure 2. Mean Annual Precipitation, inches - Bruneau KGRA Area

Land ownership in the KGRA is located equally divided between private farmlands located in the valley and BLM lands on the plateau. All of the valley and adjacent terrace slopes are irrigated for crop production with water being drawn from the Bruneau River via canals or from groundwater wells. Much of the BLM land is non-irrigable and is leased as rangeland for livestock. The Bruneau River is now being studied for possible inclusion in the Wild and Scenic River System.

Known prehistoric archaeological sites are limited to one small campsite at the mouth of the canyon at the southern edge of the KGRA. Most of the valley north of this point has not been surveyed (or records have been lost). However, historic records document an Indian winter village site at Hot Springs, and fishing camps downriver from the KGRA indicate extensive long time use of the area for hunting and fishing.

CASTLE CREEK KGRA

Physical Environment

The 125 square mile Castle Creek KGRA is located along the Snake River northwest of the Bruneau KGRA in Owyhee County (Fig. 1). It lies in the downthrown side of the southern margin of the Western Snake River Plain graben (Fig. 7). Miocene silicic volcanic rocks occupy the region of the fault zone immediately to the south of the KGRA in the foothills of the Owyhee Mountains. Idaho Group formations, dating from the Pliocene, constitute most of the rocks exposed at the surface within the KGRA and form badland topography over much of the area. Some strata contain molluscan fossils. Rock units include basalt lava flows and as well as, consolidated, unindurated lacustrine and fluvial facies. Faults in these formations just southeast of the KGRA apparently serve as plumbing for hot artesian water encountered in wells in the vicinity. Recent alluvium occupies the main stream valleys.

The area is in a semiarid desert characterized by 7-8" average precipitation (Fig. 3). Castle Creek, Catherine Creek, Birch Creek and numerous intermittent streams flow northeast draining the Owyhee Mountains and dissecting the KGRA with many small valleys marked by slopes over 30%. Extensive flat bottom lands lie along the main stream valleys and adjacent to the south side of the Snake River. Total relief is about 900 feet and mean elevation is approximately 2,770 feet msl. Soils are deep and poorly drained in the valleys and Snake River flats, moderately deep and well-drained on gradual slopes, and shallow and gravelly on steep badlands topography where they are highly erodable. Soils are

calcareous with an indurated hardpan which reduces permeability over much of the area. The KGRA is located primarily in the Salt Desert Shrub habitat and appears to occupy much of this limited habitat within Owyhee County. Extensive riparian habitat exists along the Snake River, and the area overlaps the Birds of Prey Natural Area where numerous raptors nest in the canyon walls and feed over a wide area of sagebrush and salt desert shrub.

Socioeconomic and Heritage Resources

The city of Grandview (Pop. 348)*, located in Owyhee County, is the only population center within the KGRA. It has an elementary school but secondary school students attend Bruneau schools. (See the Bruneau KGRA Socioeconomic and Heritage Resources section for Owyhee county demographic and socioeconomic statistics.)

Most of the Castle Creek KGRA area is within the jurisdiction of the Bureau of Land Management. A few sections of state land are present and the remainder is privately owned. About 40% of the KGRA is under surface or sprinkler irrigation primarily for the production of forage crops and the remaining 60% is rangeland. Major sources of irrigation water are the Snake River, Castle Creek, and groundwater wells. Geothermal water is used for irrigation and stock watering and in at least one instance for domestic space heating.

Forty-six known prehistoric archeaological sites have been located in the Castle Creek KGRA, most in the Snake River canyon around Big Foot Bar. These include villages, campsites, quarries, rockshelters, and lithic scatters. Most of the KGRA has not been surveyed but has a

* 1975 census

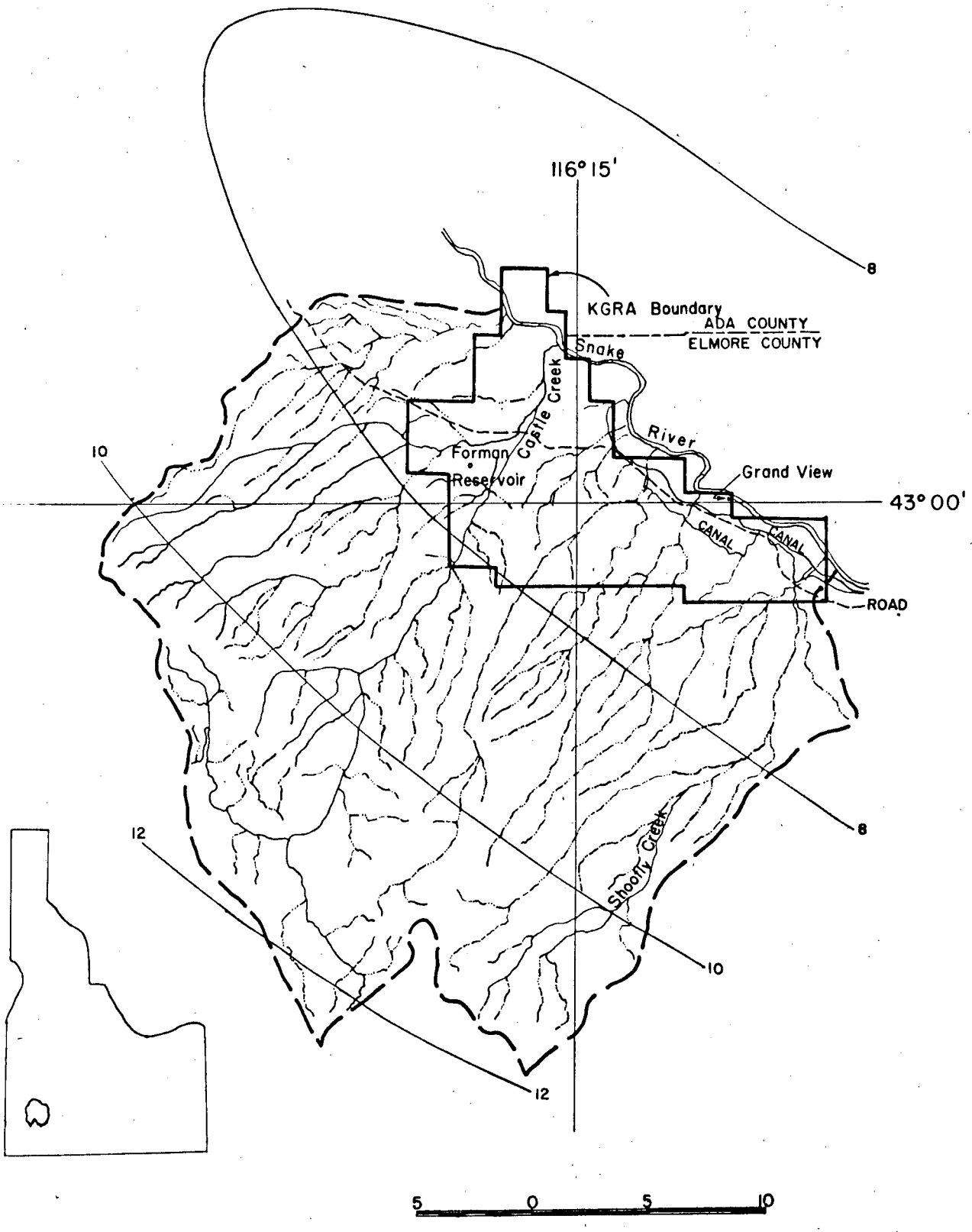


Figure 3. Mean Annual Precipitation, inches - Castle Creek KGRA Area.

high probability for additional sites. A feature of historic importance is the alternate Southern Route of the Oregon Trail which has clearly discernable ruts for much of the southeast-northwest length of the KGRA. Again the potential for campsites or cabins along this path is high but no thorough survey has been made.

CRANE CREEK KGRA

Physical Environment

The seven square mile Crane Creek KGRA is in Washington County along the breaks of the Weiser River where Crane Creek, flowing west, leaves its steep narrow canyon and enters the broad Weiser River Valley (Fig. 1). It is located along the Western Idaho Fault Zone, which marks the northern boundary of the Snake River Plain (Fig. 7). Paleozoic and Mesozoic metavolcanic and metasedimentary rocks exposed a few miles northwest of the KGRA and granitic rocks of the Idaho Batholith are believed to form the basement complex below the KGRA. Most of the exposed rocks within the KGRA are lava flows, volcaniclastic sediments, and silica-cemented arkosic sandstones of Miocene age. The youngest deposits in the area are landslide debris and surficial alluvial deposits. Hot springs along Crane Creek are located on the east side of the fault zone and may be related to hot water rising along a deep seated basement fault and into younger faults in the overlying lava and sediments. The springs surface along the margin of a siliceous sinter terrace or in adjacent sediments.

Average annual precipitation is 12-14" (Fig. 4) with about 20" of snowfall in the winter. The North and South Forks of Crane Creek with a combined average annual discharge of 30,486 cfs-days are the only streams in the KGRA. Much of the site is composed of steep canyon slopes with very shallow, stony, highly erodible soils. Total relief is about 1,500 feet and mean elevation is approximately 3,000 feet, msl. The area is in Tall Sagebrush habitat with some riparian habitat in the valleys.

Animals of concern in the area are mule deer, pronghorn, quail, chukar, overwintering waterfowl, and especially the white-faced ibis and Idaho ground squirrel which may have limited distribution in the county.

Socioeconomic and Heritage Resources

The population centers of Weiser (Pop. 4,538)*, Midvale (Pop. 409)*, and Cambridge (Pop. 442)* are all within easy striking distance of the Crane Creek KGRA. The remainder of the population for the county (Total pop. 8,500) is rural. County growth between 1970 and 1976 was 11.5%, over half of which was inmigration. Population forecasts based on existing conditions predict a steady increase in population, employment, and labor force and a positive but declining net migration rate through the year 2000. The unemployment rate has been a constant 8% in recent years. Per capita income in 1976 was $4,870 with agriculture accounting for 22% of total earnings.

The schools located in the three towns serve 1,987 students with the Weiser schools showing a recent increase and the Midvale and Cambridge schools a decrease. Student/teacher ratio is 22.1 in the Weiser schools. Health care in the county is somewhat limited with four doctors and one 30 bed hospital. Crime rate is low and showing little recent increase.

Most of the land within the KGRA is public land administered by the Bureau of Land Management with private lands restricted to the west and southwest portions of the site. In this area some surface water from Crane Creek is used for irrigation. Dryland farming also takes place. The remainder of the area is rangeland.

* 1975 census

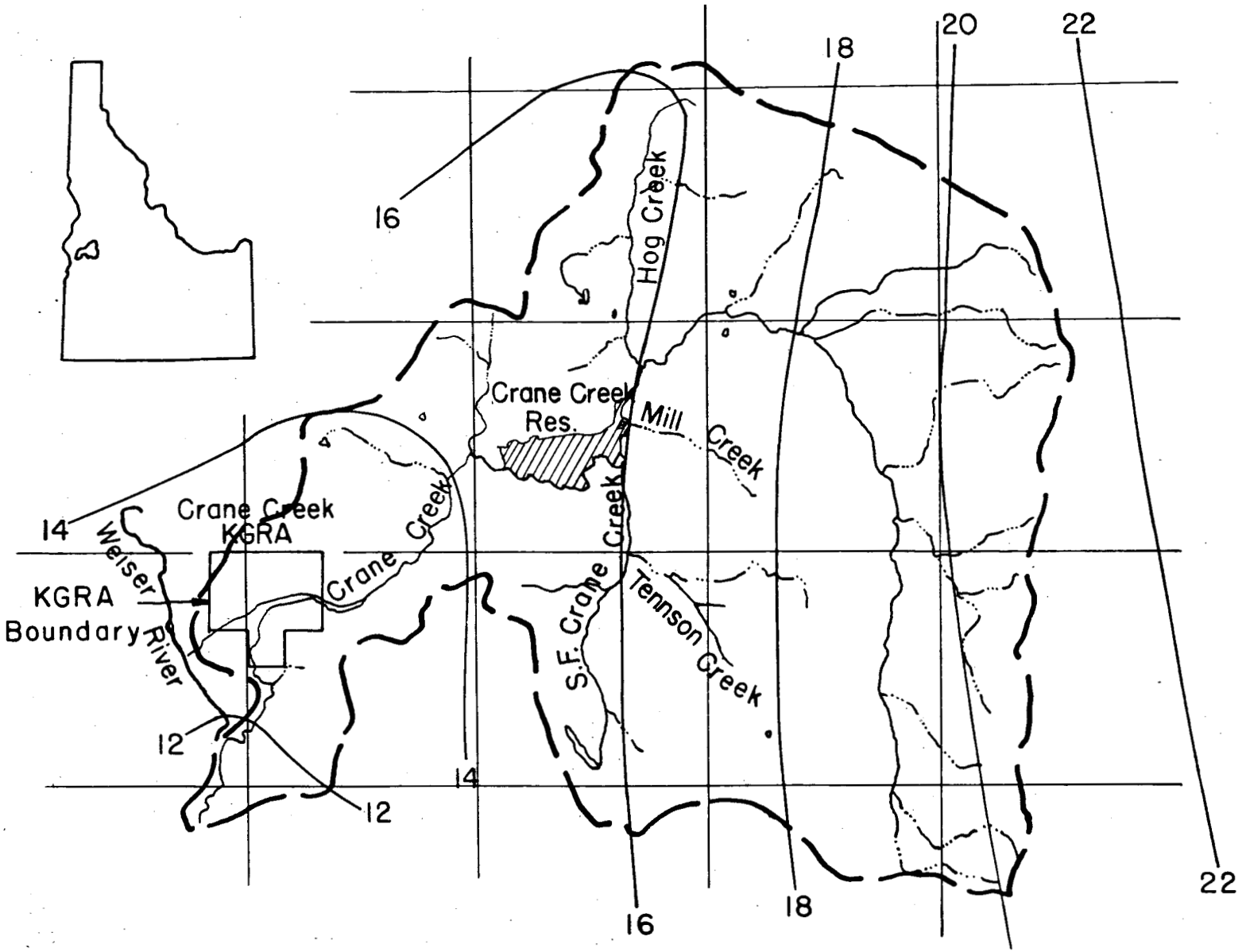


Figure 4. Mean Annual Precipitation, inches - Crane Creek KGRA Area

No archaeological survey has been conducted within the bounds of the Crane Creek area but findings elsewhere in the county point at a very high probability of prehistoric sites with considerable time depth occurring within the KGRA.

MOUNTAIN HOME KGRA

Physical Environment

The Mountain Home KGRA occupies 15 square miles at the foot of the Mount Bennett Hills in Elmore County a few miles east of Mountain Home (Fig. 1). It is located on the downfaulted side of the Snake River graben a few miles south of the fault zone forming the graben boundary (Fig. 7). The Idavada Volcanics, silicic volcanic rocks of Miocene age which were extruded along the developing fault zone, form the Mount Bennett Hills and underlie the KGRA. Rock units exposed at the surface in the KGRA are interbedded lava flows and lacustrine and fluviatile sedimentary desposits of the Idaho Group dating from the low Pliocene age. Surficial deposits included loess and stream alluvium.

The area is in a semi-arid desert zone characterized by 10-12" of average annual precipitation (Fig. 5), long hot summers and short cold winters. Four low-gradient, low-discharge permanent streams transect the area. Except for some steep valley side slopes, most of the area is gently rolling hills with slopes less than 12%. Total relief within the bounds of the KGRA is a little over 300 feet and mean elevation is about 3,370 feet. Soils are moderately deep, generally well-drained though an indurated hardpan at 20-40 inches restricts permeability over much of the area and erosion occurs easily on disturbed soils on slopes exceeding 2%. This area is located entirely within the widespread Tall Sagebrush habitat and has been extensively modified by grazing. Mule deer use this area for winter browse and sage grouse for strutting grounds while available riparian habitat harbors a diversity of non-game species.

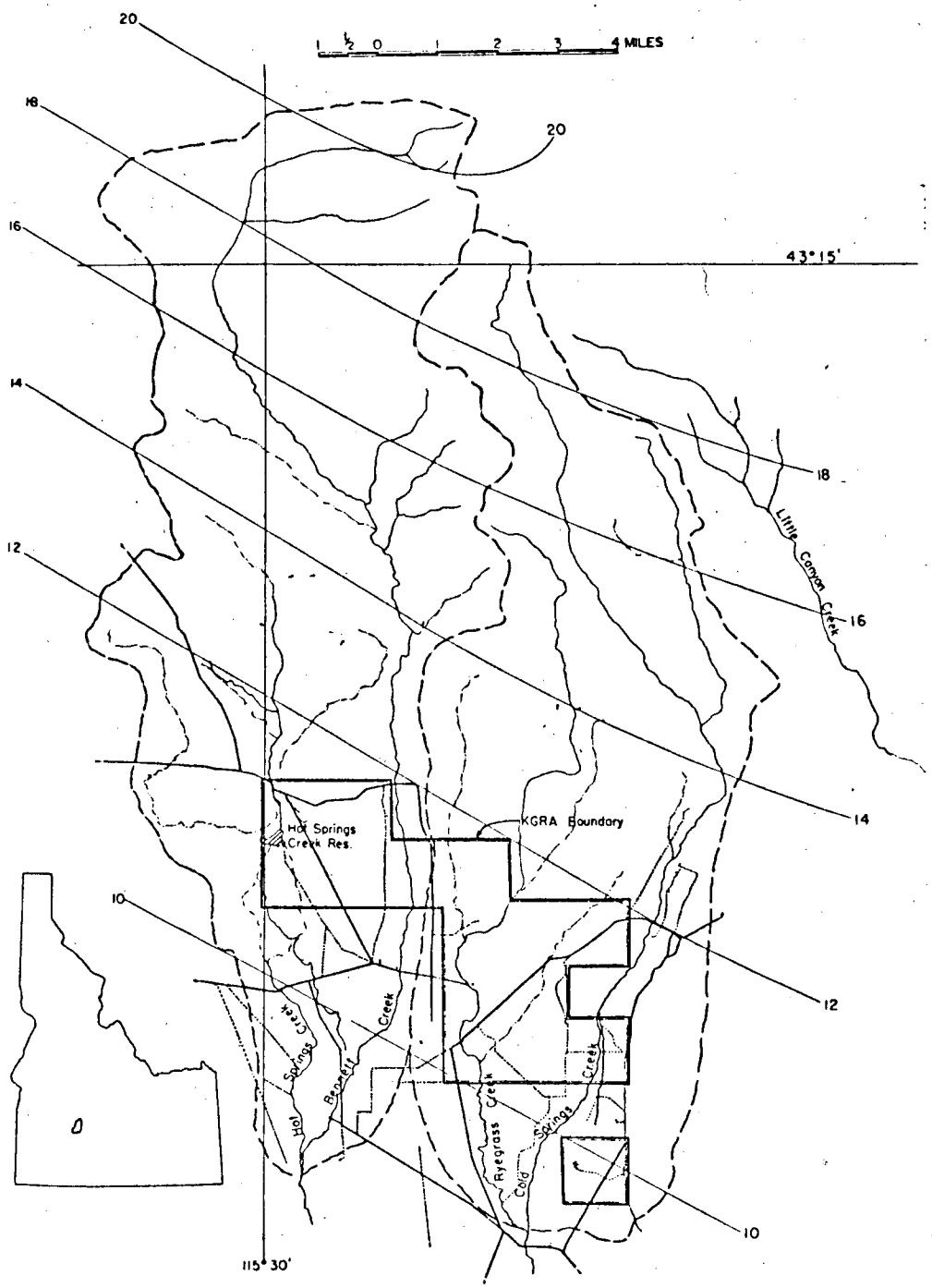


Figure 5. Mean Annual Precipitation, inches - Mountain Home KGRA Area

Socioeconomic and Heritage Resources

Mountain Home (6,811)* and Glenns Ferry (1,449)* are the two principal population centers for Elmore County (19,500). Much of the county's population centers for Elmore County (19,500), Much of the county's population is rural. Federal employees housed at the Mountain Home Air Force Base are not included in the aforementioned population figures. A population increase of 16.5% took place between 1970 and 1976, mostly in rural areas, and due to birth rather than inmigration. There was a net migration out of the county during this time period. Population forecasts based on existing socioeconomic conditions indicate a small but steady growth in population, employment, labor force, and school enrollment with continued net migration outward. The county unemployment rate was 6-7% for the period 1974-1977. Per capita income for 1976 was $5,184. Agriculture accounts for 10% of total earnings.

The largest school district, located in Mountain Home, served 4,179 students in 1977 with a student/teacher ratio of 18.6. One 77 bed hospital and four doctors serve the county. The crime rate has been low though increasing gradually in some categories reflecting the national trend. Crimes involving larceny and burglary were greatest while crimes of violence have remained low.

ownership within the KGRA consists of privately owned farmlands located primarily in the stream valleys where forage crops are grown, and Bureau of Land Management lands where grazing is the major use. Water from surface streams, springs, and wells is used for irrigation, stock watering, and domestic needs. Geothermal water has been tapped for irrigation and domestic space heating at one or two ranches in or near the KGRA.

* 1975 census

No prehistoric sites have been identified within the KGRA during the partial surveys conducted here. However, the area is near areas of known sites of long use and similar topography. Historical features include the Oregon Trail which left ruts from southeast to northwest across the KRGA and later the Kelton or Salt Lake Road across the northeast corner. One cabin remains from this period.

VULCAN KGRA

Physical Environment

The six square mile Vulcan KGRA is in the Boise National Forest in Valley County near the headwaters of the South Fork of the Salmon River (Fig. 1). It is located within the Idaho Batholith, a plutonic igneous body of quartz monzonite and granodiorite emplaced during the late Cretaceous over much of northern, central, and southwestern Idaho. Surficial desposits of recent alluvium occur in the valley of the South Fork Salmon River which flows north through the area along a possible fault, and unconsolidated morainal deposits dating from late Pleistocene alpine glaciation plaster some slopes. North-south trending faults forming the western margin of the batholith occur a few miles to the west of the KGRA and appear to be a structual control on Vulcan and other hot springs in the area (Fig. 7).

The topography of the area consists of mountain uplands to 6,800 feet, msl dissected mountain slope lands, and valley bottoms at 5,500 feet, msl. Vulcan Hot Springs is located on the lower slopes about 1/2 mile from the river. Here 13 hot water vents (89^{o}C) with a combined discharge of 450 gpm form a circular area about 50 feet across. The spring stream thus formed enters the South Fork after cooling to near normal temperatures. The average annual discharge of the Salmon River at this point is approximately 30,000 cfs-days. The site receives moderately heavy precipitation, much of it falling as snow, for an annual average of 36 inches (Fig. 6). The dark-colored subhumid forest soils formed over fractured granite bedrock on steep slopes have a high erosion hazard.

This site is located primarily in Douglas Fir habitat which is extensive in Valley County. The spring itself is surrounded by an open wet meadow habitat which is limited in the county and which provides important elk calving ground. The area is also on a mule deer migration route. The South Fork is an important spawning stream for Chinook salmon. Any disturbance of a highly erodable granitic soils in this area has the potential to smother spawning gravels to the detriment of the already endangered salmon runs.

Socioeconomic and Heritage Resources

The cities of McCall (2,147)*, Donnelly (143)*, and Cascade (1,004)* are located along highway 55 west of the KGRA and represent most of the population of Valley County (4,400). An average 22% population increase took place between 1970 and 1976 in these cities, 60% of which was due to in-migration. Continued moderate population increases are forecast through the year 2000. The unemployment rate has been a relatively high 12% over the past few years. Per capita income is $6,482. Eighty-eight percent of the land in the county is National Forest land resulting in a relatively large proportion of the labor force in federal civilian employment, logging related jobs, and seasonal employment.

Two school districts are present in the county serving 1,121 students with an average student/teacher ratio of 17.2. Two hospitals with a combined 31 bed capacity and six doctors are available to county residents. Crime rate is relatively low although larceny and burglary doubled between 1971 and 1976. Perhaps this increase is due to a greater in-migration to rural rather than urban areas--a general trend noted nationwide and throughout Idaho.

* 1975 census

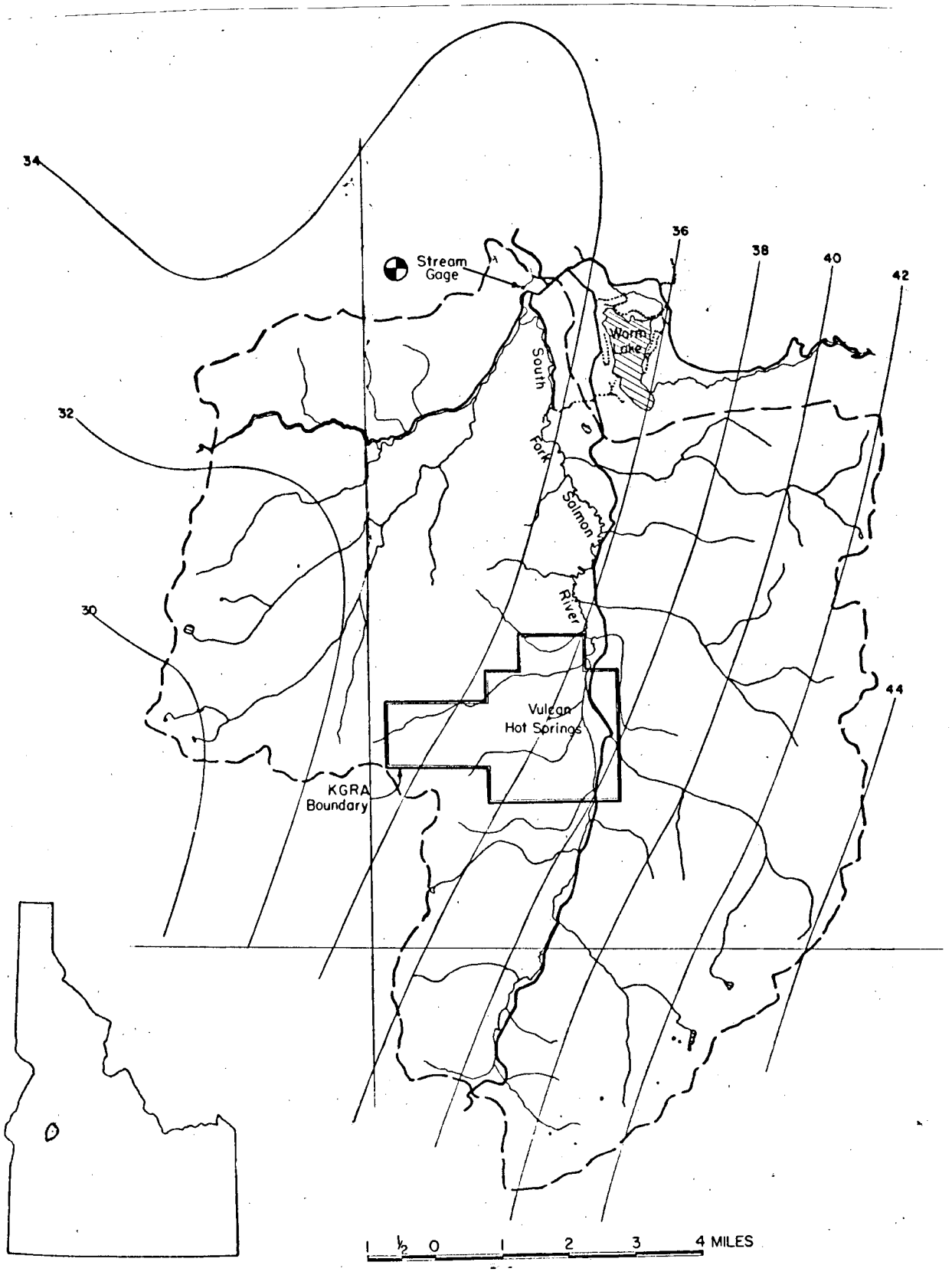


Figure 6. Mean Annual Precipitation, inches-
Vulcan KGRA Area

Within the KGRA there has been no commodity development or change from the natural conditions with the exception of a pack trail to the spring and an undeveloped campground and gravel road east of the river. Known heritage resources include two prehistoric lithic scatters found in creek bottoms. The area provided hunting and fishing grounds for both northern and southern Indian tribes throughout prehistoric times and the potential for additional cultural sites is high.

PART II: RESOURCE USE LIMITATIONS

A. GEOLOGY, SUBSIDENCE AND SEISMICITY

B. CLIMATE, METEOROLOGY AND AIR QUALITY

C. SOILS

D. HYDROLOGY AND WATER RIGHTS

E. TERRESTRIAL ECOLOGY AND THE FEDERAL BIRDS OF PREY SANCTUARY

F. HERITAGE RESOURCES

G. SOCIOECONOMIC CHARACTERISTICS

PART II (A):
GEOLOGY, SUBSIDENCE AND SEISMICITY

During the first KGRA workshop, it became apparent that the geologic and geophysical data base for the KGRAs was quite limited. Geotechniques Inc. was contracted, to evaluate the adequacy of the existing data base and outline areas where additional geologic and geophysical information were needed. By this approach, the inadequacies of the present data could be compensated for prior to developmental planning.

Geology

Table 2 summarizes the subcontractor's results concerning the present geologic limitations to geothermal development in each KGRA. Existing geologic data is categorized in three ways under the first section heading, "Adequacy of Existing Geologic Data": surface, subsurface and deep subsurface data. A check under any of these headings for a given KGRA indicates that the data with respect to this category are inadequate, and suggests that additional geologic information would be needed prior to the development of an impact statement. Specific information required to complete the data base is listed under "Evaluation of Needed Geologic Information." Table 2 is included to facilitate a discussion of the general geologic limitations to geothermal planning and development. The reader may refer to Geotechniques' paper for a more involved discussion of their results (see Appendix A) Figure 7 illustrates the geographical location of each KGRA in context to major defined fault zones delineated by Geotechniques.

At the second geothermal workshop in January, 1979, Hardyman stated that the surficial geologic data are fairly complete at all KGRA sites.

General reconnaissance geologic maps exist for all areas at scales of 1:125,000 to 1:150,000, but the surface expression of known faults are not indicated on these maps. Assessing younger fault displacements and locations yields valuable information for determining possible areas of subsidence.

The state of subsurface geologic information is either sketchy or nonexistent for all KGRAs. In order to delineate subsurface faults and measure displacements, better lithologic descriptions must be obtained through further investigation of records and additional well logging. Information concerning depth to basement rock and its configuration are not presently known. A general assessment of characteristics in Tertiary-aged intrusives across central Idaho and Oregon would aid in determining the geothermal potential at each KGRA and the source of thermal waters.

Seismicity

Table 3 summarizes the subcontractor's results concerning the present seismic hazards associated with geothermal production in each KGRA. A check under the first section heading, "Adequacy of Existing Seismic Data," suggests that the present data base is incomplete. Additional seismic data that are required to complete the data base is listed under "Evaluation of Needed Seismic Information." The third section heading, "Assessment of the Potential Seismic Hazards," cites specific data that substantiate potential seismic activity in the KGRAs.

Due to the regional nature of the seismic data, the Mountain Home, Castle Creek and Bruneau KGRAs are treated as one area because they are in such proximity to one another and, together, to the Snake River Plain.

The reader may refer to Geotechniques' paper for a more involved discussion of the information listed in table (see Appendix A).

All of the KGRAs lie within potential seismic zones--the greatest of which appear to be the Crane Creek and Vulcan KGRAs. In order to assess potential seismic activity, Geotechniques, Inc., had to rely on both a limited geologic and seismic data base that is regional in extent. Definite conclusions concerning the potential of earthquake damage due to natural and induced causes cannot be drawn until more site-specific data are obtained.

A detailed geologic and geophysical investigation of fault delineation over a large scale is warranted. In addition, microseismic monitoring is required to outline baseline seismicity prior to any development and to determine over a longer period of time if the KGRAs are, indeed, seismic.

Subsidence

Table 4 summarizes the subcontractor's results concerning the present subsidence hazards associated with geothermal production in each KGRA. Under the first section heading, "Adequacy of Existing Subsidence Data," a check present for any given KGRA indicates that the respective data base is incomplete. The need for additional data collection in these areas is suggested. Posed problems for resolution and suggested methods of investigation are listed under "Evaluation of Needed Subsidence Information." The third section heading, "Assessment of Potential Subsidence Hazards" cites specific data that substantiate potential subsidence in the KGRAs. Bruneau and Castle Creek KGRAs are treated as one area because they are in such proximity to one another. The reader may refer to Geotechniques' paper for a more involved treatment of the summarized material (see Appendix A).

Geologic materials that are predominant in four of the KGRAs (Mountain Home, Bruneau - Castle Creek and Crane Creek) are susceptible to subsidence. Past and present irrigation activity at Mountain Home, Bruneau and Castle Creek could activate ground water level declines; triggering subsidence. Further, geothermal production would increase the potential for subsidence (by causing rapid water level draw-downs) if deep thermal waters are recharging shallow water systems.

Repeated first order level nets (this word infers the same meaning as "recording net" in a hydrologic sense) arranged across the KGRAs would supply information to accurately document future subsidence. Rock core samples subjected to laboratory tests for strength and compaction may yield some data from which subsidence potential could be hypothesized. As mentioned earlier, geothermal development could activate subsidence if thermal waters are responsible for shallow surface system's recharge. It is, therefore, necessary to pin point the source of thermal waters and unravel their travel path. Just as production may initiate seismic activity, water withdrawal and re-injection, if not properly monitored, may cause subsidence.

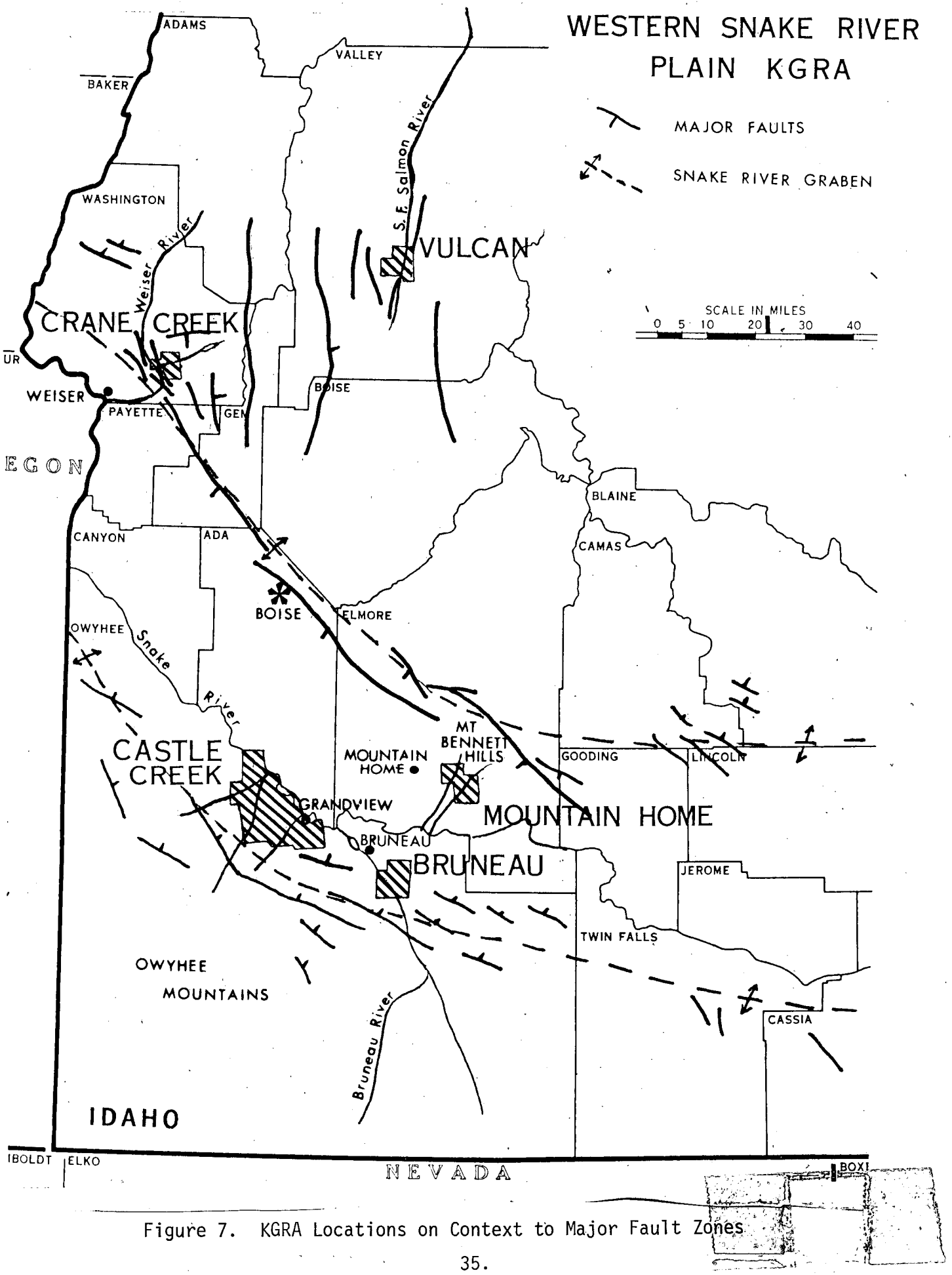


Figure 7. KGRA Locations on Context to Major Fault Zones

KGRA	ADEQUACY OF EXISTING GEOLOGIC DATA: Surficial Data	Sub-Surface Data	Deep Sub-Surface Data	EVALUATION OF NEEDED GEOLOGIC INFORMATION: Surficial Data	Sub-Surface Data	Deep Sub-Surface Data
Mountain Home		X	X	Delineation of faults concealed by the Bruneau Formation is needed.	General information is required.	General information is required.
Bruneau		X	X	Delineation of faults is necessary.	The thickness of silicic volcanic rocks must be verified. - - - - - - - - - - - - Delineation of faults is necessary.	Basement rock lothologies must be studied more thoroughly.
Castle Creek	X	X	X	Incomplete status of geologic mapping ---------- Delineation of surface.	Fault displacements need to be studied further well logging and better lithologic description.	Depth to the basement, basement configuration, and thickness and extent of silicic volcanics is not known.
Crane Creek	X	X	X	Incomplete status of geologic mapping	Subsurface lithologies and locations of faults without surface expression are not known.	The depth to the basement is not presently known.
Vulcan	X	X	X	Incomplete status of geologic mapping	Incomplete status of subsurface geology and geophysical data ---------- Delineation of bedrock faults is necessary.	An assessment of trends of tertiary intrusion rocks across central Idaho and Oregon would be valuable.

Table 2. Geology - Summary of Concerns

Note: A check present under any subcategory for "Adequacy of Existing Geologic Data" indicates that the status of those data are inadequate.

KGRA	Adequacy of Existing Seismic Data	Evaluation of Needed Seismic Data	Assessment of Potential Seismic Activity
Mountain Home - Castle Creek - Bruneau Area	X	Detailed geologic mapping is required. Acquisition of seismic reflection data would aid in delineating sub-surface faults. Micro seismic surveys monitoring activity over long periods from deep holes would help to determine if the area, indeed, is seismic.	Nearby areas exhibit relatively high seismic activity.
Crane Creek	X	Aerial reconnaissance and a detailed analysis of anomalous sites is needed. Micro seismic monitoring is necessary to establish baseline data in the Cascade-Sweet zone	1976-1977 data show significant seismic activity to the northeast of the KGRA.
Vulcan	X	Geologic mapping is needed. Micro seismic surveys of sufficient duration would allow the delineation of zones of seismicity.	Swarm activity occurred in 1970 within 15 kilometers of this KGRA.

Table 3. Seismicity - Summary of Concerns
Note: A check under "Adequacy of Existing Seismic Data" indicates that the present data base is incomplete.

KGRA	Adequacy of Existing Subsidence Data	Evaluation of Needed Subsidence Information	Assessment of Potential Subsidence Hazards
Mountain Home	X	Repeated leveling data would be necessary to assess if subsidence has occurred in this area. Laboratory compaction tests would allow an estimate of compaction potential.	Geologic materials of the area prove susceptible to subsidence. Ground water level declines of more than 20 feet from 1968 to 1977 occurred to the south.
Bruneau - Castle Creek Areas		It is necessary to discern if deep aquifers are recharging shallow ground water systems due to the potential of subsequent water level drawdown.	Geologic materials of the area prove susceptible to subsidence. Heavy irrigational use may cause a decline in water levels -- development could accelerate the declines.
Crane Creek		It is necessary to discern whether thermal waters are meteoritic waters recycled at depth or older waters that are upwelling. Development could trigger water level declines.	Geologic materials of the area prove susceptible to subsidence.
Vulcan			It is hypothesized that subsidence in this area would be caused by water level drawdowns in regions of fracturing or altered bedrock.

Table 4. Subsidence - Summary of Concerns
Note: A check present under "Adequacy of Existing Subsidence Data" indicates that the present data base is incomplete.

PART II (B):
CLIMATE, METEOROLOGY, AND AIR QUALITY

Combined climatic, meteorological and air quality data gathered from all KGRAs suggest that environmental problems could arise with geothermal development. The meteorology and micro-climate of the specific KGRA sites, however, are not known and, as a result, the ambient air quality remains unqualified. These deficiences in the initial data base were recognized at the first KGRA workshop. At the same time, two key issues arose concerning air quality:

(1) The KGRAs are geographically located where lack of air circulation may be a serious problem, should development proceed.

(2) Air pollution is a potential problem if hydrogen sulfide gases are present and not diluted through air movement.

The subcontractor's report denotes where additional data is needed and discusses specific conerns of geothermal development at each KGRA.

Climate and Meterology

Table 5 summarizes the subcontractor's results concerning the present climatological and meteorological limitations to geothermal development in each KGRA. Checks under the first section heading, "Adequacy of the Existing Environmental Date Base," suggest that the entire data base for all KGRAs is incomplete. The second section heading, "Adverse Weather Conditions," cites potential extreme weather conditions within each KGRA.

Present knowledge of the micro-climate in the KGRAs is grossly generalized and was collected by extrapolating data from three main sources. Geotechniques concluded, in all cases, that "In order to be more precise and accurate, meteorological and climatic data should be

gathered directly from each KGRA by establishing a suitable recording and monitoring system of instruments" (see Appendix A). A site-specific data base would probably be required to confirm the validity of extrapolated micro-climate data and recorded adverse weather conditions should be considered as potential damaging events. The need for specific additional information, however, will be use-specific.

Air Quality

The existing air quality information constitutes an incomplete and biased data set. Micro-climate data are necessary to supplement air quality data in assessing problems for specific geographic locations and specific uses. Emmissions of particulate matter and hydrogen sulfide, for example, could reach dangerous levels in valleys where air stagnation results. Four of the KGRAs are located in valley regions where air stagnation is intensified by conditions of fog and inversion. In order to determine the degree of air stability at each KGRA site, a site-specific data base is required. Depending upon the intended use, this may or may not be a significant problem.

Air quality data is inherently biased because it is collected near population centers or where industrial activity predominates. Consequently, any extrapolation from this data permits only broad estimates of the actual environmental conditions of the KGRAs.

Geotechniques stated that in areas where increased activity proceeds (industrial development, highway construction or simply population growth), a corresponding increase in emmissions at both point and area source levels is also measured. A list of pollutants and point sources is included for Elmore, Twin Falls, Valley and Washington counties in the

subcontractor's report. The resultant air quality of all KGRAs is a complex interaction of regional air masses that circulate in partly random patterns. Reliance on values extrapolated from one source of air quality data should be questioned.

KGRA	Adequacy of the Existing Environmental Data	Adverse Weather Conditions
Mountain Home	X	- Occasional, moderate dust storms - Occasional recordings of funnel clouds or tornados - Destructive winds are rare.
Bruneau - Castle Creek Area	X	Occasional, moderate dust storms or thunder storms
Crane Creek	X	Occasional thunderstorms and hail of little consequence
Vulcan	X	- Hail up to one half inch in diameter falls in this area. - Strong valley winds uproot trees in shallow soil that are poorly anchored.

Table 5. Climate and Meteorology - Summary of Concerns
Note: A check under "Adequacy of Existing Environmental Data" indicates an incomplete data base.

PART II (C):

SOILS

Savage submitted a report on existing soil surveys and land use information for five KGRAs. A study of this nature was deemed necessary at the first geothermal workshop for two reasons: (1) Limitations to geothermal production imposed by either soil properties or topographic characteristics within each KGRA need to be documented by case and location; and (2) Current soil and water use practices that conflict with proposed development plans must be recognized before compromises and resolution measures are attempted.

Table 6 summarizes Savage's soil study results. Prioritized land and water uses are listed for each KGRA under the second section heading, "Land and Water Use Conflicts". The reader may refer to Savage's paper for a more detailed presentation of information summarized in the table.

At the present time, the SCS is attempting to complete all county soil surveys by 1983. Savage adds that only the SCS surveys contain adequate information from which resource limitations should be assessed. FS, BLM and Chugg surveys are adequate for determining irrigability status and broad land use planning. Appendix C is an excerpt from Savage's report and is included to clarify the quality and completeness of soil surveys in each of the KGRAs.

For all KGRAs, physical limitations contributing to potential soil erosion exist. Erosion hazard is associated with specific landforms where soils are shallow, immature, and sparsely vegetated. Topographic lows frequently saturated throughout the year present limitations to certain types of development. More specifically, shallow, stony soils on steep slopes present potential topographic and drainage limitations for the Crane Creek area. Vulcan soils are highly erodable and steep slope gradients predominate within the permit boundaries. Mountain Home soils contain cemented pan layers which inhibit percolation increasing surface runoff potential. These KGRAs may experience accelerated soil erosion rates and, ultimately, high turbidity levels in ground and surface waters if developmental areas are poorly located.

Land and water use patterns for Bruneau, Castle Creek, Crane Creek and Mountain Home present possible conflicts for geothermal development (Figs. 8-12). Private lands are largely irrigated and public lands are utilized as rangeland for livestock. At the Mountain Home KGRA, geothermal waters are presently harnessed by ranchers for irrigation use or residents for space heating applications. The Idaho Department of Water Resources expects to publish more up-to-date maps of land use soon.

A major deficiency in all KGRA soil data bases is the lack of soil chemistry analysis by either laboratory testing or field investigation techniques. A detailed chemical analysis and description of soil types constitutes a fairly complete soil survey record upon which changes in soil characteristics can be evaluated.

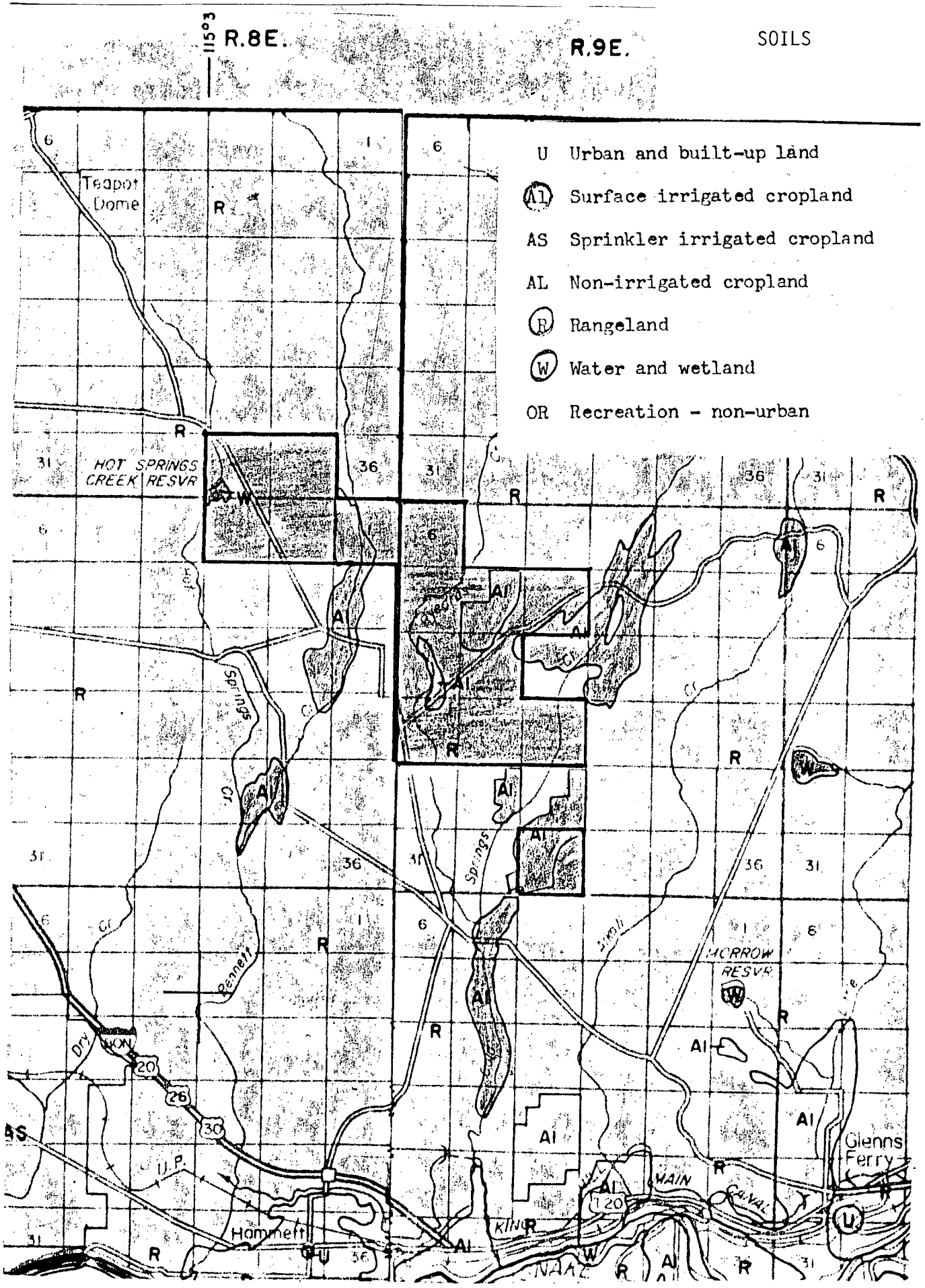
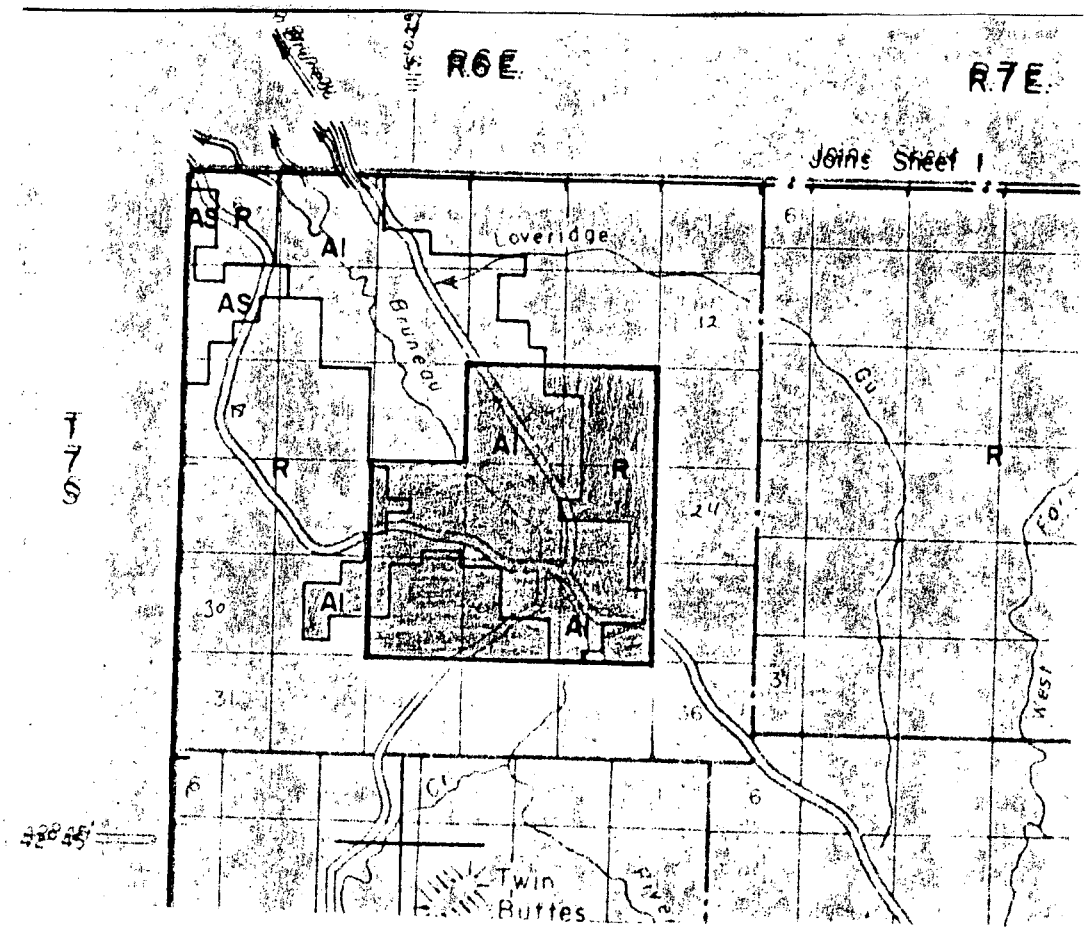


Figure 8. Mountain Home KGRA. SCS land use map, 1975.



U Urban and built-up land

Al Surface irrigated cropland

AS Sprinkler irrigated cropland

AL Non-irrigated cropland

R Rangeland

W Water and wetland

OR Recreation - non-urban

Figure 9. Bruneau KGRA. SCS land use map, 1975.

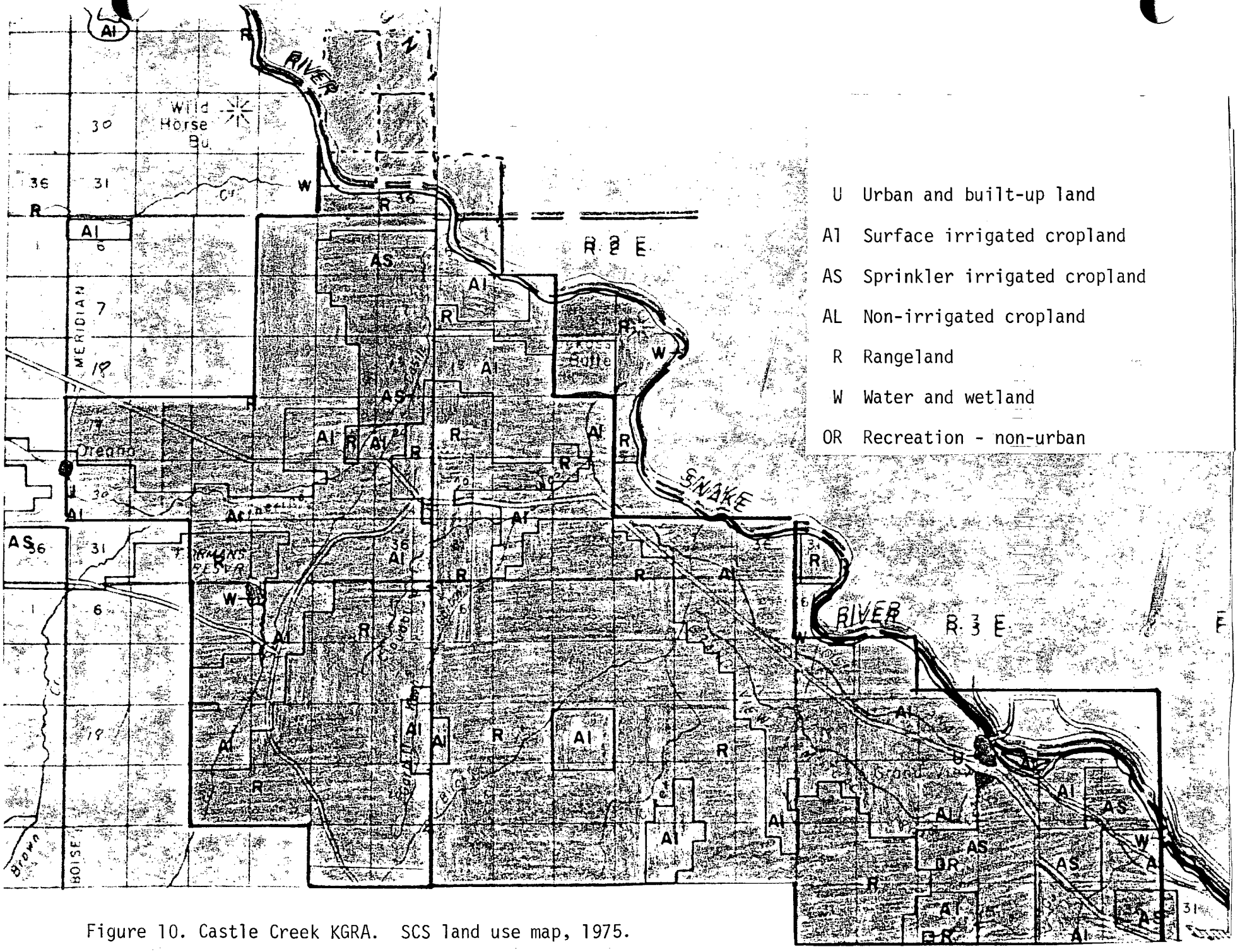


Figure 10. Castle Creek KGRA. SCS land use map, 1975.

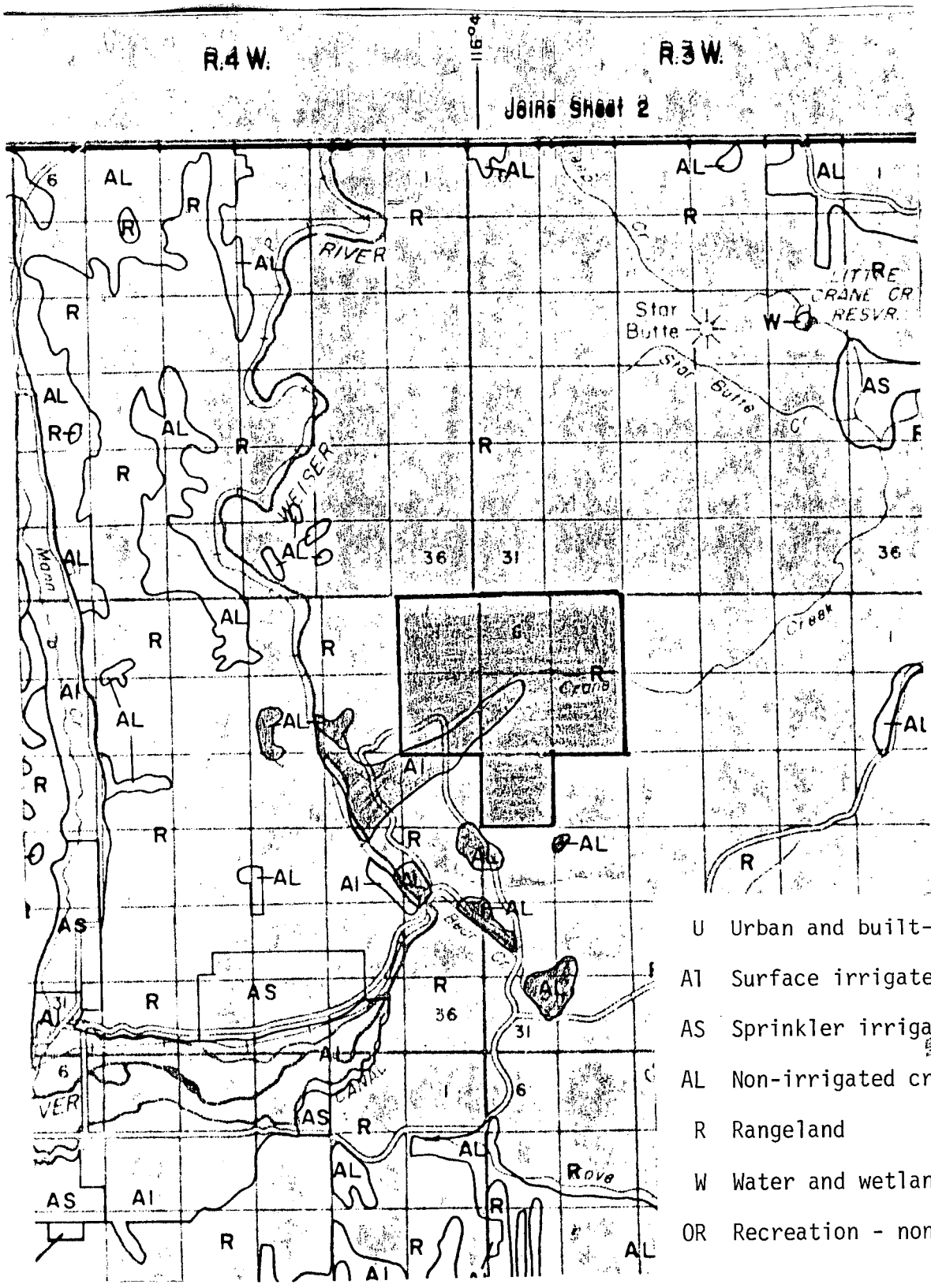


Figure 11. Crane Creek KGRA. SCS land use map, 1975.

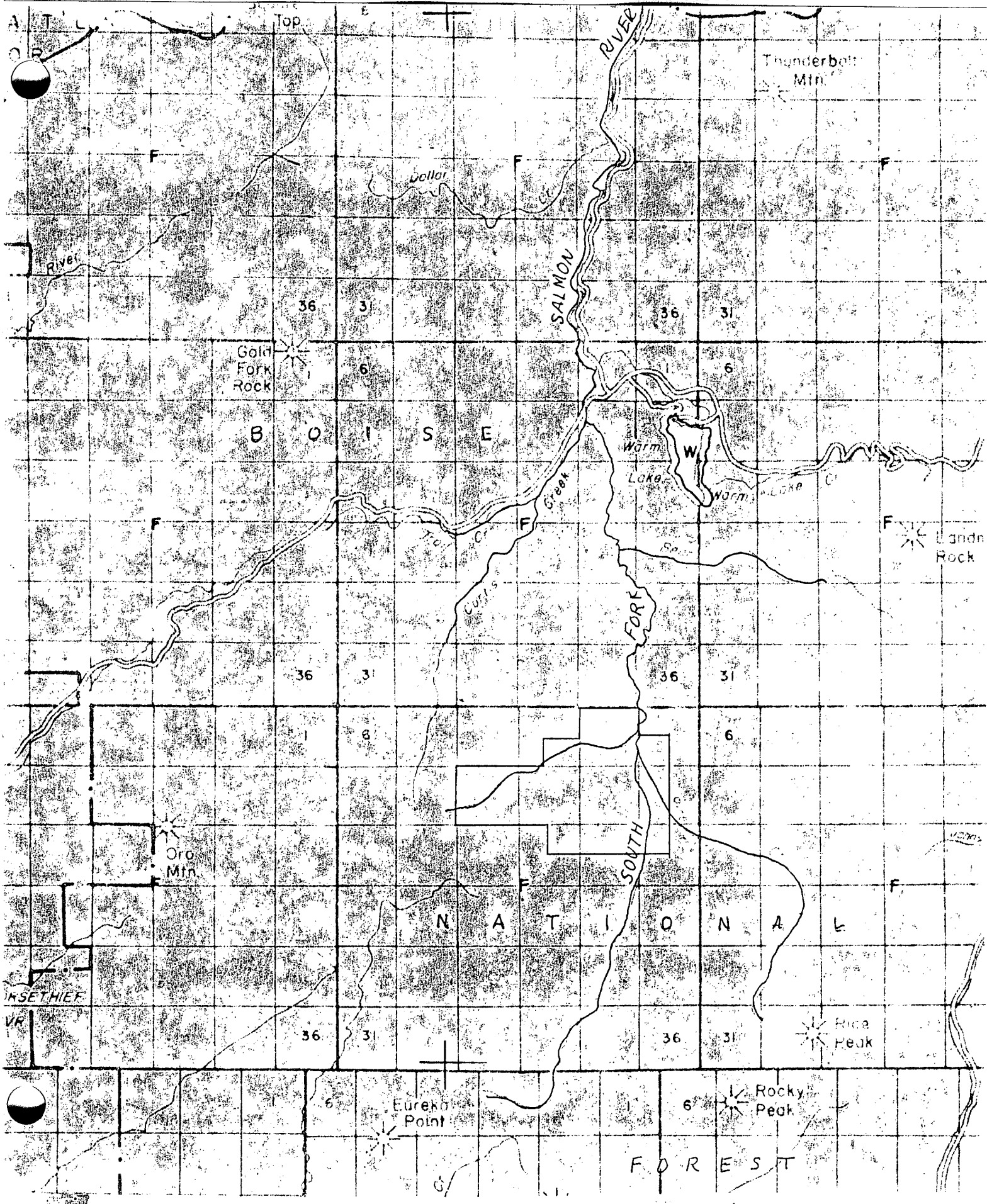


Figure 12. Vulcan KGRA - Land use map called National Forest Land.

KGRA	Land and Water Use Conflicts	PHYSICAL LIMITATIONS CONTRIBUTING TO EROSION Soil Limitations	Topographic Limitations	Drainage Limitations	Specific Limitations
		General: Shallow, immature, sparsely vegetated soils	General: Steep slopes	General: poorly drained, river bottoms and flood plains; cement pans	
Bruneau	Irrigated farm lands(private) and rangeland for livestock (public) present conflicts.				
Castle Creek	Irrigated farm lands (private) and rangeland for livestock (public) present conflicts.				
Crane Creek	Valleys are utilized for farmland and terraces are dissected.		Steep slopes	Shallow, stony soils	
Mountain Home	Irrigated farm lands (private) and rangeland for livestock (public) present conflicts. Geothermal resources are used by ranchers for irrigation or space heating presently.			Cemented, calcareous pan layers inhibit percolation increasing surface runoff potential. Saturated topographic lows present limitations to certain types of geothermal development.	
Vulcan Hot Springs		Highly erodable soils	0 to 60% slope gradient throughout the area		Heavily forested

Table 6. Soils - Summary of Concerns

PART II (D):
HYDROLOGY AND WATER RIGHTS

Miller and Warnick submitted a report on available hydrologic and hydrogeologic data for all KGRAs. An adequate evaluation of water quality/ hydrology problems is indicated as being necessary for several reasons. A general knowledge of the geothermal resource is required as a basis to further understand engineering design problems associated with production and overall impacts on the surface environment. For example, development plans cannot proceed until fundamental questions are answered such as those that follow:

(1) What is/are the source(s) of thermal waters and how long can geothermal production be sustained.

(2) What are the inter-relationships of hot fluids, surface waters and shallow ground water systems?

(3) Are spent fluids best disposed of by reinjection or discharge into surface waters?

(4) Is a monitoring network necessary to detect the effects of fluid injection?

(5) What uses are best supported by the unique geochemical quality of the thermal waters?

(6) What effects will Idaho water laws and rights have on the development of the resource?

Surface environmental impacts would include the effects of geothermal production on the quantity, quality and availability of surface or ground waters which sustain floral, faunal and human communities. Hence, the hydrologic limitations discussed in this section interface physical concerns previously discussed and surface environmental concerns that follow.

Table 7 summarizes Miller's and Warnick's results. Existing hydrologic data are categorized in four ways under the first heading as follows--ground-water flow system, water balance, water quality and consumptive use data. With the exception of the data collected at Crane Creek, none of the hydrologic data from any of the five KGRAs are considered complete. The second section heading, "Special Concerns," is subdivided into categories under which limitations are listed with respect to water rights laws, water use conflicts, land use conflicts, environmental pollution or disturbance potential and water chemistry. The reader may refer to Miller's and Warnick's paper for a more involved treatment of the limitations listed in Table 7 (see Appendix A).

Additional hydrologic and hydrogeological data are required to adequately define the groundwater flow system, outline the water balance in a particular KGRA or adjacent basins, determine water quality for ground and surface waters or clarify consumptive water use patterns within a community. Ultimately, if each category above is represented by a completed data base, a general knowledge of the geothermal resource can be obtained.

Adjudication of all water rights (required for an entire drainage basin) is necessary in each KGRA, with the exception of the Vulcan, prior to any consideration of development. Crane Creek, Castle Creek and Bruneau KGRA's have established irrigation practices that could present major water use conflicts. Specific land use conflicts are identified for these same KGRA's in the summary table. The location of water rights by permit number for four KGRA's is illustrated in Figs. 13-16.

Geothermal development presents a possible threat of environmental pollution or disturbance in three KGRAs. At Bruneau, aquifer pollution due to waste water disposal should be a concern. A stream that flows through the permit boundary is currently being studied for possible inclusion in the Wild and Scenic River System. At Castle Creek, environmentalists warn that development could threaten the extinction of sensitive species in the Federal Birds of Prey Sanctuary along the Snake River. Finally, the South Fork Salmon River supports a large anadromous fish population which directly enhances the recreational value of the Vulcan Hot Springs - Warm Lake area. At this location, thermal or chemical pollution of surface streams could endanger fish species or devalue the aesthectics. Part II (E), following discusses limitations centered about the Federal Birds of Prey Natural Area.

Reports of high fluoride contents in the ground waters of both the Bruneau and Castle Creek KGRAs require special attention. If cooling operations at geothermal plants would tend to concentrate fluoride in surface streams via disposal, there would be a measurable impact on all environmental elements.

KGRA	ADEQUACY OF EXISTING HYDROLOGIC DATA				SPECIAL CONCERNS				
	Definition of Ground Water Flow	Outline of the Water Balance into the KGRA or adjacent drainage Basins	Water Quality Data for Ground and Surface Waters	Consumptive Water Use Data	Water Rights Limitations	Water Use Limitations	Water Use Limitations	Environmental Limitations	Specific Limitations
Bruneau	X	X	X	X	Adjudication of all water rights is needed.	Major conflicts with established irrigation activity	U.S.D.D. gunnery range	Aquifer pollution due to waste disposal This area is under study for inclusion in the National Wild and Scenic River System.	High fluoride content of ground waters
Castle Creek	X	X	X	X	A possible violation may result of the instream minimum flow law and water permit for Power issued to Idaho Power Co.. Adjudication of all water rights is needed.	Major conflicts with established irrigation activity	proposed Swan Falls-Guffey Power project on the Snake River	Environmental disturbance of the Federal Birds of Prey Sanctuary along the Snake River	High fluoride content of ground waters
Crane Creek	X	X		X	Adjudication of all water rights is needed.	Major conflicts with established irrigation activity	Proposed multipurpose dam at the Galloway Site on the Weiser River		
Mountain Home	X	X	X	X	Adjudication of all water rights is needed.	Minimal conflict with established irrigation activity			
Vulcan Hot Springs	X	X	X	X	Water rights downstream of the KGRA boundary must considered.			Environmental disturbance to streams that support anadromous fish population The Vulcan Hot Spring and Warm Lake areas support much recreational activity. Geothermal development may decrease the aesthetic value of this area.	

Table 7. Hydrology - Summary of Concerns
Note: A check below any of the four hydrologic data categories indicates that the data base in question is incomplete.

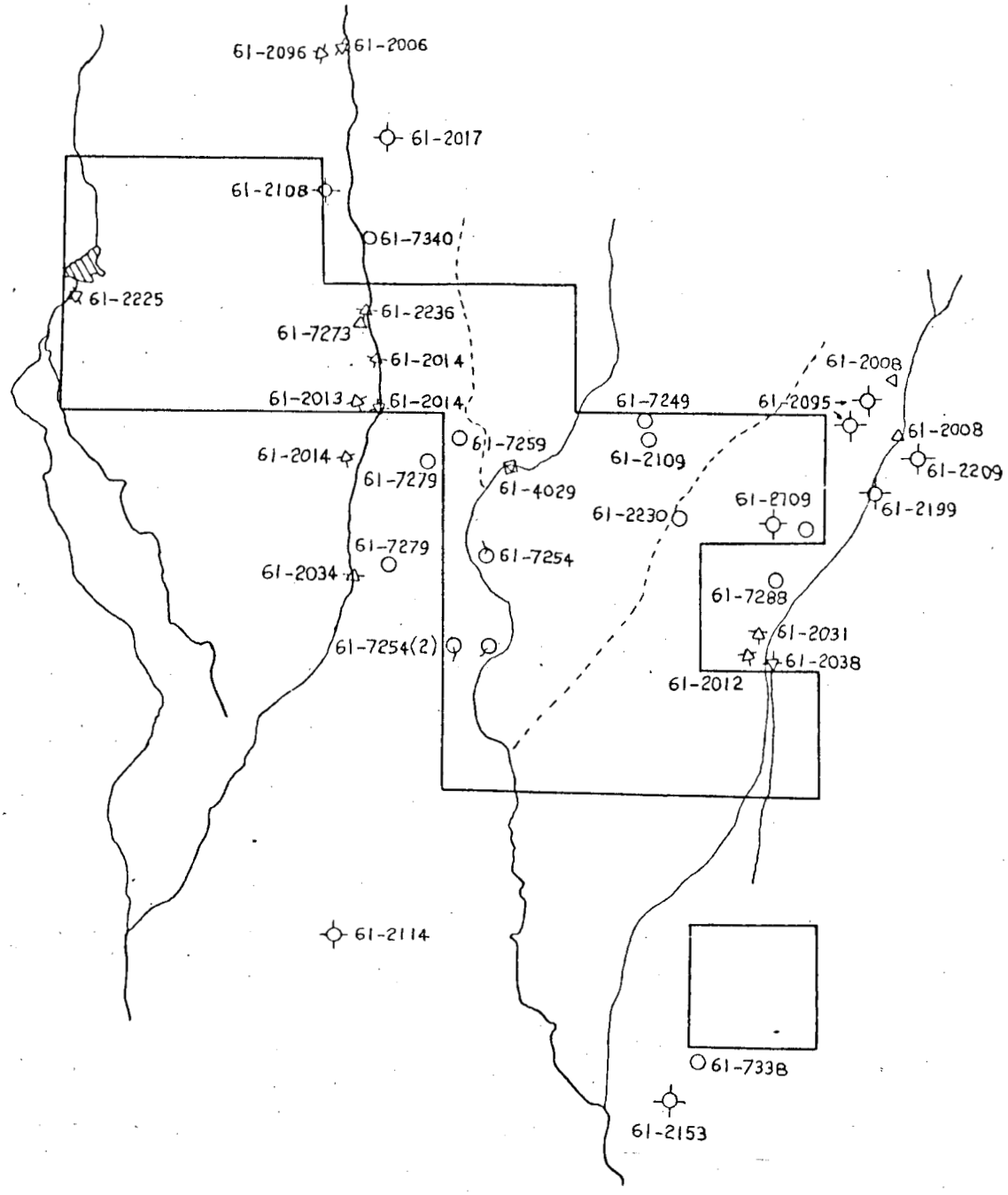


Figure 13. Location map for known water rights in the vicinity of the Mountain Home KGRA area.

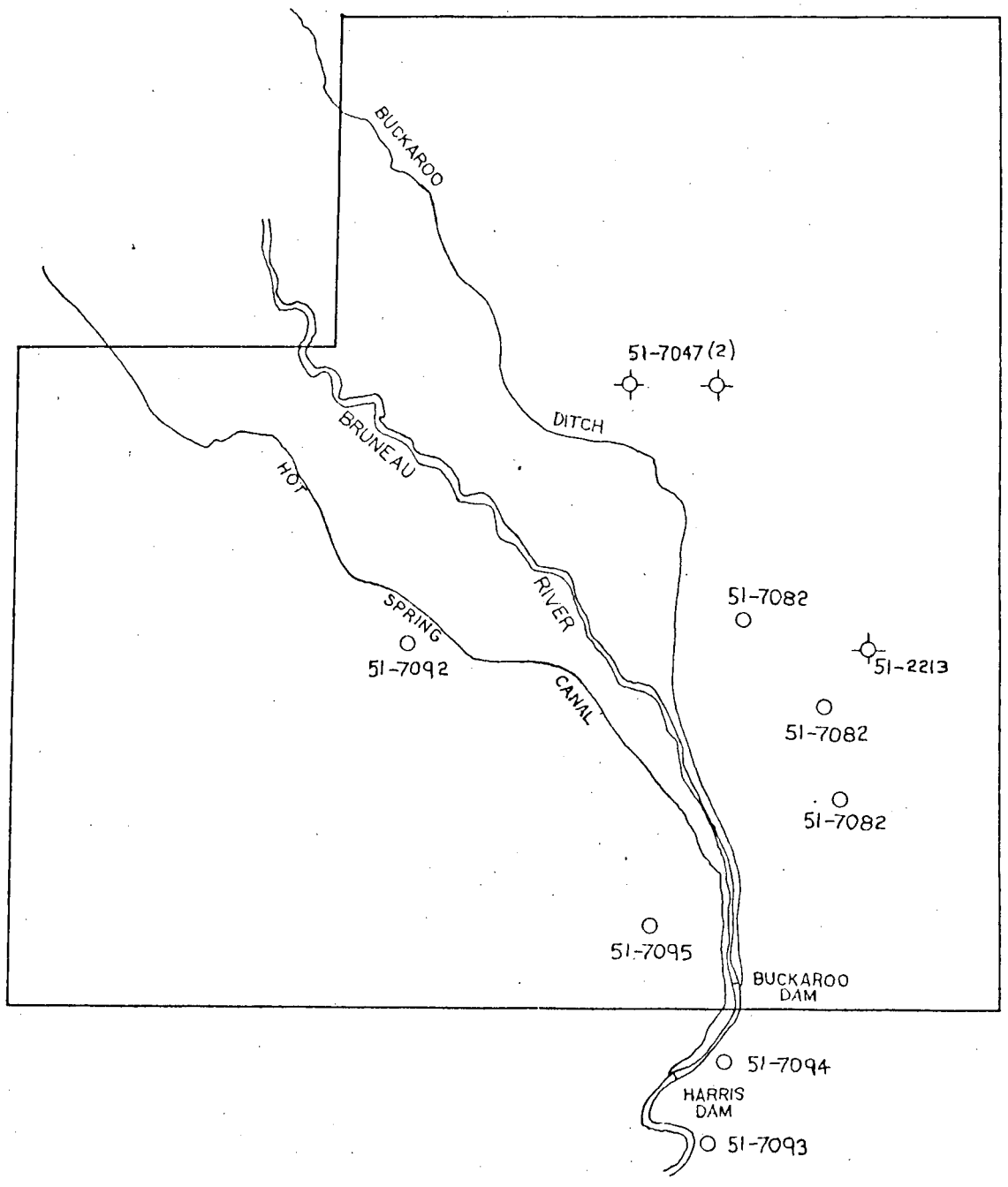


Figure 14. Location map for water rights in the Bruneau KGRA area and vicinity.

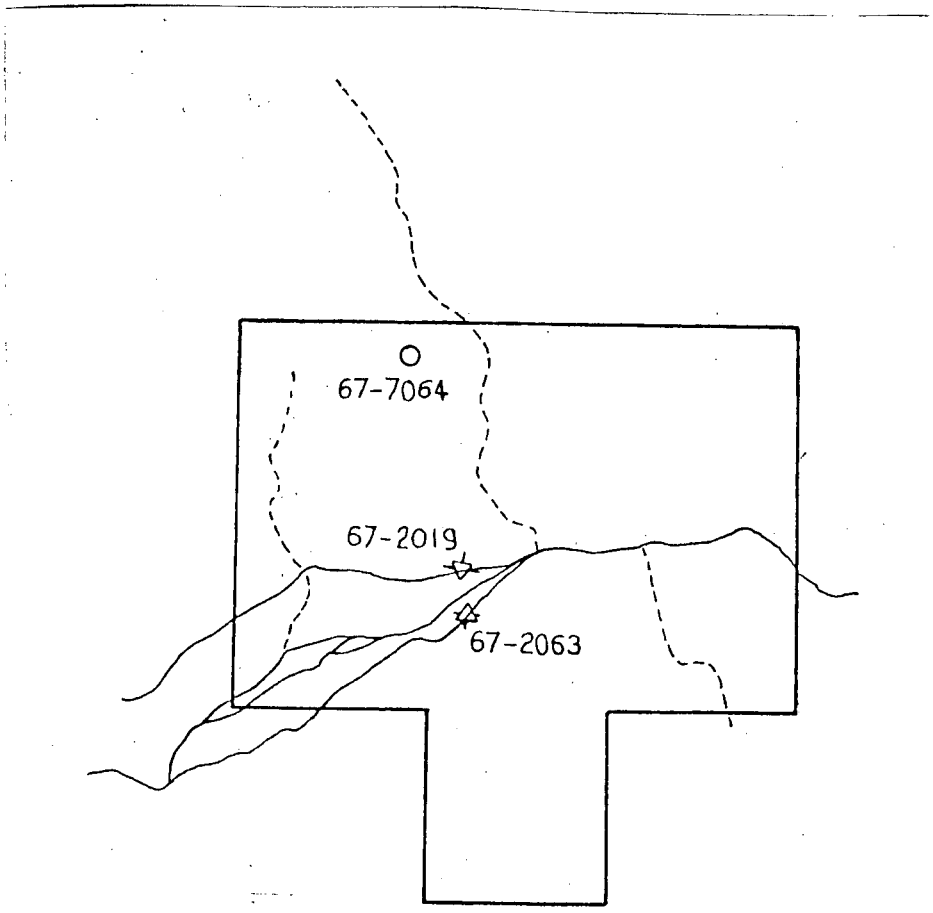


Figure 15. Location map for known water rights in the Crane Creek KGRA.

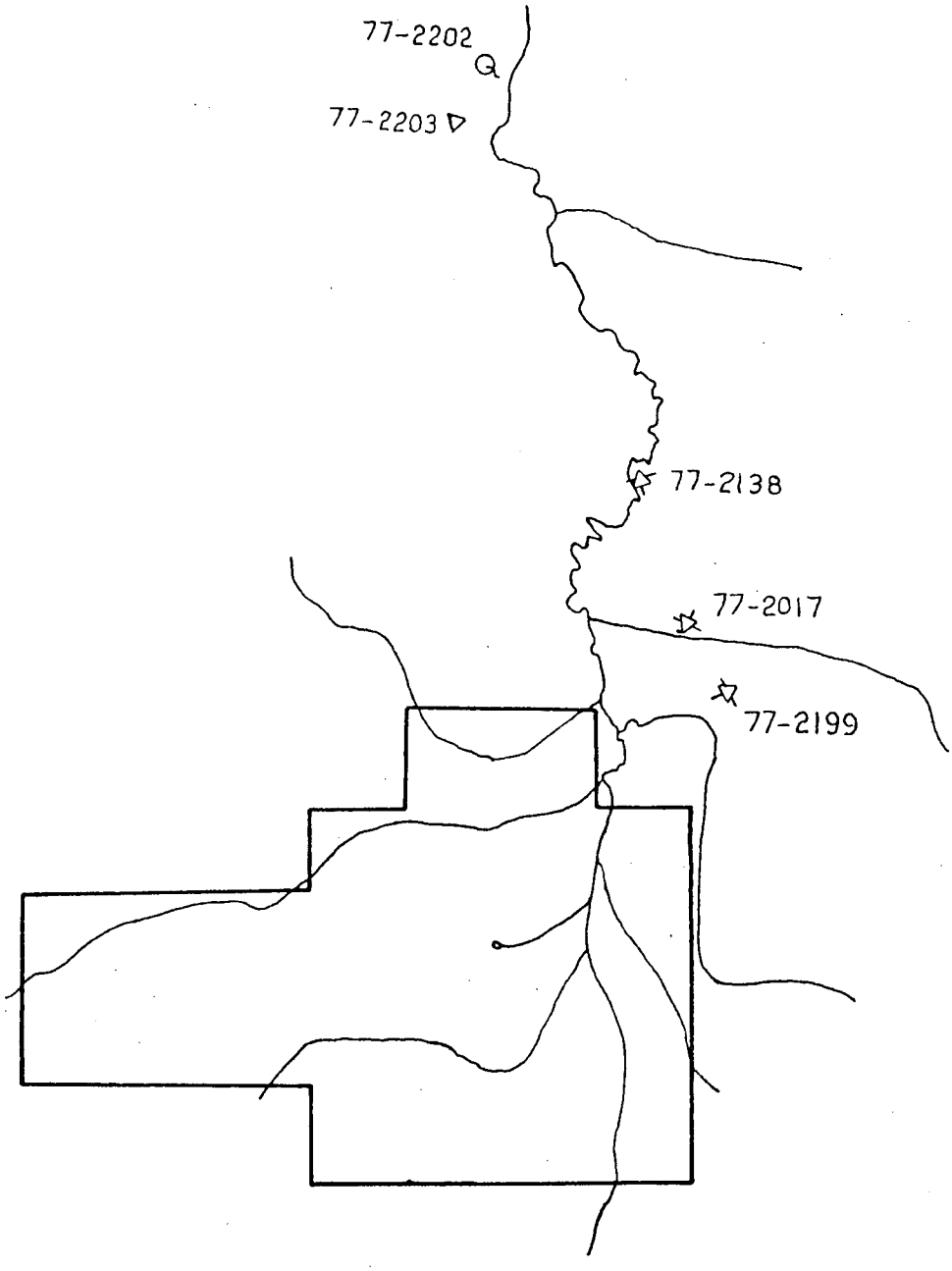


Figure 16. Location map for known water rights in the vicinity of the Vulcan Hot Springs KGRA area.

PART II (E):
TERRESTRIAL ECOLOGY AND THE FEDERAL BIRDS OF PREY SANCTUARY

Jorgensen and Johnson gathered and synthesized available terrestrial environmental data for the five KGRAs. A key concern that evolved at the first geothermal workshop was to gather sufficient ecological data upon which management decisions would be based. In order to establish this data base, an ecological study was designed to inventory the terrestrial communities dominating each KGRA. From this data set, sensitive species and habitats subject to serious impact would be noted and given special consideration in planning strategy.

Table 8 summarizes Jorgensen's and Johnson's results. The first and second section heading list, respectively, the habitat classification and species designated of special concern for each KGRA. Under the third section heading, "Other Concerns and Recommendations" a synopsis of problems associated with each KGRA and general assessments are cited. The reader may refer to the subcontractors' paper for a detailed discussion of material summarized in the table (see Appendix A).

One third of the Castle Creek permit area overlaps the Federal Birds of Prey Natural Area. The sanctuary houses 284 pairs of birds in high inaccessible cliffs along the Snake River. The Sage Brush habitat supports an immense food chain which, in turn, supports the birds of prey.

Existing studies that attempt to determine sensitive species' tolerance to invasion of hunting and nesting territories can only be of partial value in assessing impacts of development on KGRA areas. If the food base is not effected by production, then the nesting

situation should not change. Depending on the proximity of nesting ground to cooling towers, noise may or may not be a factor in causing a disturbance of the stable environment.

Perhaps the greatest impact upon this area will be opening up adjacent areas for geothermal development.

White recommended that a fifteen kilometer buffer strip be established on either side of the ridge that parallels the Snake River to alleviate the possibility of any serious impacts on the ecosystem. Jorgensen and Johnson added that the present proposed boundaries of the Castle Creek and Bruneau KGRAs should be re-evaluated to ease impact on the terrestrial ecology.

A reduction or alteration in extensive riparian habitats within the KGRAs could limit game and non-game species populations. Additional information is needed to clarify the status of designated sensitive species before development begins. Key species should be adequately protected.

KGRA	Location	Species of Special Concern		Other Concerns and Recommendations
		Plant	Animal	
Castle Creek	Area occupies much of the limited Salt Desert Shrub Habitat. One third of the area overlaps the Snake River Birds of Prey Natural Area.	A Stragalus Mulfordiae "Milk-vetch"	Chukar, Prarie Falcon, Peregrine Falcon, Bald Eagle, Osprey and over-wintering water foul.	A reduction in extensive riparian vegetation habitat could limit game and non-game species population. Present proposed boundaries of the Castle Creek and Bruneau KGRAs should be re-evaluated to ease impact on the terrestrial ecology.
Bruneau	Area occupies a fraction of the tall sage brush habitat.	Same as above	Same as above	Same as above
Mountain Home	Area is located entirely within the tall sagebrush habitat.	Primula cusickiana "Primrose"	Mule Deer, Sage Grouse	Consideration must be given to the reduction in Mule Deer and Sage Grouse populations if the habitat is altered extensively.
Crane Creek	Area is located within the tall sagebrush habitat.		Mule Deer, Pronghorn, California Quail, Chukar White-faced Ibis, Idaho Ground Squirrel and over wintering fowl.	Additional information is needed to clarify the status of the White-faced Ibis and the Idaho Ground Squirrel before development begins. Key species populations maintained by extensive riparian vegetation should be adequately protected.
Vulcan	Area is located on a wet meadow habitat.		Elk	Developing the KGRA imposes a serious risk on reducing Elk numbers because it disturbs a major calving ground. Mule Deer migration and Chinook Salmon breeding may also be disturbed.

Table 8. Terrestrial Ecology and Birds of Prey - Summary of Concerns

PART II (F):
HERITAGE RESOURCES

A review was conducted of the cultural and natural heritage resource data relevant to the five KGRAs under study by Knudson and Pfaff. Development of any kind powered by geothermal energy could adversely impact heritage resources if sites remain undocumented. Therefore, it is mandatory that these non-renewable heritage resource sites be located and evaluated prior to the disturbance of any ground initiated by development activity.

Table 9 summarizes the overview of existing heritage resource data bases within each KGRA. Heritage resources are categorized into three groups: paleontological, prehistorical, and historical data. With the exception of historical data collected within the Vulcan KGRA, the cultural and paleontological data available for all KGRAsare inadequate to allow a comprehensive assessment of development impacts upon them. This is demonstrated by the checks under the first section heading "Adequacy of Existing Heritage Resource Data." An impact evaluation can be developed only after inventory data are made available. Under the limitation headings, documented or hypothesized localities of paleontological, prehistorical and historical sites are listed. The reader may refer to Knudson's and Pfaff's paper for a more involved treatment of the information presented in Table 6 (see Appendix A).

Fossil-rich Pliocene and Pleistocene beds are exposed at certain known localities in Southwest Idaho and additional exposures may outcrop within KGRA boundaries. Most KGRAs have been heavily exploited in the vicinity of hot springs by human groups (especially various Indian cultures) for over 10,000 years. Within the past 200 years, Euroamericans

(fur traders, miners, emigrants, etc.) have either homesteaded or traveled through the KGRAs - as evidenced by residential remnants. In the light of this information, the need for additional field reconnaissance in all KGRAs is definitely indicated.

	ADEQUACY OF EXISTING HERITAGE RESOURCE DATA					
	Paleonto-logical Data	Prehistoric Data	Historic Data			
Bruneau	X	X	X	Molluscan, plant and vertebrate fauna are preserved in the Chalk Hills, Glens Ferry, and Bruneau Formations	Olsen found over 200 cultural sites in the Bruneau Canyon in 1937 (the records are unpublished and lost) and a small camp site at the southern KGRA border was verified. Shoshoni winter villages and camps were most likely established at Hot Springs on the western KGRA border. A survey unearthed 173 prehistoric sites adjacent to to the KGRA that date to 10,000 years.	Homesteads, early schools or community structures may occur in this KGRA.
Castle Creek	X	X	X	Fossil-rich Pliocene and Pleistocene deposits (including fossil horse assemblages of the Hagerman section are potentially found in this KGRA and adjacent areas.	Lithic resource sites and large village sites in the Snake River Canyon suggest a rich prehistoric data base within the KGRA. The canyon-plateau-uplands region is believed to have supported prehistoric cultures from 8000 years ago. Mixed groups of Shoshoni and N. Paiute occuppied this area.	Euroamericans traveled and homesteaded along the South Route of the Oregon Trail which runs along the northwest-southeast length of the KGRA. The Oregon Trail is receiving Federal identification for preservation. Grand View and Clark's ferries operated within the KGRA.
Crane Creek	X	X	X	Upper Miocene faunal remains in the Payette Formation are used as lithologic contact designation for the Columbia Plateau bedded sequence.	Folsom projectile points dated to 10,900 years ago attest to a cultural time depth throughout the KGRA and vicinity. Artifacts including Midvale complex materials (4,000-7,000 years) and similar Sangler site remains (600 years) may be present here. Nez Perce and Shoshoni Indians exploited the lower Weiser Valley.	Historic archeological and architectural resources are of great variety and potential of significance in this area.
Mountain Home	X	X	X	Although the data base is undeveloped, fossil-rich formations in this KGRA are unlikely to be found based on the type of bedrock.	Perennial streams and hot springs may have supported a few cultural groups in the area. The KGRA was exploited by the Shoshoni Indians and cultural materials indicate 11,000 years of human use of this area.	Travel routes such as the Oregon Trail and Kelton Road suggest that this area has been a popular traffic crossing. Remnants of residential sites and homesteading in the area may be minimal though.
Vulcan Hot Springs	X	X		Although the data base is undeveloped, the potential for producing significant remains is low due to the nature of the rock type in the KGRA.	Two prehistoric lithic scatters discovered in dense vegetation suggest that more sites are present. Nez Perce and Shoshoni exploitation of this area is probable. Evidence suggests that the KGRA has been exploited by human population 10,000 years.	

Table 9. Heritage Resources - Summary of Concerns
Note: A check appearing under "Adequacy of Existing Heritage Data" indicates the present data base in incomplete.

PART II (G):
SOCIOECONOMIC CHARACTERISTICS

An inventory and evaluation of the existing socio-economic data for the ten-county Southwest Idaho region was conducted by Lewis & Associates. This was required because appraisals of agricultural and population impacts subsequent to geothermal development are meaningless until they can be related to baseline, site-specific data. One objective of this study was to recommend a strategy for providing a reliable and complete data set upon which projected impacts and comparisons could be based. In addition, the scope of the study yields insight into the general sociological and economic characteristics of the region.

Table 10 summarizes the results. The first section heading, "Adequacy of Existing Socioeconomic Data," specifies areas in which demographic data are lacking, as indicated by a check. Restraints to development imposed by inadequacies of public services and other demographic factors are listed under "General Limitations." The reader may refer to the original report for a more detailed discussion of information presented in the summary table (see Appendix A).

The subcontractor concludes that the existing socioeconomic data base is adequate to begin environmental impact studies. While projections of population, labor force and employment may be regarded as excellent, however, additional data in the education and health care fields for all KGRAs would be valuable. Lewis states that "Data pertaining to the socio-economic structure of the KGRAs is some what outdated but appears to be more than adequate." For example, retail trade and selected

services data are more than six years old, but the supply of goods and services is projected to increase directly as demand rises in accordance with development.

Comprehensive and current data on housing quality, availability and cost are unavailable for Southwest Idaho. Agricultural land uses within the KGRA vicinities need to be inventoried. A general survey of the housing situation and an inventory of both agriculture and land use activity within the KGRA vicinities are merited.

For most areas in Southwest Idaho, a major geothermal development could cause a shift away from a rural, nonmanufacturing environment. Significant retraining and cultural adaptation demanded by such a labor shift would precipitate some problems. These problems are not considered significant because the pace and magnitude of changes will be relative to the size of the local communities involved.

In conclusion, it is recommended that no additional demographic data be collected, but that gaps in the existing data base be completed at the time that impact studies are made.

	Adequacy of Existing Socioeconomic Data Concerning:	General Limitations
Population		Population data for the principal centers is outdated.
Labor Force		Counties with low total unemployment numbers may have a difficult time meeting the labor demands of a new industry.
Economic Structure		
Employment		
Retail Trade		Several counties in the study region have relatively few retail establishments. Existing retail capacity must be related to potential population changes in an impact assessment.
Wholesale Trade		Wholesaling is generally concentrated in urban areas. Data on wholesale activity at the county or regional level is limited.
Selected Services		Rural areas offer a limited number and range or selective service.
Manufacturing		The activity is largely concentrated in Ada and Canyon Counties. A shift from a rural-agricultural to a non-rural-manufacturing culture will not be without problems.
Income Distribution Data		Owyhee and Washington Counties are characterized by a high percentage of families below the poverty line. The study region is considered a below-average income area in a below average income state. Geothermal development could have a differential impact on different income groups.
Agriculture		Agricultural land resources and utilization are challenged by geothermal development. Specific land uses in the vicinity of the KGRAs need to be inventoried. The off-farm labor activity of farmers impacted by geothermal development must be considered. Data collection is necessary to discern whether farmers are interested in industrial jobs or seeking occupational change.
Mining		
Baseline Projections of Population and Economic Activity		
The Public Sector		
Public Finance Data		
Education		Significant industrialization can lead to large impacts on the area's education system.
Crime		There is a chance that the crime rate will increase with significant industrialization.
Health Care		Data collection efforts should be aimed at identifying specific locaitons of hospitals and doctor's offices in the vicinity of the KGRAs.
Land Use		Leasing of land for geothermal development will require environmental impact statements and permits from environmental agencies.
Recreation		

Table 10. Socioeconomic Limitations - Summary of Concerns
Note: A check under "Adequacy of Existing Socioeconomic Data" indicates that the present data base is inadequate.

PART III:
GENERAL CONCLUSIONS

1) Additional environmental data should be collected to fill in the gaps of the existing data base at the time when the type of development at each KGRA is known.

2) Potential land and water use conflicts should be resolved after water rights are adjudicated and an investigation of land ownerships is conducted within each KGRA vicinity.

3) Funds should be allocated to support a study which researches a long-term monitoring strategy to assess surface and subsurface environmental impacts.

4) A resource conservation strategy discussed at the second geothermal workshop is outlined as follows:

Step 1: Define and establish a reliable, site-specific data base for each KGRA.

Step 2: Define all legal problems and resource use limitations encountered at the physical, hydrological, and surface environmental levels of geothermal production.

Step 3: Establish the kind (type and size) of development to be supported by geothermal resources.

Step 4: A complete reconnaissance survey at various scales for natural and cultural resources would be merited in the development areas; not limited to just permit boundaries.

Step 5: Details of resource conservation should be discussed between concerned parties and effective management decisions should evolve through such a meeting.

Solutions to proposed problems and special concerns can be overcome given the cooperation of all involved parties and a well planned resource conservation strategy.

5) Because the KGRA's are arbitrarily defined based upon overlapping development interests, and not necessarily because of specific inherent resource potential, studies beyond those borders should be encouraged.

APPENDIX A- List of Subcontractors

Geotechniques Inc., 1978, KGRA Comprehensive Completion Report - Geology: Boise, Idaho, pp.

_____, 1978, KGRA Comprehensive Completion Report - Seismicity: Boise, Idaho, pp. 14.

_____, 1978, KGRA Comprehensive Completion Report - Subsidence: Boise, Idaho, pp. 13.

_____, 1978, KGRA Comprehensive Completion Report - Climate and Meterology: Boise, Idaho, pp. 17.

_____, 1978, KGRA Comprehensive Completion Report - Air Quality: Boise, Idaho, pp. 19.

Jorgensen, C.D. and Johnson, T.L., 1978. Literature Review and Assessment of Terrestrial Ecological Data for Selected KGRAs in the Snake River Plain, Idaho: Crade Creek, Vulcan, Castle Creek, Bruneau, Mountain Home: Dept. of Zoology, BYU, Provo, Utah, 157 pp.

Knudson, R. and Pfaff, M., 1978. Heritage Resources and Known Geothermal Resources Areas (KGRAs) in Idaho: A Preliminary Evaluation: Laboratory of Anthropology, University of Idaho, Moscow, ID., 47 pp.

Lewis, W.C., 1978. Geothermal Development of Southwest Idaho: The Socioeconomic Data Base: Lewis & Associates, Logan, Utah, Sect. 7-8, pp.

Miller, C.L. and Warnick, C.C., 1978. Assessment of Hydrology and Water Quality of the KGRA Areas of the Snake River Basin: Idaho Water Resources Research Institute, University of Idaho, Moscow, Idaho. 159 pp.

Savage, N., 1978. Snake River Basin KGRA Environmental Report - Soils, Department of Biological Sciences, University of Idaho, Moscow, Idaho, 45 pp.

APPENDIX B

(The following material is excerpted from: "Survey of Environmental Regulations Applying to Geothermal Exploration, Development, and Use," WAPORA, Inc., Washington, D.C., Feb., 1978. 245 pp. -- EPA Report No. EPA-600/7-78-014; NTIS Accession No. PB 281023.)

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Federal Geothermal Leasing and Development Program

ENVIRONMENTAL PROVISIONS OF LEASES

In accord with a Memorandum of Understanding among the BLM, USGS, and the Fish and Wildlife Service, an internal document, the Bureau of Land Management, in cooperation with the Geological Survey, formulates the general requirements of geothermals leases and issues special stipulations, as necessary, which often are concerned with environmental protection. The BLM is responsible for monitoring for compliance with environmental protection requirements outside the operating area and the USGS examines operation to insure compliance. This function is carried out by the USGS Supervisor whose duties are established by the regulations. He is a representative of the Secretary subject to the direction and supervisor authority of the USGS. He also issues orders to operators for remedial action.

The broad requirement for compliance with all applicable federal, state, and local environmental standards in the geothermal regulations is discussed above in Section II. However, in addition to any action required by the standards, the lessee is ordered by the BLM regulations to 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 is to be managed in accord with the lessee's plan of operation.

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 stream banks. The lessee shall employ such soil and resource conservation and protective 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 emission standards.

6. 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.

7. 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.

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

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

10. 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.

11. Restoration. The lessee shall provide for the restoration of all distrubed lands in an approved manner.

The USGS regulations do not reference local environmental control requirements at the BLM document does. Because of this distinction, a lessee may be confronted with a situation in which the stipulations to his lease reference and incorporate applicable local standards which are preempted by omission in the USGS operating regulations. In addition, although the Supervisor is authorized to issue more stringent standards than the existing ones, it is not inconceivable that the lease may contain more restrictive stipulations than the Supervisor's order. GRO Orders, defined and described below, offer a vehicle for minimizing potential problems generated by the minor differences between the BLM leases and USGS operating requirements. In addition USGS has the authority to insert site-specific special post-lease conditions into the lease.

The plan of operation, which must be approved by both USGS and BLM, requires, among other things, a detailed presentation of the layout of operations and narrative descriptions of proposed measures to be taken to implement the above list of environmental actions. In addition, the position of mud

tanks, reserve pits, cooling towers, pipe racks, etc., are prescribed. These separately relate to water and air pollution control and noise abatement. Monitoring is required for one year prior to production to develop baseline data on existing air and water quality, noise, seismic and land subsidence activities, and ecological systems of the leased land (30 CFR, Section 270.34 (k)).

A sample BLM geothermal resources lease is shown in Appendix F. It will be seen that the lease does not specifically incorporate the compliance language of the regulations, although Section 14 could hardly be more specific in requiring protection of the environment in that all mitigating actions required by BLM shall be taken to prevent all the types of environmental degradation enumerated above. The stringency of this section of the lease is subject only to the discretion of BLM in stipulating the require mitigating actions. The BLM notice of intent to conduct geothermal exploration operations (shown in Appendix G) does not contain, in Condition 1, the compliance language of the regulations.

Both the BLM and USGS regulations require lessees to submit annual reports on measures taken to comply with environmental requirements. USGS is closely supervising The Geysers and Imperial Valley operations, but this type of scruitny may not be maintainable as geothermal leases increase both in acreage and numbers of lessees involved.

Lessees are also required to report within 24 hours occurrences of significant environmental damage or noncompliance with standards. The definition of "significant" is unclear, but failure to report could result in suspension or termination of the lease. On the other hand, the Supervisor is authorized, whether the report is made or not, to shut down any operations he determines are causing or can cause pollution, a feature of concern to geothermal operators. Except in extreme cases, the limitations are interpreted to give the operator a change to remedy the problems.

BLM, much more than USGS, is highly concerned with the protection of historic or scientific values. The lease requires notification of all historic or prehistoric ruins, fossils, or artifacts discovered and specifies that they shall be left intact. Prior to commencing operations, the lessee must furnish a certified statement that archaeological values do not exist or that they may exist where land is to be disturbed. In the latter case, he must engage a qualified archaeologist to survey and salvage such values before operations may begin. Failure to comply may constitute a violation of the Antiquities Act (16 USC 431-433).

The degree of this interest is best illustrated by a recent occurrence which a BLM spokesman states is not apocryphal. The return of rocks removed from a lease site for testing was required because they formed part of the surroundings of a no longer active house of pleasure, patronized in earlier days by cowboys, which is not subject to potential entry on the list of national historic sites.

GEOTHERMAL RESOURCES OPERATIONS ORDERS

Geothermal resources operations orders are formal orders issued by USGS to supplement the general regulations found in 30 CFR 270 by detailing the procedures operations must follow in a given area or region. The purpose of this arrangement is to allow consideration of more area-specific operating and environmental conditions.

The USGS has issued seven GRO's. They are:

- GRO Order No. 1 - Exploratory Operations
- GRO Order No. 2 - Drilling, Completion, and Spacing of Geothermal Wells
- GRO Order No. 3 - Plugging and Abandonment of Wells
- GRO Order No. 4 - General Environmental Protection Requirements
- GRO Order No. 5 - Reports and Forms
- GRO Order No. 6 - Pipelines and Surface Production Facilities
- GRO Order No. 7 - Production and Royalty Measurement, Equipment and Testing Procedures

While appropriate environmental protection and reclamation measures are generally required by the GRO's, it is, as indicated above, GRO Order No. 4, promulgated on August 15, 1975, which mandates environmental protection for all stages of exploration and development in federal geothermal resources lands located in the USGS central and western regions.

Generally speaking, regardless of its stated purpose, some of the provisions of GRO Order No. 4 which are incorporated by reference into BLM leases are weaker and more ambiguous than the language of the regulations or the lease. Its overall effect will probably be determined largely by the seriousness with which lessees accept the order and how strenuously the Supervisor enforces it.

Relevant federal and state environmental standards are usually made applicable along with existing technology, but local and/or regional standards apply only in certain instances. Exceptions to compliance with any of the standards can be granted by the Supervisor on a case-by-case basis. Conversely, he may establish more stringent standards by field-order, usually in the form of special stipulations.

The lessee's overall general responsibility to protect the environment is to:

1. Provide maximum protection to the environment during exploration and development operations;

2. Rehabilitate impacted areas;

3. Protect by all necessary means the public health and safety;

4. Conduct operations in compliance with all applicable federal laws and executive orders.

Monitoring of "readily identifiable localized environmental impacts" caused by the activities specifically under the lessee's control shall be conducted by the lessee. Frequency of such monitoring activity will be decided by the Supervisor who will consider each site's conditions in establishing the monitoring rates. As described above, a year of baseline data on air, water quality, noise, seismic and land subsidence activities, and ecological systems must be generated before production goes on stream.

The following impacts and accompanying requirements are set out in the Order as being "protectable:"

- Aesthetics. Visual impact, where feasible, shall be minimized by careful site selection. The facilities should be constructed so as to blend with their natural surroundings.

- Land Use and Reclamation. Essentially, USGS requires that geothermal operations distrub land, water, and vegetation as little as possible. Operations and reclamation procedures are subject to approval by the Supervisor and the surface management agency involved (BLM, Forest Service). Since multiple use of the leased land is allowed, geothermal operations are not to interfere unreasonably with other authorized uses. Entry to fragile areas must be controlled by limited access routes or by use of special vehicles.

- Public Access. Such access is to be unrestrained except when circumstances mandate controlled access to:

  - protect public health and safety;
  - prevent undue interference with operations or security;
  - protect the public, wildlife, and livestock from hazardous geothermal activity.

- Recreation. Areas designed for recreation near geothermal areas are to be "adequately protected" from degradation. Development sites are to be located 61 m (188 ft.) from established recreation sites and accompanying access routes. The Supervisor, however, may allow the lessee to relocate the recreation site if the surface management agency agrees to the change.

- Slope Stability and Erosion Control. Mitigating measures for soil and natural resource protection are required to prevent sedimentation from occurring in waterways.

- Biota. Mitigation measures required to protect endangered or threatened flora and fauna may exceed those required by the lease. Under the

Endangered Species Act, reclamation and restocking of destroyed flora and fauna by the lessee is required if the area will not naturally recover.

- Cultural Resources Protection. The lessee may not disturb "any known cemetery or burial ground of any group or culture." Preservation of historic sites shall be in accordance with Executive Order 11593 ("Protection and Enhancement of the Cultural Environment") and conducted with the lessee's "due diligence." Caution must be exercised by BLM/USGS and the applicant so as to protect historically-important areas. Even if historic properties are not listed in the Historic Register, local public interest might necessitate mitigating measures by a lessee in order to offset adverse public opinion.

- Subsidence and Seismicity. Land subsidence shall be prevented by surveys and by adequate record-keeping of operations. If the Supervisor finds that subsidence is potentially significant or that it has occurred, then he may reduce or terminate operations or require seismograph monitoring equipment. Surveys shall be conducted in accordance with county/state requirements, and bench marks shall be established before "prolonged" production begins.

- Pollution and Waste Disposal. All federal and state standards with respect to air, land, water, and noise pollution must be complied with by the lessee. Additionally, erosion control and any waste disposal shall be conducted in compliance with such laws. This section is divided into various categories, with emphasis placed on control of water pollution. Requirements set out for various forms of pollution are:

    - Natural water shall not be contaminated by the lessee. The rest of the environment shall be only minimally affected.

    - If disposal of harmful liquids (including toxic and heated substances) cannot meet the standards, the liquids are to be injected back into a geothermal well or any other formation approved by the Supervisor.

    - The Supervisor's approval is necessary for disposal of solid wastes at approved sites.

    - Federal, state, or regional air pollution standards are the criteria for air emissions and the lessee must obtain any necessary permits for air emissions from the appropriate air pollution control agency. This permit plus required reports must be submitted to the Supervisor.

    - No water pollution is permitted to occur by reason of pits and sumps. The lessee has to reasonably restore the aesthetic and natural resource values of the area when the use of pits and sumps ceases.

    - The lessee is require to train operating personnel in pollution prevention methods.

In addition to the above requirements, noise levels may not exceed 65 dB(A) unless all residents located within .8 km (0.5 mi) of the operation agree to an increased level or an emergency arises. The ambient noise level used for ranking the permissibility of additional noise is "the minimum sound level at the relevant place and time in the absence of the source noise and shall include consideration for the type of land use, and the season, atmospheric conditions, and the time of day." Noise parameters can be established by the Supervisor, after assessment, in accordance with federal or state criteria with adjustments for specific site conditions.

Noise levels are to be measured at .8 km (0.5 mi) from the source or at the lease boundary line, whichever is greater. Noise meters shall be those that meet U.S. Standard Specifications. Measurements shall be made at least three meters (9.84 ft) from a structure and one meter (3.28 ft) above ground level. Site variables, such as weather conditions, are to be taken into consideration. Monitoring frequency shall be determined by the Supervisor.

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Pertinent Idaho rules, regulations and agencies

Idaho

Drilling for Geothermal Resources Rules and Regulations and Minimum Construction Standards --

Sections 42-4001-4015 of Idaho Code conferred upon the Department of Water Resources the authority to regulate the drilling, operation, maintenance, and abandonment of all geothermal wells in the state. The Department's authority also includes regulatory jurisdiction over environmental hazards pertaining to the exploration and development of geothermal resources.

The Foreword to the rules states that they apply only to wells 305 m (1,000 ft) or deeper, including those drilled for exploratory purposes as defined in Section 3.10. Wells shallower than 305 m (1,000 ft) are not covered "even though the well may be for seismic work, heat flow, or other exploration." These limitations, however, are evidently open to interpretation because a Department spokesman states: "All exploratory wells over 15.4 cm (6 in) in diameter are covered by our regulation and require a geothermal permit regardless of depth. All geothermal production or injection wells regardless of size or depth are also covered by the rules and regulations."

The rules give the Department very specific authority over drilling practices and well spacing. A permit is required to drill a well, modify an existing one, or convert a production well to an injection well.

The Water Resources Director is required to approve all well spacing programs or prescribe modifications he feels are necessary for proper development considering the same factors as those enumerated in the Arizona regulations.

The casing and blow-out prevention requirements of these rules are so specific that their total impact would be lost in summarizing them. They are thus reproduced in full in Figure V-1.

There are additional blow-out prevention requirements established both for explored and unexplored areas. A Department employee may be present during any drilling phase in the latter and may order additional casing to be run if he sees fit. A logging unit must be installed and operated continuously once the shoe has been drilled out of the conductor pipe until the well has been drilled to the total depth. Data to be recorded include:

1. Drilling mud temperatures (in and out).
2. Drilling mud pit level.
3. Drilling mud pump volume.
4. Drilling mud weight.
5. Drilling rate.
6. Hydrocarbon and hydrogen sulfide gas volume (with alarm).

An annualr BOPE (blow-out prevention equipment) with a minimum working pressure of 68.04 atm (1,000 PSI) is required on the surface casing and the conductor pipe. If the exit drilling mud temperature reaches 125°C (257°F), drilling operations must cease until the Department of Water Resources has been notified.

In explored areas a gate valve with a minimum working pressure rating of 20.41 atm (300 PSI) and a BOPE as described above are required on the casing head. Mud temperature must be monitored continuously or read manually and logged for each 9 m (30 ft) of depth drilled.

Equally specific abandonment requirements are set forth which cover type and placing of cement and use of drilling fluid in the procedure.

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Idaho and Louisiana

No environmental impact requirements

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Idaho

The Idaho Air Pollution Control Act as amended (Idaho Code Title 39, Chapter 29) confers upon the Board of Environmental Pollution and Health the authority to adopt rules and regulations for the control of air pollution in Idaho. The regulation as adoped in 1972 was subsequently amended

to serve as the state's plan to implement the ambient air quality standards of the federal Clean Air Act. The Department of Health and Welfare is the implementing agency.

Rules and Regulations for the Control of Air Pollution in Idaho --
These rules set forth three ambient air quality standards of potential interest to the geothermal industry in addition to the six required. These include:

Sulfuric Acid Mist:
Primary and secondary standards:
Maximum 24-hour concentration - 12 $\mu g/m^3$ not to be exceeded more than once/month
Maximum 1-hour concentration - 30 $\mu g/m^3$ not to be exceeded more than twice/week

Fluorides:
Primary and secondary air quality standards are those concentrations in the ambient air which result in a total fluoride content in vegetation used for feed and forage of not more than:

40 ppm dry basis - annual arithmetic mean
60 ppm dry basis - monthly concentration for two consecutive months
80 ppm dry basis - monthly concentration never to be exceeded

These standards will probably have no effect on geothermal operations.

Settleable Particulate:
Primary and secondary standards are:
0.8 $mg/cm^2/mo$ not to be exceeded more than 25 percent of the time

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Idaho

Water Quality Standards and Wastewater Treatment Requirements --
These standards and regulations were adopted pursuant to Title 39 Chapter 1 and Title 67 Chapter 52 Idaho Code and Chapter 87 Idaho Sessions Laws 1973. Regulatory authority is given to the Idaho Department of Environmental and Community Services.

The dissolved oxygen water quality standard prohibits a DO concentration of less than 6.0 mg/l or 90 percent of saturation whichever is greater. This is applied to all flowing waterways and to lakes and reservoirs except for specified bottom depths of the latter where the limit is 4.0 mg/l. For comparison, the new federal criteria [17] do not place limits on DO in the public water supply use category, but call for a minimum of 5.0 mg/l to maintain good fish populations.

The limits on temperature increases are quite strict. No measurable increase is permitted when water temperatures are 19°C (66°F) or above, and

increases are limited to 1.1°C (2°F) when water temperatures are 18°C (64°F) or less. For some specified waterways, the upper and lower limits are 20°C (68°F) and 19°C (66°F), respectively. "Measurable increase" means no more than 0.28°C (0.5°F) rise in temperature of the receiving water as measured immediately outside the mixing zone. This standard indicates that all waters of the state are to be kept suitable for cold water fishes.

The turbidity standard is also strict. No industrial activity may cause turbidity to exceed 5 JTU or where this level is already exceeded, may cause alone or in combination with other effluents, an increase of more than 5 JTU.

Idaho also imposes a standard on radioactivity other than that of natural origin. This type of regulation will require interpretation in any case where radon or any other radioactive material is associated with geothermal products. It could be considered of natural origin, but would constitute a pollutant nevertheless.

In the regulations governing wastewater discharges, adequate treatment is determined to be the equivalent of 85 percent BOC and suspended solids removal or conformance with any more stringent limitations necessary to meet the state's water quality standards. Presumably, in the absence of federal effluent limitations and new source performance standards for geothermal production and use, this provision would prevail in NPDES permit conditions.

Wastewater discharge to disposal wells must be treated up to the quality of the existing underground waters or in conformance with the Idaho Drinking Water Standards. The Drinking Water Standards provide that more suitable supplies should be sought when certain substances are present in a water supply in excess of specified concentrations, and when others are present in excess of the stated concentrations, the water supply should be rejected. Very few of the substances, if any, would be expected to be a product of geothermal development. It might be noted, however, that the grounds for rejection are almost identical to the permissible federal criteria for public water supplies on lead, selenium, aresenic, and other inorganic chemicals.

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Idaho

Solid Waste Management Regulations and Standards --

These regulations were adopted by the Board of Health and Welfare and are implementd by the Department of Health and Welfare. They require that all solid wastes shall be managed from storage to disposal in a manner which will prevent health hazards, public nuisances, or pollution of the environment. Specifically, handling methods are not to:

1. Provide sustenance to rodents or insects which are capable of causing uman disease or discomfort;

2. Cause or contribute to the pollution of air;

3. Cause of contribute to the pollution of surface or underground waters;

4. Cause excessive abuse of land;

5. Cause or contribute to noise pollution;

6. Abuse the natural aesthetic quality of an area; or

7. Physically impair the environment to the detriment of man and beneficial plant life, fish, and wildlife.

Conditional use permits for disposal areas which are less than sanitary landfills may be acquired under some conditions. These circumstances include:

1. Extremely low population density in an isolated area;

2. Geology or topography of the area is such to prohibit a sanitary landfill;

3. No collection or transfer system is available or practical;

4. Local climatic conditions are too adverse;

5. There is no involvement of federal lands or federal facilities;

6. Wastes are of a type not suitable for disposal in a sanitary landfill; or

7. Other unusual circumstances.

The standards for sanitary landfill include a requirement for a sufficient number of borings or wells to determine the soil characteristics, geology, and groundwater conditions and for background water quality standards. A well to monitor groundwater quality may be required at those sites where conditions of rainfall, geology of the site, soil characteristics, groundwater management, and drainage are marginal. Where surface waters may cause a leachate problem or if a leachate problem develops, a collection and treatment system will be required.

Disposal of liquids and hazardous wastes in a sanitary landfill is not permitted until the methods of disposal, suitability of the site, and plan of operation have been approved and a conditional use permit issued. When possible, all teoxic and hazardous wastes are to be neutralized or otherwise made harmless prior to disposal.

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[Idaho has no pertinent statute or regulations concerning noise control.]

Completeness of Soil Survey Data

The following table shows the approximate degree of completion of soil surveys on the five KGRAs. Although all areas are projected for completion by 1983, only the SCS surveys contain data adequate for virtually all potential soil uses.

Agency	KGRA					Land Surveyed
	Vulcan	Mtn. Home	Bruneau	Castle Creek	Crane Creek	
SCS	N.A.	20% / 80%	10% / 40%	8% / more	15% / more	Private Lands*
FS	100% / 0	N.A.	N.A.	N.A.	N.A.	National Forest
BLM	N.A.	0	50% / 0	17% / more	100% / 0	BLM Lands
Chugg	N.A.	N.A.	100% / 0	100% / 0	N.A.	All Land Ownerships
Total by 1983	100%	100%	100%	100%	100%	

N.A. Not Applicable

*Except Mtn. Home where SCS is mapping all land ownerships

completed / ongoing or projected