GL00916

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Division of Minerals and Geology

Department of Natural Resources
1313 Sherman Street, Room 715
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DEPARTMENT OF NATURAL RESOURCES

Roy Romer
Governor

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Vicki Cowart
State Geologist
and Director

News Release

February 2, 1995
For Immediate Release

News Contact: Jim Cappa
(303) 866-3293

GEOTHERMAL MAP OF COLORADO AND DIGITAL DATA RELEASED

The Colorado Geological Survey has released a updated review and electronic database of the geothermal sites in Colorado. In the late 1970s and early 1980s the U.S. Department of Energy supported an intensive study of the geothermal sites in Colorado. The current study, also funded by the Department of Energy, was conducted during 1992 and 1993 and is intended to update and enter into electronic databases all the known physical and chemical characteristics, the current activity and usage, and the location of the state's geothermal sites. Ten new chemical analyses were also completed at selected geothermal sites.

Geothermal waters are used in the state for a variety of purposes including raising tropical fish and alligators in the San Luis Valley, greenhouses, space heating, and in resort spas in such places as Glenwood Springs, Idaho Springs, Steamboat Springs, Ouray, Pagosa Springs and Hermosa. All of Colorado's geothermal sites are considered to be low temperature, that is, less than 90 degrees Celsius (195 degrees Fahrenheit).

The study includes 1:1,000,000 map showing the location of the all geothermal sites, a report with a discussion of the current activity and usage of the sites, and a 3.5-inch, high-density, DOS diskette that contains tables of the location, chemistry, and

(MORE)

information on each of the geothermal sites in Lotus, Dbase and ARC-Export formats.

Copies of "1992-1993 Low Temperature Geothermal Assessment Program, Colorado" by James A. Cappa and Harold T. Hemborg (Open File Report 95-1) are available over the counter for $15 from the Colorado Geological Survey. The fee covers the map, written report, and diskette. Telephone and mail orders require an additional $5 for shipping and handling. VISA and MasterCard are accepted. Orders should be submitted to: Orletta Fairchild, Publications Department, Colorado Geological Survey, 1313 Sherman St., Room 715, Denver, CO, 80203. The survey's telephone number is (303) 866-2611 and the FAX number is (303) 866-2461.

# # #

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MEMORANDUM

TO: Howard Ross, UURI

FROM: Jim Cappa, CGS

DATE: August 5, 1993

SUBJECT: Data for Phase 2 funding, low temperature geothermal project.

ITEM	1993 INVENTORY	1980 INVENTORY	% CHANGE
# THERMAL WELLS AND SPRINGS	+170	120	+42
# RESOURCE AREAS	96	56	+71
# AREAS DIRECT HEAT USE	28	28	0

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MEMORANDUM

TO: Howard Ross, UURI

FROM: Jim Cappa, CGS

DATE: August 5, 1993

SUBJECT: Preliminary results of 1993 low temperature geothermal program.

The work on the Colorado portion of the low temperature geothermal research program consist of four main parts: 1) field investigations and sampling of known and new geothermal sources; 2) research of various geothermal and water quality data bases for analytical data on known and new geothermal sources; 3) research of the Colorado State Water Engineer and Colorado Oil and Gas Commission well permit files; and 4) entry of data into a GIS compatible data base and production of a 1:1,000,000 scale map and accompanying data bases.

The field investigation and sampling portion of the program is just about complete. CGS staff members have made 4 separate one week trips around selected areas of Colorado visiting known geothermal areas and discovering new ones in the process. We have collected water samples for chemical analysis at nine of the sites we have visited. The field investigations have allowed us to gain first hand information on the physical and chemical characteristics and current usage of the geothermal resources. We have also obtained a subjective measure of the quality and degree of development. Being at the geothermal site has allowed us to meet local people who have knowledge of other unreported geothermal sources and also are acquainted with the usages of the sources.

We have utilized several published data bases to gain further information on the location and geochemistry of the geothermal sources. Most of the information compiled in the present program came from two principal publications of the CGS on geothermal resources: CGS Bull. 39, 1978, An Appraisal of Colorado's Geothermal Resources, and Inform. Ser. 6, 1976, Hydrogeochemical Data of Thermal Springs and Wells in Colorado.

Both of these publications were the result of a DOE geothermal program of the late 1970's and early 1980's. WATSTOR, a U. S. Geological Survey water quality data base, was utilized and as a result 19 new geothermal sources of water >20° C were added to the data base. The GEOTHERM data base, another U. S. Geological Survey compilation, was also investigated but it contained information already entered into the data base from the CGS publications of 1978 and 1976. Other data sources included various literature references, technical articles, University theses, resource user chemical reports, and municipal governments.

The well permit files of the State Oil and Gas Commission and the State Water Engineer were investigated. One important geothermal source, the Deganahl well, was added as a result of this investigation.

The data bases of the current program have been designed and most of the data has been entered at this writing. Three geochemical analyses are still outstanding and a few days of field investigation are still pending.

The current program indicates that several areas in the state continue a long history of substantial utilization of their geothermal resources such as Glenwood Springs, Idaho Springs, Steamboat Springs, Pagosa Springs, Poncha Springs, Mount Princeton and Ouray. All of these areas, at the minimum, utilize their resources for swimming pools and spas. Some, such as Pagosa Springs, utilize geothermal heat for space heating in municipal and other buildings. 8 spas, etc.

There are several other areas in the state that are on the fringe of development. That is, they have some development of geothermal resources; however, there are indications that geological and geophysical studies could be used to increase the area and pace of development. These include the following: Trimble Hot Springs north of Durango, in La Plata County; Orvis Hot Springs north of Ouray in Ouray County; a large area southeast of Pagosa Springs along the Archuleta Antiform in Archuleta County; the eastern San Luis Valley in Saguache and Alamosa Counties; the area around Rico and Dunton Hot Springs in Dolores County, and the Cottonwood Hot Springs in Chaffee County. 8 near devel.

Other geothermal resources that are geologically significant but far from a center of significant population are: the Deganahl well in Routt County, the Brands Ranch well in Jackson County, the Craig warm water well in Moffatt County, and the Hartsel Hot Springs in Park County. 9 additi.

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October 7, 1994

Howard Ross
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

Dear Howard:

I enjoyed the Geothermal Resources Council meeting and learned quite a bit about current activities in both the low and high temperature geothermal fields. I am grateful to the you and the UURI for the offer to pay for my travel expenses. The expenses for the trip and meeting are listed below:

Mileage personal car to & from Airport(54 miles x .20)	$10.80
Airline ticket, Denver to Salt Lake City & return	$143.00
Parking at Stapleton Airport	$17.00
Meeting Registration (One Day)	$150.00
Lodging, Little America Hotel, 10\3	$93.00
Meals 10\3-10\4	$37.00
TOTAL	$450.80

Please send the check to me at the letterhead address. Thanks again for your help on this presentation.

Sincerely,

James A. Cappa

James A. Cappa
Chief, Minerals and Mineral Fuels
Enclosure: Receipts

COLORADO CITIES WITH GEOTHERMAL RESOURCE POTENTIAL
Resources (>50 deg. C) collocated less than 5 miles

TOWN NAME	COUNTY	POPULATION, 1990	DISCH. TEMP.	DEPTH, FT.	FLOW, L/MIN.	TDS, MG/L	REMARKS
CHROMO	ARCHULETA	5	70	526	284	101	DISTANCE 4 MILES, DUTCH CROWLEY OIL WELL TEST
GLENWOOD SPRINGS	GARFIELD	6561	51	SPRINGS	8565	21500	DISTANCE 1 MILE, FEASIBILITY STUDY
HARTZEL	PARK	43	52	SPRING	204	2280	DISTANCE 1 MILE
HERMOSA	LA PLATA	NA	44	SPRING	38(?)	3240	DISTANCE 3 MILES, TRIPP HOT SPRING, RES. TEMP. EST. 45-70 DEGREES
IDAHO SPRINGS	CLEAR CREEK	1834	53	142	136	1900	GROUP OF THREE SPRINGS AND 1 WELL
MAD CREEK	ROUTT	NA	62	SPRING	100-200	508-552	GROUP OF 5 UNUSED SPRINGS
MINERAL HOT SPRINGS	SAGUACHE	NA	60	SPRING	379	650	DISTANCE 6 MILES, SEVERAL UNUSED SPRINGS
MT. PRINCETON HOT SPRINGS	CHAFFE	NA	56-83	SPRING	345	68-76	SEVERAL SPRINGS AND WELLS IN THE CHALK CREEK AREA
OURAY	OURAY	644	69	SPRING	416	1650	POOL HOT SPRING, SEVERAL OTHERS IN THE AREA
PAGOSA SPRINGS	ARCHULETA	1207	58	SPRING	908	3040	BIG SPRING, SEVERAL OTHER SPRINGS AND WELLS IN THE AREA
PONCHA SPRINGS	CHAFFEE	244	71	SPRINGS	757	685	DISTANCE 1 MILE
REDSTONE	PITKIN	135	56	SPRING	38	2750	DISTANCE 5 MILES, GRANGES HOT SPRING
RICO	DOLORES	92	44	WELLS, DEPTH UNK.	53	2750	DISTANCE 1 MILE, WELLS MAY BE PLUGGED?
RIDGEWAY	OURAY	423	52	SPRING	CLOSED, 1978	2300	DISTANCE 3 MILES, ORVIS HOT SPRING
ROCKWOOD	LA PLATA	NA	32	SPRING	180	3800	DISTANCE 3 MILES, PINKERTON HOT SPRINGS
SALIDA	CHAFFEE	4737	71	SPRING	757	685	DISTANCE 6 MILES, PONCHA HOT SPRINGS
STEAMBOAT SPRINGS	ROUTT	6695	39	SPRINGS	37-450	6170	DISTANCE 1 MILE, RES. TEMP. +70 DEG.
WAGON WHEEL GAP	MINERAL	NA	57	SPRING	186	1500	DISTANCE 2 MILES
WAUNITA HOT SPRINGS	GUNNISON	NA	80	SPRING	151	600	TWO GROUPS OF HOT SPRINGS
	TOTAL	22620					

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RESULTS OF THE 1992-1993 LOW-TEMPERATURE GEOTHERMAL ASSESSMENT PROGRAM IN COLORADO

James A. Cappa
Colorado Geological Survey

Acknowledgements

This low-temperature geothermal assessment program was funded by the U. S. Department of Energy-Geothermal Division. The Colorado Geological Survey serves as a subcontractor to the Oregon Institute of Technology-Geo Heat Center for the purposes of fulfilling the terms of this contract within the State of Colorado.

Abstract

Previous assessments of Colorado's low-temperature geothermal resources were completed by the Colorado Geological Survey in 1920 and in the mid to late-1970s. The purpose of the 1992-1993 low-temperature geothermal resource assessment is to update the earlier physical, geochemical, and utilization data and compile computerized databases of the location, chemistry, and general information of the low-temperature geothermal resources in Colorado. The main sources of the data included published data from the Colorado Geological Survey, the U. S. Geological Survey WATSTOR database, and the files of the State Division of Water Resources.

The staff of the Colorado Geological Survey in 1992 and 1993 visited most of the known geothermal sources that were recorded as having temperatures greater than 30° C. Physical measurements of the conductivity, pH, temperature, flow rate, and notes on the current geothermal source utilization were taken. Ten new geochemical analyses were completed on selected geothermal sites. The results of the compilation and field investigations are compiled into databases.

For the purposes of this report a geothermal area is defined as a broad area, usually less than three square miles in size, that may have several wells or springs. A geothermal site is an individual well or spring within a geothermal area. The 1992-1993 assessment

reports that there are 93 geothermal areas in the Colorado, up from the 56 reported in 1978; there are 157 geothermal sites up from the 125 reported in 1978; and a total of 382 geochemical analyses are compiled, up from the 236 reported in 1978.

Six geothermal areas are recommended for further investigation: Trimble Hot Springs, Orvis Hot Springs, an area southeast of Pagosa Springs, the eastern San Luis Valley, Rico and Dunton area, and Cottonwood Hot Springs.

1. Introduction

Low-temperature geothermal resources are defined as those having a surface temperature of 20° to 100° C. Previous assessments of Colorado's low-temperature geothermal resources were completed by the Colorado Geological Survey (CGS) in 1920 and in the mid to late-1970s. The purpose of the 1992-1993 low-temperature geothermal resource assessment is to update the earlier physical, geochemical, and utilization data and compile computerized databases of the location, chemistry, and general information of the low-temperature geothermal resources in Colorado.

During 1992 and 1993 the staff of the CGS visited most of the known geothermal sources that were recorded as having temperatures greater than 30° C. Physical measurements of the conductivity, Ph, temperature, flow rate, and notes on the current geothermal source utilization were taken. Ten new geochemical analyses were completed on selected geothermal sites.

The earliest work describing the geothermal resources of Colorado was completed by R. D. George et al. (1920), Mineral Waters of Colorado, CGS Bulletin 11. In 1978, the CGS published Bulletin 39, An Appraisal of Colorado's Geothermal Resources, by Barrett and Pearl which contained descriptive information on the sites, including location, current usage, geological setting and an analysis of various geothermometers for each of the geothermal areas of the state.

New assessments of geothermal resources are necessary because utilization of geothermal resources changes over a period of years. In some cases flow rates and temperature of the geothermal sources have change because of various reasons, either natural or man-induced.

The data collected and compiled for this survey are recorded in four computer databases. Figure 1 shows the location of each of the geothermal areas determined from the 1992-1993 survey.

2. Data Sources

Data were compiled from a variety of sources including published and unpublished materials. The most important published source material includes: George et al., 1920, Colorado Geological Survey Bulletin 11; Barrett and Pearl, 1976, Colorado Geological Survey Information Series 6; and Barrett and Pearl, 1978, Colorado Geological Survey Bulletin 39. The most important unpublished sources were the Colorado Department of

Water Resources well permit files, the U. S. Geological Survey WATSTOR database, and analytical reports from private laboratories given to the principal investigator by geothermal source owners and operators. As part of the assessment program ten new geochemical analyses were completed.

All geochemical data which maintained a cation-anion charge balance of ± 15% were entered into the databases. Geothermal sources with only one analysis were entered regardless of the charge balance.

3. Data Format

All the data describing the location, geochemical analyses, and general characteristics were compiled into databases. For purposes of this program a geothermal area is defined as a geologically cohesive land area that may or may not contain several geothermal wells or hot springs. Generally an area is less than approximately three square miles. A site is defined as an individual geothermal well or hot spring within an area. Each geothermal area within the database has a unique ID number. Different sites within a geothermal area have unique area-site numbers. All the tables list the ID number, Site number, and Geothermal Source (Name). Excerpts from the databases are shown below in the following tables.

Table 1 is a location database (GTHLOC); it describes the county, quadrangle map, section, township, range, latitude and longitude, and Universal Transverse Mercator grid references.

Table 2 contains the long form of the geochemical database(GTHCHEM1). All the geochemical and sample data collected during this survey is stored in this Table. There can be multiple entries of geochemical data for each site.

Table 3 is the short form of the geochemical database(GTHCHEM2). It contains an abbreviated element list and has only one entry per site. Where multiple chemical analyses were available all the results were averaged to make just a single entry.

Table 4 contains the general information database (GTHGEN). It has information such as temperature, flow rate, type, references, and current usage for each geothermal site.

4. Fluid Chemistry

Because of time constraints a lower limit of 30° C was set on any geothermal spring or well to be visited in the field. The temperature, pH, conductivity, flow rate and current usage for each site were recorded. The University of Utah Research Institute (UURI) provided 10 new geothermal water analyses as part of the low-temperature geothermal assessment program. Sites for a complete water analysis were selected on a subjective criteria of developmental significance and lack of recent or quality geochemical data. The 10 sites selected for new water analyses in Colorado are:

Craig Warm Water Well
Desert Reef (Florence)

Dotsero, South
Mt. Princeton (Hortense Well)
Ouray (Pool or Box Canyon Spring)
Routt (aka Strawberry)
Steamboat Springs (Heart Spring)
Waunita Hot Springs
Juniper Hot Springs
Pagosa Hot Springs (Big Spring)

The results of the new samples are included in Table 2. There were no new results that had serious implications for the prior known geochemistry of the geothermal areas.

Other sources of geochemical information were utilized in compiling the database. The most significant source of geochemical data was the U. S. Department of Energy supported study performed by the CGS in the late 1970s (Barrett and Pearl, 1976). Any geochemical analysis that had a cation-anion balance error greater than 15% was discarded except for the case described below.

Geochemical data derived from the U. S. Geological Survey WATSTOR database was entered into the current database; unfortunately, most of those reports do not have an analysis for HCO_3^- or CO_3^{-2} which causes severe errors in the cation-anion balance. As most of these analyses are the only one for that particular site they have been retained in the database even though they do not balance within the specified limits.

5. Discussion and Summary

The location of all the geothermal sites compiled during this assessment program is shown on Figure 1. A frequency plot of all the geothermal temperatures from each site is shown in Figure 2. The greatest number of temperature measurements fall in the 25° to 40° C categories. There is another peak in the 51° to 55° C range.

The 1992-1993 low-temperature geothermal assessment program added 10 new chemical analyses to the geochemical database of the state's geothermal waters. Other sources of geochemical data were reviewed and all good quality, that is less than 15% cation-anion balance error, geochemical analyses were entered into the long form geochemical database, Table 2. Certain areas with higher than 15% cation-anion balance were left in the database because they were the only analysis for an area or site. Usually the most significant errors in the cation-anion balance were found in the U. S. Geological Survey WATSTOR database and are due to a missing HCO_3 analysis.

Several corrections were made to locations and names of hot springs and wells described in the older literature. The CGS Information Series 6 (Barrett and Pearl, 1976) was updated during 1993 and the correct locations were entered into the revised publication. Corrections were also made to several location entries in the U. S. Geological Survey WATSTOR database.

A summary of the results of the 1992-1993 geothermal assessment and a comparison to the 1976-1978 geothermal assessment are shown in the following Table A:

ITEM	1993 ASSESSMENT	1976-78 ASSESSMENT	% CHANGE
GEOTHERMAL AREAS	93	56	+66%
GEOTHERMAL SITES	157	125	+26%
GEOCHEMICAL ANALYSES	382	236	+62%
SITES OF DIRECT HEAT UTILIZATION	64	64	0
SITES OF DISTRICT HEAT USE	20	?	
SITES OF GREENHOUSES, AQUACULTURE	4	?	

Table A: Summary of the results of the 1993 Low-Temperature Geothermal Assessment Program compared to the 1976-1978 geothermal assessment.

6. Recommendations

The current assessment indicates that several areas in the state continue a long history of substantial utilization of their geothermal resources. The prime areas include Glenwood Springs, Idaho Springs, Steamboat Springs, Pagosa Springs, Mount Princeton, and Ouray. All of these areas, at the minimum, utilize the geothermal resources for swimming pools and spas. Some areas such as Ouray and Pagosa Springs utilize geothermal heat for space heating in municipal and other private buildings.

There are other areas in the state that are collocated with or near population centers and are on the fringe of geothermal development. That is, they have had some development of their geothermal resources; however, there are indications that geological and geophysical studies may be used in a Second Phase geothermal assessment to increase the geothermal area and spur development in these areas. The geothermal areas that are candidates for a Second Phase are (not listed in any order of importance):

1) Trimble Hot Springs, La Plata County.
2) Orvis Hot Springs, Ouray County.
3) A large area southeast of Pagosa Springs along the Archuleta Antiform, Archuleta County.
4) Eastern San Luis Valley, Saguache and Alamosa Counties.
5) Rico and Dunton Hot Springs, Dolores County.
6) Cottonwood Hot Springs, Chaffee County.

Other areas that are geologically significant but far from a center of population are:

1) Deganahl well, Routt County.

2) Brands Ranch well, Jackson County.
3) Craig warm water well, Moffatt County.
4) Hartsel Hot Springs, Park County.

7. References

Barrett, J. K., and Pearl, R. H., 1976, Hydrogeological data of thermal springs and wells in Colorado: Colorado Geological Survey Information Series 6, 124p.

Barrett, J. K., and Pearl, R. H., 1978, An appraisal of Colorado's geothermal resources: Colorado Geological Survey Bulletin 39, 224p.

George, R. D., Curtis, H. A., Lester, O. C., Crook, J. K., and Yeo, J. B., 1920, Mineral waters of Colorado: Colorado Geological Survey Bulletin 11, 474p.

Colorado Geothermal Springs and Wells - Figure 1

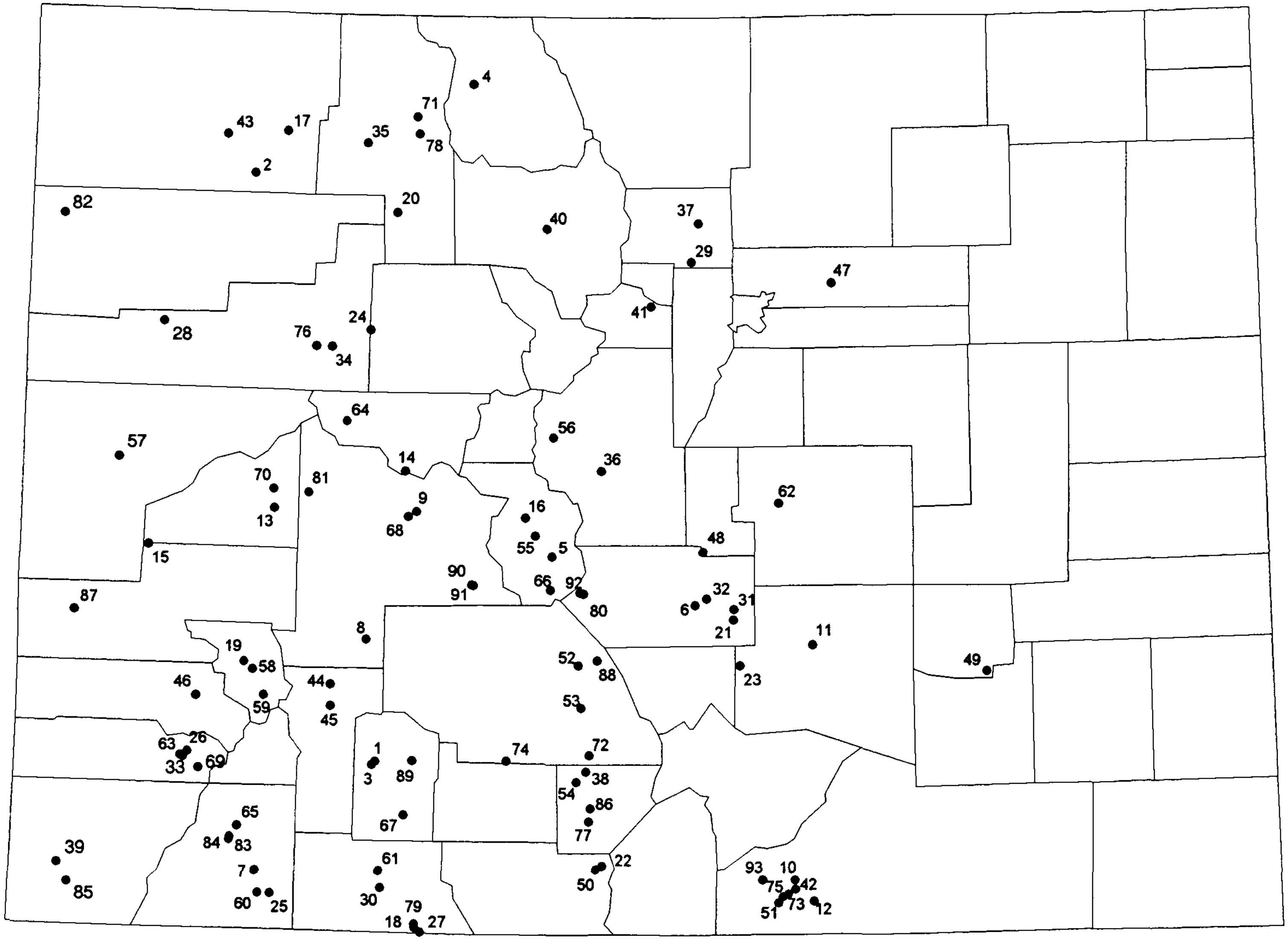

Figure 2: FREQUENCY DISTRIBUTION
COLORADO GEOTHERMAL SOURCES

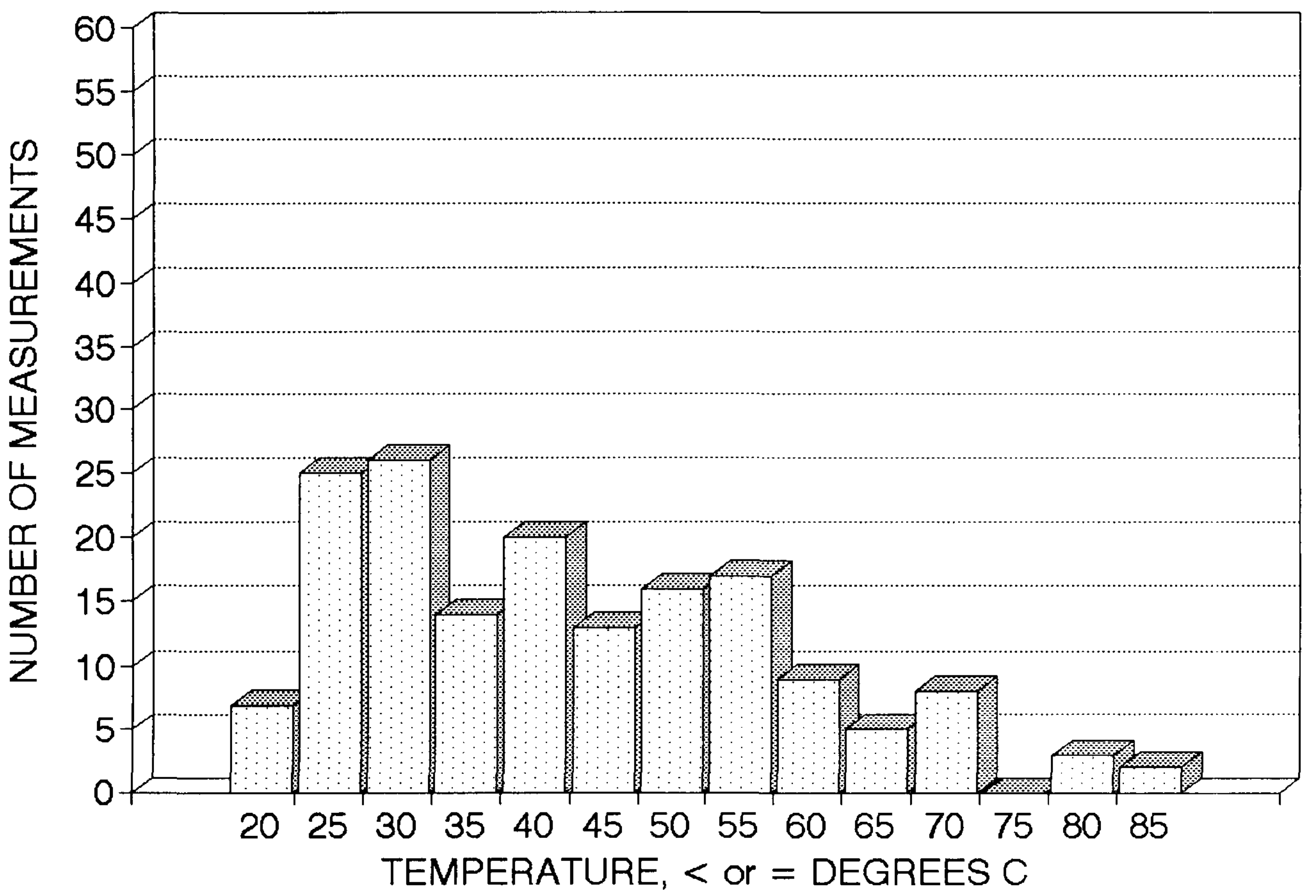

TABLE 1: LOCATION OF GEOTHERMAL SOURCES IN COLORADO

[Abbreviations: HS= Hot Spring; W= Well; Sec= Section; Qtr= Quarter; Twp=Township, d=direction; Rge= Range, d=direction; Merid= Meridian
Lat/LonD= Latitute/Longitude Degrees, M= Minutes, S= Seconds, Dec= Decimal Degrees; Utm= Universal Tranverse Mercator Coordinates;
Rel=Reliability, 1= within 100 feet, 2=within 660 feet, 3=within 1,320 feet, 4= within 2,640 feet, 5= within 5,280 feet, 6= greater than 5,280 feet]

ID	Site	Geothermal Source	Type	Quadrangle	County	Sec	Qtr/Qtr	Twp	Twpd	Rge	Rged	Merid.	LatD	LatM	LatS	LonD	LonM	LonS	X-Utm	Y-Utm	Rel
1	1	Antelope Warm Spring	HS	Workman Creek	Mineral	1	SWSE	40	N	2	W	NMPM	37	44	36	107	2	14	320502	4179086	1
2	1	Axial	W	Axial	Moffat	23	NESE	4	N	93	W	6TH	40	18	1	107	47	3	263367	4464596	2
3	1	Birdsie Warm Spring	HS	Workman Creek	Mineral	14	NWNE	40	N	2	W	NMPM	37	43	42	107	3	13	319021	4177454	3
4	1	Brands Ranch	W	Pitchpine Mountain	Jackson	31	SWSE	9	N	81	W	6TH	40	42	16	106	32	4	370371	4506869	1
5	1	Browns Canyon Warm Spring	HS	Nathrop	Chaffee	23	SESW	51	N	8	E	NMPM	38	39	13	106	3	11	408367	4278657	3
5	2	Browns Canyon (Chimney Hill)	W	Nathrop	Chaffee	28	SENE	51	N	8	E	NMPM	38	38	40	106	4	41	406180	4277665	2
5	3	Browns Grotto Warm Spring	HS	Nathrop	Chaffee	27	SWSW	51	N	8	E	NMPM	38	38	13	106	4	26	406533	4276829	3
6	1	Canon City Hot Springs	W	Royal Gorge	Fremont	31	SESW	18	S	70	W	6TH	38	25	56	105	15	41	477185	4253598	2
7	1	Carson #1 Well	W	Rules Hill	La Plata	36	NWSW	35	N	8	W	NMPM	37	15	25	107	41	57	260619	4126587	2

1992-1993 LOW TEMPERATURE GEOTHERMAL PROJECT

TABLE 2: GEOCHEMICAL ANALYSES OF GEOTHERMAL SOURCES IN COLORADO (Long List)(Milligrams/Liter)

[Abbreviations: HS= Hot Spring; W= Well; E= Estimated; ND= Not detected]

References are listed at the end of the table.

ID	Site	Geothermal Source	Type	Reference	Date Sampled	Temp C	Cond mm	pH	CaCO3	HCO3	PO4	Ca	Mg	Na	K
1	1	Antelope Warm Spring	HS	1	8/1975	32	180		90	110	ND	4.0	0.3	44.0	0.1
1	1	Antelope Warm Spring	HS	1	10/1975	32	160	8.9	95	77	0.03	1.7	0.6	43.0	0.3
1	1	Antelope Warm Spring	HS	3	6/1993	32	234	9.1							
2	1	Axial	W	4	6/1975	22	1,750	7.1	520	630	0.09	140.0	140.0	71.0	14.0
3	1	Birdsie Warm Spring	HS	1	?/1975	30	200	8.6							
3	1	Birdsie Warm Spring	HS	3	6/1993	30	218	9.2							
4	1	Brands Ranch	W	1	?/1975	30	405	6.0							
4	1	Brands Ranch	W	1	5/1993	39	524	6.4							
5	1	Browns Canyon Warm Spring	HS	1,7	?/1975	25	775	8.0				9.0		170.0	2.4
5	2	Browns Canyon (Chimney Hill)	W	7	?/1975	27						7.0		170.0	2.7
5	3	Browns Grotto Warm Spring	HS	1,7	?/1975	23	720	7.0				18.0		180.0	3.4
6	1	Canon City Hot Springs	HS	2	?/1920	35				804		169.4	53.6	160.8	33.2
6	1	Canon City Hot Springs	HS	1	9/1975	40	1,900	6.3	728	887	2.20	190.0	62.0	190.0	15.0
6	1	Canon City Hot Springs	HS	1	1/1976	40	2,010	6.2	728	888	0.03	190.0	55.0	180.0	16.0
6	1	Canon City Hot Springs	HS	1	4/1976	40	1,980	6.1	728	888	0.09	170.0	61.0	190.0	15.0
6	1	Canon City Hot Springs	HS	3	6/1993	40		6.1							
7	1	Carson #1 Well	W	4	9/1984	38	1,280	8.2	724			2.7	0.3	310.0	2.8

REFERENCES

1 Barret, J. K. and Pearl, R. H., 1976, Hydrogeochemical data of thermal springs and wells in Colorado: Colorado Geological Survey, Inform. Ser. 6 (rev. 1993).

2 George, R. D., Curtis, H. A., Lester, O. C., Crook, J. K., and Yeo, J. B., 1920, Mineral waters of Colorado: Colorado Geological Survey Bull. 11.

3 Colorado Geological Survey 1992-1993 sampling program

4 U. S. Geological Survey WATSTOR data base

5 Colorado State Department of Water Resources well files

6 Sharp, W. N., 1970, Extensive zeolitization associated with hot springs in central Colorado: U. S. Geological Survey Prof. Paper 700-B, p. b14-b20.

7 Dick, J. D., 1976, Geothermal reservoir temperatures in Chaffee County, Colorado: Northeastern Louisiana Univ., Unpubl. MS Thesis., 171p.

8 Bush, A. L., Bromfield, C. S., and Pierson, C. T., 1959, Areal geology of the Placerville quadrangle, San Miguel County, Colorado: U. S. Geological Survey Bulletin 1072-E

9 Other Sources

TABLE 3: GEOCHEMICAL ANALYSES OF GEOTHERMAL SOURCES IN COLORADO (Short list) (Milligrams/Liter)

[Abbreviations: HS= Hot Spring; W= Well; ND= Not Detected]

Brackets ([ ]) in the TDS column indicate Conductivity measurements; Conductivity * .58 is a good regional indicator of TDS

ID	Site	Geothermal Source	Type	pH	TDS	Na	K	Ca	Mg	Fe	SiO2	B	Li	HCO3	SO4	Cl	F	Cation-Anion Balance, %
1	1	Antelope Warm Spring	HS		151	44.0	0.1	4.0	0.3	0.02	41		0.01	110	2	3	2.0	5.1
2	1	Axial	W	7.1	1,250	71.0	14.0	140.0	140.0	0.11	18			630	530	17	0.6	0.4
3	1	Birdsie Warm Spring	HS	9.2	[209]													--
4	1	Brands Ranch	W	6.4	[465]													--
5	1	Browns Canyon Warm Spring	HS	8.0	[775]	170.0	2.4	9.0			28							--
5	2	Browns Canyon (Chimney Hill)	W			170.0	2.7	7.0			47							--
5	3	Browns Grotto Warm Spring	HS	7.0	494	180.0	3.4	18.0			46							--
6	1	Canon City Hot Springs	HS	6.2	1,220	180.2	19.8	179.9	57.9	0.03	23	0.20	0.23	867	123	186	1.5	0.1
7	1	Carson #1 Well	W	8.2	789	310.0	2.8	2.7	0.3	0.07	23	0.19		--	1	14	1.5	96.4

1992-1993 LOW TEMPERATURE GEOTHERMAL PROJECT

TABLE 4: GENERAL INFORMATION OF GEOTHERMAL SOURCES IN COLORADO

Abbreviations

[Type: HS= Hot Spring; W= well]

[Use: Bnd= bathing, not developed; Bd= bathing, developed; N= no use; MW= mineral water; AC= Aquaculture; ACs= Aquaculture, stock tank; A= Agricultural irrigation; SH= Space Heating; GH= Greenhouse; ?= Not Known]

ID	Site	Geothermal Source	Type	Use	Temp C	Flow l/m	Well depth, m
1	1	Antelope Warm Spring	HS	N	32	11,46	
2	1	Axial	W	?	22		3.6
3	1	Birdsie Warm Spring	HS	N	30	53	
4	1	Brands Ranch	W	Bnd	34	304E	
5	1	Browns Canyon Warm Spring	HS	N	25	4	
5	2	Browns Canyon (Chimney Hill)	W	N	27		
5	3	Browns Grotto Warm Spring	HS	N	23	19	
6	1	Canon City Hot Springs	HS	N	39	4 to 19	
7	1	Carson #1 Well	W	?	38		744.8

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Division of Minerals and Geology

Department of Natural Resources
1313 Sherman Street, Rm. 715
Denver, Colorado 80203
Phone (303) 866-2611
FAX (303) 866-2461

January 10, 1994

Howard Ross
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

Dear Howard:

We've finished the GIS work on the geothermal areas and produced a 1:1,000,000 map of the the geothermal areas as per our contrct. A copy is enclosed for your comments.

Sincerely,

James A. Cappa
Chief, Minerals and Mineral Fuels

enclosure:

Paul Lienau -
Please review and comment.
HR

January 10, 1994

James A. Cappa
Chief, Minerals and Mineral Fuels
Colorado Geological Survey
Department of Natural Resources
1313 Sherman Street, Rm. 715
Denver, CO 80203

Dear Jim:

Thanks for the opportunity to review your draft report for the low temperature geothermal assessment program. The report reads very well and seems to have everything we requested, while still being short and to the point. I especially enjoyed reading the Discussion section with writeups of the main thermal springs and wells. Good job, Jim!

In response to your question, I think it is useful to include both Table 2 (long form) and Table 3 (short form) for the geochemistry database. We anticipate that all the state teams would want to make the report and database available to the public and encourage you to do so. When the report is ready for distribution, you may wish to announce it in the Geothermal Resources Council Bulletin and other trade journals as well as the CGS publication list.

Jim, I noted a few typos and developed a few questions and comments while going through the report. These are attached. Please call me if you want to discuss any of the comments. I will FAX a copy of this letter to Paul Lienau for his information. He will ~~may~~ also wish to see a draft copy of the report before you finalize it.

Sincerely,

Howard P. Ross
Project Manager

encl.

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Division of Minerals and Geology

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Phone (303) 866-2611
FAX (303) 866-2461

December 27, 1993

Howard Ross
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

Dear Howard:

I've enclosed a copy of the draft report for the low temperature geothermal assessment program for your review. Also included are printouts of the data bases for Colorado. You will note that Table 2 is quite comprehensive and contains much more data than is called for in this program. I believe that this geochemical information is useful and would like to leave it in the final report. I'd appreciate your thoughts on this. The 1:1,000,000 location map is complete but still requires a bit of computer-drafting juggling.

The CGS would like to make this information available on disc to the public through our open file report process. I don't see anything in the contract that mentions this so I assume it is OK. Is it? Thanks for your help.

Sincerely,

Jim

James A. Cappa
Chief, Minerals and Mineral Fuels

enclosure:

ADDENDUM TO STANDARD CONTRACT AGREEMENT
for
STATE GEOTHERMAL ENERGY RESEARCH,DEVELOPMENT,
AND DATABASE COMPILATION

between

THE OREGON STATE SYSTEM OF HIGHER EDUCATION
OREGON INSTITUTE OF TECHNOLOGY

and

THE COLORADO GEOLOGICAL SURVEY

STATEMENT OF WORK

1.0 INTRODUCTION

The United States Department of Energy - Geothermal Division (DOE/GD) supports the development of indigenous and environmentally advantageous energy alternatives to the traditional fuels. There is a very large, nearly unused supply of low- and moderate-temperature geothermal resources in the United States that could be brought on line over the next decade. The increased use of Geothermal Heat Pumps (GHPs) could also reduce the need for traditional fossil fuel consumption for space heating and cooling.

The U.S. Congress has appropriated funds for a program of Low-Temperature Geothermal Resources and Technology Transfer and DOE/GD has funded EG&G, Idaho to establish contracts with the Oregon Institute of Technology - Geo-Heat Center (OIT-GHC), the Idaho Water Resources Research Institute (IWRRI) and the University of Utah Research Institute (UURI) to implement this program.

Important parts of this program are to bring the inventory of the nation's low- and moderate-temperature resources up to date, to complete a collocation study of these resources and communities and other potential users, and to collect and disseminate information necessary to expand the use of GHPs. OIT-GHC will have the lead role in the collocation study and will establish subcontracts with the state resource teams. UURI will work with the State Teams on gathering, documenting, and assembly of low- and moderate-temperature hydrothermal resource data and will assist in technical monitoring of the State Team efforts and publications. IWRRI will be responsible for establishing the hydrothermal resource data for Idaho and for performing geothermal reservoir evaluations throughout the western United States.

The technical tasks described herein may be considered Phase I of the Low-Temperature Geothermal Resources and Technology Transfer program. If Phase I proves successful, and additional funds are appropriated by Congress, the program may be expanded and continued. Phase II would likely include detailed resource evaluations of priority areas identified in Phase I.

Funding for the Low-Temperature Geothermal Resources and Technology Transfer Program is limited, and the success and continuation of the program is dependent upon a productive Phase I effort. Participating State Teams are encouraged to seek state or organization cost shares (in cost or in-kind) to enhance this contract effort.

2.0 TECHNICAL TASKS

The following technical tasks will be accomplished under this subcontract.

2.1 Complete an updated inventory of low- and moderate-temperature resources for the State of Colorado, current to June 1, 1992. Review drilling records and other information to identify new resources and verify temperatures and flow rates of springs and wells which may have changed substantially since the previous statewide geothermal resource inventory. Identify geological, geophysical, geochemical, and hydrologic studies which relate to these resources. The minimum temperature for a low-temperature resource is defined to be 10°C above the mean annual air temperature at the surface and should increase by 25°C/km. Occurrences to 150°C will be included.

2.2 Conduct a fluid geochemistry study of the more important resource areas for which existing data are questionable or unavailable. UURI will provide up to ten (10) quantitative fluid chemical analyses for each state in support of this study.

2.3 Complete a computer database listing compatible with Lotus 123 format tabulating for each occurrence: name, location (T,R,S), county, longitude, latitude, depth, flow, temperature, chemistry, and other data as appropriate and available.

2.4 Review OIT-GHC geothermal resource and demographic data for the State of Colorado for accuracy and completeness, as part of the collocation study.

2.5 Assist OIT-GHC, UURI, and IWRRI in studies to prioritize low- and moderate-temperature resource areas for new development. Develop conceptual geologic models and groundwater data for selected resources.

3.0 REPORTS, DATA, AND OTHER DELIVERABLES

3.1 A geothermal database listing in hardcopy and diskette form will be submitted to UURI. The listing will include all known low- and moderate- temperature spring and well occurrences in the State of Colorado. Principal facts will include location, depth (well), flow rate (if known), etc.

3.2 Letter reports and memoranda reviewing collocation data and priority rankings will be submitted to OIT-GHC and UURI.

3.3 A final summary report, not to exceed 50 pages, describing all tasks and their results, and documenting any new temperature, geologic, geochemical or geophysical data will be submitted to UURI, OIT-GHC, and IWRRI. This report may incorporate interim letter reports and memoranda as appendices. The report will include a geothermal resource occurrence map of the state, black and white, scale 1:1,000,000 or acceptable alternative.

3.4 Interim progress reports will be submitted to UURI and OIT quarterly.

4.0 SCHEDULE OF PERFORMANCE AND REPORTING

4.1 The period of performance for this agreement will terminate December 31, 1993, unless modified by letter agreement and signed by the Colorado Geological Survey, OIT-GHC, and UURI.

4.2 A review of the OIT-GHC collocation study will be completed and a letter report or memorandum of comment submitted to OIT-GHC and UURI within one month after receipt of the draft document from OIT-GHC.

4.3 A preliminary database listing of geothermal resource occurrences will be submitted to UURI within four months after the execution of this agreement.

4.4 A final database listing of geothermal resource occurrences will be submitted to UURI within twelve months after the execution of this agreement.

4.5 A final report documenting all new data and activities completed under this agreement will be submitted to UURI not later than December 31, 1993.

5.0 RESPONSIBLE PARTIES

5.1 The Principal Investigator for this agreement will be James A. Cappa, Colorado Geological Survey.

5.2 The Technical Project Managers for this agreement will be Howard P. Ross, UURI and Paul J. Lienau, OIT-GHC.

5.3 The Contracting Officer for this agreement will be Douglas Yates, OIT.

6.0 FUNDING

This contract agreement provides for funding not to exceed $35,000.00 for the completion of all technical tasks and submittal of all required deliverables.

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

M E M O R A N D U M

TO: Jim Cappa, Colorado Geological Survey

FROM: Howard Ross, UURI

SUBJECT: Initial thoughts on CGS draft geothermal database format

DATE: March 5, 1993

Jim, here are some thoughts, based in part on my review of other team databases. Perhaps some tables should be titled "Thermal Springs and Wells" since the information is more specific, as are the analyses and locations. Bob Blackett, Utah Geological Survey, uses Table 1 for location information (answers "where is it?" right away). The UGS and other teams plan to code the entries with a reference number which is common to all tables- this is similar to the old GEOTHERM record number.

Table 1 - General Information
- Identify if sample is hot spring or well (s or w).
- Express flow in L/m, rather than gpm.
- Indicate depth of sample (production zone) if well
- Identification (record or reference no.)
- Indicate code for current use (spa, heating) if any.
- T*F parameter is different, could indicate potential for use

Table 2 - Geochemical Analyses
- Identification or record number
- Hot Springs - Source is repeated
- Date Sampled - useful, but could be obtained from reference

You could reduce this table to "geothermal essentials" on one page, and include rarely reported chemistry on optional pages. It would be important to include pH, TDS, cations and ions used in geochem thermometers, isotope data; see example from Utah Geological Survey, Table 3.

Add a column for ion balance, to indicate analytical quality

Generally the chemical analyses are reported in milligrams per liter for most geothermal studies; this is true for the earlier file GEOTHERM and other geothermal publications. Many of the elements included in your table are not very important for geothermal considerations, would be present in small amounts (ug/l), or rarely reported, and could be relegated to an extra table (2A) for less frequent use.

Temperature and flow duplicate information in Table 1

Table 3 - Location

Could use a record no. to coordinate with other tables
You may want to input Latitude and Longitude in decimal form
A column of UTM coordinates may facilitate computer plotting
Quadrangle - could be useful, but County, Township, Range, Section are probably more important and should come first.

Jim, I am enclosing copies of the first pages of the Utah Geological Survey tables developed by Bob Blackett. I think several of the other teams like this format and will follow it fairly closely, with some optional additions. I think Bob has boiled down lots of possible entries to the most essential items, and presents them quite well. You might want to discuss his choices with him. His phone number is (801) 467-7970, and he has welcomed call from the other state teams.

Please call me when you wish to discus the database format in more detail.

**************** -COMM.JOURNAL- ********************** DATE DEC-27-1993 ***** TIME 09:57 **** P.1

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-U OF U RESEARCH -

(FAX-310 V2.12)* - 801 584 4453- ***********

UURI FAX

UNIVERSITY OF UTAH
RESEARCH INSTITUTE
391 Chipeta Way, Suite C
Salt Lake City, Utah 84108-1295

Phone: (801) 584-4437
FAX: (801) 584-4453

DATE: December 27, 1993 PAGE 1 OF 2

DELIVER TO: James A. Cappa FAX: (303) 866-2461

COMPANY Colorado Geological Survey

FROM: Howard Ross

Jim:

Here is a copy of the standard DOE Disclaimer statement for federally funded projects. Sorry for the delay.

Best Regards,

Howard

Acknowledgement and disclaimer statements must be used within technical manuscripts (including extended abstracts) produced under Federal contracts and grants (and non-Federal manuscripts where appropriate). Each contract or grant should be reviewed for specific required statements. The following are example acknowledgement and disclaimer statements:

ACKNOWLEDGEMENT

> This work was supported, in whole or in part, by the U.S. Department of Energy, Contract NO. DE-AC07-85ID12489. Such support does not constitute an endorsement by the U.S. Department of Energy of the views expressed in this publication.

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STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Division of Minerals and Geology

Department of Natural Resources
1313 Sherman Street, Rm. 715
Denver, Colorado 80203
Phone (303) 866-2611
FAX (303) 866-2461

MEMORANDUM

TO: Howard Ross, UURI

FROM: Jim Cappa, CGS

DATE: August 5, 1993

SUBJECT: Preliminary results of 1993 low temperature geothermal program.

The work on the Colorado portion of the low temperature geothermal research program consist of four main parts: 1) field investigations and sampling of known and new geothermal sources; 2) research of various geothermal and water quality data bases for analytical data on known and new geothermal sources; 3) research of the Colorado State Water Engineer and Colorado Oil and Gas Commission well permit files; and 4) entry of data into a GIS compatible data base and production of a 1:1,000,000 scale map and accompanying data bases.

The field investigation and sampling portion of the program is just about complete. CGS staff members have made 4 separate one week trips around selected areas of Colorado visiting known geothermal areas and discovering new ones in the process. We have collected water samples for chemical analysis at nine of the sites we have visited. The field investigations have allowed us to gain first hand information on the physical and chemical characteristics and current usage of the geothermal resources. We have also obtained a subjective measure of the quality and degree of development. Being at the geothermal site has allowed us to meet local people who have knowledge of other unreported geothermal sources and also are acquainted with the usages of the sources.

We have utilized several published data bases to gain further information on the location and geochemistry of the geothermal sources. Most of the information compiled in the present program came from two principal publications of the CGS on geothermal resources: CGS Bull. 39, 1978, An Appraisal of Colorado's Geothermal Resources, and Inform. Ser. 6, 1976, Hydrogeochemical Data of Thermal Springs and Wells in Colorado.

Both of these publications were the result of a DOE geothermal program of the late 1970's and early 1980's. WATSTOR, a U. S. Geological Survey water quality data base, was utilized and as a result 19 new geothermal sources of water >20° C were added to the data base. The GEOTHERM data base, another U. S. Geological Survey compilation, was also investigated but it contained information already entered into the data base from the CGS publications of 1978 and 1976. Other data sources included various literature references, technical articles, University theses, resource user chemical reports, and municipal governments.

The well permit files of the State Oil and Gas Commission and the State Water Engineer were investigated. One important geothermal source, the Deganahl well, was added as a result of this investigation.

The data bases of the current program have been designed and most of the data has been entered at this writing. Three geochemical analyses are still outstanding and a few days of field investigation are still pending.

The current program indicates that several areas in the state continue a long history of substantial utilization of their geothermal resources such as Glenwood Springs, Idaho Springs, Steamboat Springs, Pagosa Springs, Poncha Springs, Mount Princeton and Ouray. All of these areas, at the minimum, utilize their resources for swimming pools and spas. Some, such as Pagosa Springs, utilize geothermal heat for space heating in municipal and other buildings.

There are several other areas in the state that are on the fringe of development. That is, they have some development of geothermal resources; however, there are indications that geological and geophysical studies could be used to increase the area and pace of development. These include the following: Trimble Hot Springs north of Durango, in La Plata County; Orvis Hot Springs north of Ouray in Ouray County; a large area southeast of Pagosa Springs along the Archuleta Antiform in Archuleta County; the eastern San Luis Valley in Saguache and Alamosa Counties; the area around Rico and Dunton Hot Springs in Dolores County, and the Cottonwood Hot Springs in Chaffee County.

Other geothermal resources that are geologically significant but far from a center of significant population are: the Deganahl well in Routt County, the Brands Ranch well in Jackson County, the Craig warm water well in Moffatt County, and the Hartsel Hot Springs in Park County.

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Division of Minerals and Geology

Department of Natural Resources
1313 Sherman Street, Rm. 715
Denver, Colorado 80203
Phone (303) 866-2611
FAX (303) 866-2461

MEMORANDUM

TO: Howard Ross, UURI

FROM: Jim Cappa, CGS

DATE: August 5, 1993

SUBJECT: Data for Phase 2 funding, low temperature geothermal project.

ITEM	1993 INVENTORY	1980 INVENTORY	% CHANGE
# THERMAL WELLS AND SPRINGS	+170	120	+42
# RESOURCE AREAS	96	56	+71
# AREAS DIRECT HEAT USE	28	28	0

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Department of Natural Resources

1313 Sherman Street, Rm. 715
Denver, Colorado 80203
Phone (303) 866-2611
FAX (303) 866-2115

Howard Ross
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

April 12, 1993 Rec 4/19/93 HR

RE: Geothermal Project Quarterly report; First Quarter, 1993.

Dear Howard:

Activity on the geothermal project has been picking up over the past two weeks as other obligations have been completed or delegated to other staff members . A brief description of the First Quarter activities follows:

* Design preliminary data bases; three separate data bases are being used; location, general and geochemical.
* Submit preliminary data bases to UURI in February.
* Implement changes to preliminary data bases following suggestions of UURI.

At the present time we are devoting considerable effort to the data bases. Current tasks are:

* Enter data into the location data base. We are finding a substantial amount of small errors in the older reports of geothermal locations in the reports completed in the late 70's and early 80's.
* A complete geochemical data base using all available geochemical information has been designed. Based upon your suggestions we will submit the short version to UURI at the end of the project.
* A search of the records of the State Water Engineer's files has revealed the presence of 141 new geothermal wells drilled since 1984. Some of these are probably shallow "heat pump" wells and are not true low temperature geothermal resources. All records going back to 1975 will be researched during the second quarter.

* A field trip is planned for the first week in May to investigate and sample geothermal resources in the northern and central parts of the state. Specific target areas include Brands Ranch in Jackson County, Hot Sulphur Springs in Grand County, Haystack Butte Near Boulder and the Dotsero Hot Springs in Eagle County.

Sincerely,

James A. Cappa
Chief, Minerals and Mineral Fuels

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108-1295
TELEPHONE 801-524-3422

October 15, 1992

Dr. Jim Cappa
Chief, Minerals & Mineral Fuels Section
Colorado Geological Survey
1313 Sherman St., Rm 715
Denver, CO 80203

Dear Jim:

It was good to hear from you and to know you are progressing with the Colorado geothermal project. After our conversation I decided to send a few items along which you may find of interest.

Enclosed is a copy of the Program for the 1992 Annual GRC meeting, to let you know what was presented. The papers are published in the GRC Transactions Volume 16, which is fairly expensive ($50). If any papers are of particular interest to you we may be able to get reprints from the authors, or make copies from our volume of the Transactions. Please let me know if you have any interest in these.

Also enclosed is a just revised copy of our Guide to Water Sampling, by Ruth Kroneman, UURI's chief chemist. If you have any specific questions, please feel free to call Ruth at (801) 524-3434. I also suggest that you call Bob Blackett, the Utah Geological Survey geothermal P.I., for a general discussion of sampling procedures. Bob would be happy to share thoughts on field procedures, experience, equipment, etc. Bob can be reached at (801) 467-7970.

Please let me know if I can provide, or direct you to, any additional information.

Sincerely,

Howard

Howard P. Ross
Section Head/Applied Geophysics

HR/mt
Enclosure

10/20/92

Jim -
I delayed mailing this until we had revised our water sampling report. Please feel free to call Bob Blackett of the Utah Geologic Survey.

- As of November 2 my telephone no. will be changed to 584-4444.

Regards,
Howard Ross

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

June 25, 1992

Mr. Paul J. Lienau
Geo-Heat Center
Oregon Institute of Technology
3201 Campus Drive
Klamath falls, OR 97601

Dear Paul:

Enclosed is a letter from James Cappa, Chief, Mineral and Mineral Fuels section, Colorado Geological Survey, with supporting budget, audit, and resume information for the Colorado Low-Temperature subcontract. Jim will be the Principal Investigator for this subcontract.

If you have any questions regarding this subcontract please feel free to contact Jim Cappa directly, or call me if I can help.

Sincerely,

Howard

Howard P. Ross
Project Manager

encl.

STATE OF COLORADO

ROY R. ROMER
GOVERNOR

JOHN W. ROLD
DIRECTOR

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING — 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 866-2611

Rec 10/16/92 HPR

October 13, 1992

Howard P. Ross
University of Utah Research Instit.
Earth Science Laboratory
391 Chipewa Way, Suite C
Salt Lake City, UT 84108-1295

Dear Howard:

I have reviewed and updated, where necessary, the preliminary geothermal resource and demographic data for the State of Colorado as requested in Task 2.4. I removed the "Northrop Reformatory" from the collocation data base as there is no such location in Colorado. My suspicion is that the "Northrop Reformatory" is an old name for the Buena Vista Correctional Center. The feasability of heating the Buena Vista center from the Mount Princeton Hot Springs was investigated during the 1970's. The project was not an economic venture at that time.

I have enclosed a paper printout of the data review. Also, a floppy disk is included which contains the data review on a Quattro Pro, version 4.0, file.

Sincerely,

James A. Cappa
Chief, Mineral and Mineral Fuels Section

cc: Paul Lienau, OIT-GHC

COLORADO GEOTHERMAL PROJECT
TABLE 1: GEOTHERMAL SOURCE LOCATION

ID	GEOTHERMAL SOURCE	TYPE	QUADNAME	COUNTY	SECTION	QTRQTR	TOWNSHIP	TD	RANGE	RD	MERIDIAN	LATDEG	MIN	SEC	LATDEC	LONGDEG	MIN	SEC	LONGDEC	X-UTM	Y-UTM	LOC REL
1	Antelope Warm Spring	HS	Workman Creek	Mineral	1	SWSE	40	N	2	W	N.M.P.M.	37	44	36	37.7433	107	2	14	-107.0372	320502	4179087	1
2	Birdsie Warm Spring	HS	Workman Creek	Mineral	14	NWNE	40	N	2	W	N.M.P.M.	37	43	42	37.7283	107	3	13	-107.0536	319021	4177454	3
3	Brands Ranch	W	Pitchpine Mountain	Jackson	31	SWSE	9	N	81	W	SIXTH	40	42	16	40.7044	106	32	4	-106.5344	370370	4506869	1
4	Brown's Canon Warm Spring	HS	Nathrop	Chaffee	23	SESW	51	N	8	E	N.M.P.M.	38	39	13	38.6536	106	3	11	-106.0531	408368	4278657	3
5	Brown's Grotto Warm Spring	HS	Nathrop	Chaffee	27	SWSW	51	N	8	E	N.M.P.M.	38	38	13	38.6369	106	4	26	-106.0739	406533	4276829	3
6	Canyon City Hot Springs	W	Royal Gorge	Fremont	31	SWSE	18	S	70	W	SIXTH	38	25	57	38.4325	105	15	46	-105.2628	477064	4253630	2
7	Cebolla "A", (Powderhorn)	HS	Powder Horn	Gunnison	4	NWNE	46	N	2	W	N.M.P.M.	38	16	26	38.2739	107	5	54	-107.0983	316445	4238081	1
8	Cebolla "B", (Powderhorn)	HS	Powder Horn	Gunnison	4	NWNE	46	N	2	W	N.M.P.M.	38	16	26	38.2739	107	5	54	-107.0983	316445	4238081	1
9	Cebolla "C", (Powderhorn)	HS	Powder Horn	Gunnison	4	NWNE	46	N	2	W	N.M.P.M.	38	16	26	38.2739	107	5	54	-107.0983	316445	4238081	1
10	Cement Creek Warm Spring	HS	Cement Mountain	Gunnison		Unsurveyed						38	50	6	38.8350	106	49	34	-106.8261	341497	4299843	1
11	Clark Spring	W	Northeast Pueblo	Pueblo	1	NENE	21	S	65	W	SIXTH	38	15	29	38.2581	104	36	35	-104.6097	534146	4234313	3
12	Colonel Chinn	W	Hotchkiss	Delta	14	CNE	14	S	92	W	SIXTH	38	50	22	38.8394	107	38	3	-107.6342	271365	4302050	3
13	Conundrum Hot Springs	HS	Maroon Bells	Pitkin		Unsurveyed						39	0	43	39.0119	106	53	27	-106.8908	336287	4319595	1
14	Cottonwood Hot Springs	HS	Buena Vista West	Chaffee		Unsurveyed						38	48	46	38.8128	106	13	35	-106.2264	393521	4296507	2
15	Cottonwood (Jump Steady)	HS	Buena Vista West	Chafee		Unsurveyed						38	48	46	38.8128	106	13	35	-106.2264	393521	4296507	2
16	Cottonwood (Merrifield well)	W	Buena Vista West	Chafee	28	NENE	14	S	79	W	SIXTH	38	48	35	38.8097	106	13	24	-106.2233	393782	4296165	2
17	Craig Warm Water	W	Castor Gulch	Moffat	9	SESE	6	N	91	W	SIXTH	40	29	11	40.4864	107	36	3	-107.6008	279559	4484783	1
18	Deganahl	W	Yampa	Routt	18	SESE	2	N	85	W	SIXTH	40	8	9	40.1358	106	57	43	-106.9619	332851	4444468	2
19	Dexter Spring	W	Pikes Stockade	Conejos	8	NENE	35	N	11	E	N.M.P.M.	37	17	41	37.2947	105	47	6	-105.7850	430422	4127653	1
20	Don K Ranch	W	Wetmore	Pueblo	5	NENE	22	S	68	W	SIXTH	38	10	13	38.1703	105	0	48	-105.0133	498832	4224502	1
21	Dotsero	HS	Dotsero	Eagle	12	SENW	5	S	87	W	SIXTH	39	37	56	39.6322	107	6	5	-107.1014	319655	4388840	2
22	Dotsero south	HS	Dotsero	Eagle	12	SENW	5	S	87	W	SIXTH	39	37	52	39.6311	107	5	58	-107.0994	319819	4388712	4
23	Dunton	HS	Dolores Peak	Dolores		Unsurveyed						37	46	17	37.7714	108	5	33	-108.0925	227606	4184751	4
24	Dutch Crowley	W	Chromo	Archuleta		Unsurveyed						37	1	1	37.0169	106	47	3	-106.7842	341276	4098037	1
25	Eldorado Springs "A"	W	Eldorado	Boulder		Unsurveyed						39	55	56	39.9322	105	16	47	-105.2797	476099	4420062	2
26	Eldorado Springs "B"	HS	Eldorado	Boulder		Unsurveyed						39	55	56	39.9322	105	16	47	-105.2797	476099	4420062	2
27	Eoff	W	Serviceberry Mountain	Archuleta	7	SESW	34	N	1	W	N.M.P.M.	37	11	28	37.1911	106	59	43	-106.9953	322899	4117734	1
28	Florence	W	Florence	Fremont	7	NENW	19	S	68	W	SIXTH	38	24	53	38.4147	105	2	43	-105.0453	496047	4251625	2
29	Fremont Natatorium	W	Canon	Fremont	26	NWNW	18	S	70	W	SIXTH	38	27	37	38.4603	105	11	45	-105.1958	482914	4256697	2
30	Geyser	HS	Rico	Dolores		Unsurveyed						37	44	48	37.7467	108	7	1	-108.1169	225361	4182078	3
31	Glenwood Springs (Big Spring)	HS	Glenwood Springs	Garfield	9	SENE	6	S	89	W	SIXTH	39	32	58	39.5494	107	19	18	-107.3217	300511	4380117	2
32	Glenwood Springs (Drinking Spring)	HS	Glenwood Springs	Garfield	9	SENE	6	S	89	W	SIXTH	39	32	58	39.5494	107	19	18	-107.3217	300511	4380117	2
33	Glenwood Springs (Vapor Cave)	HS	Glenwood Springs	Garfield	9	SENE	6	S	89	W	SIXTH	39	33	3	39.5508	107	19	11	-107.3197	300682	4380267	2
34	Glenwood Springs (Graves Springs)	HS	Glenwood Springs	Garfield	9	NWNW	6	S	89	W	SIXTH	39	33	18	39.5550	107	20	7	-107.3353	299358	4380764	3
35	Glenwood Springs (Spring A)	HS	Glenwood Springs	Garfield	10	SWNW	6	S	89	W	SIXTH	39	32	58	39.5494	107	19	10	-107.3194	300702	4380112	2
36	Glenwood Springs (Spring B)	HS	Glenwood Springs	Garfield	10	SWNW	6	S	89	W	SIXTH	39	33	2	39.5506	107	19	4	-107.3178	300849	4380232	2
37	Glenwood Springs (Spring C)	HS	Glenwood Springs	Garfield	10	SWNW	6	S	89	W	SIXTH	39	33	4	39.5511	107	19	0	-107.3167	300946	4380291	2
38	Glenwood Springs (Spring D)	HS	Glenwood Springs	Garfield	10	SWNW	6	S	89	W	SIXTH	39	33	4	39.5511	107	19	0	-107.3167	300946	4380291	2
39	Glenwood Springs (Railroad Spring)	HS	Glenwood Springs	Garfield	10	NENW	6	S	89	W	SIXTH	39	33	16	39.5544	107	18	51	-107.3142	301170	4380655	4
40	Hartsel (Sping A)	HS	Hartsel	Park	8	NESE	12	S	75	W	SIXTH	39	1	5	39.0181	105	47	40	-105.7944	431223	4318873	1
41	Hartsel (Spring B)	HS	Hartsel	Park	8	NESE	12	S	75	W	SIXTH	39	1	5	39.0181	105	47	40	-105.7944	431223	4318873	1
42	Haystack Butte	W	Niwot	Boulder	33	NWNE	2	N	70	W	SIXTH	40	6	1	40.1003	105	13	51	-105.2308	480325	4438703	3
43	Hot Sulphur Springs (Spring A)	HS	Hot Sulphur Springs	Grand	3	SWSE	1	N	78	W	SIXTH	40	4	33	40.0758	106	6	40	-106.1111	405257	4436555	2
44	Hot Sulphur Springs (Spring B)	HS	Hot Sulphur Springs	Grand	3	SWSE	1	N	78	W	SIXTH	40	4	33	40.0758	106	6	41	-106.1114	405234	4436556	2
45	Hot Sulphur Springs (Spring C)	HS	Hot Sulphur Springs	Grand	3	SWSE	1	N	78	W	SIXTH	40	4	32	40.0756	106	6	39	-106.1108	405281	4436524	2

46 Hot Sulphur Springs (Spring D)	HS	Hot Sulphur Springs	Grand	3	SWSE	1	N	78	W	SIXTH	40	4	30	40.0750	106	6	38	-106.1106	405304	4436462	3
47 Idaho Springs (Spring A)	HS	Idaho Springs	Clear Creek	1	NENW	4	S	73	W	SIXTH	39	44	20	39.7389	105	30	43	-105.5119	456133	4398693	2
48 Idaho Springs (Spring B)	HS	Idaho Springs	Clear Creek		Unsurveyed						39	44	21	39.7392	105	30	43	-105.5119	456134	4398724	2
49 Idaho Springs (Spring C)	HS	Idaho Springs	Clear Creek	1	NENW	4	S	73	W	SIXTH	39	44	19	39.7386	105	30	44	-105.5122	456109	4398662	2
50 Idaho Springs (Lodge well)	W	Idaho Springs	Clear Creek		Unsurveyed					SIXTH	39	44	22	39.7394	105	30	43	-105.5119	456134	4398755	2
51 Juniper Hot Springs	HS	Juniper Hot Springs	Moffat	16	NESW	6	N	94	W		40	28	1	40.4669	107	57	10	-107.9528	249653	4483563	1
52 Lemon	HS	Placerville	San Miguel	34	SESE	44	N	11	W	N.M.P.M.	38	0	55	38.0153	108	3	11	-108.0531	231968	4211705	2
53 McIntyre	HS	Pikes Stockade	Conejos	18	NWNW	35	N	11	E	N.M.P.M.	37	16	48	37.2800	105	49	7	-105.8186	427429	4126045	1
54 Mineral Hot Springs (Spring A)	W	Villa Grove	Saguache	7	SWNW	45	N	10	E	N.M.P.M.	38	10	8	38.1689	105	55	5	-105.9181	419580	4224746	3
55 Mineral Hot Springs (Spring B)	HS	Villa Grove	Saguache	7	SWNW	45	N	10	E	N.M.P.M.	38	10	8	38.1689	105	55	6	-105.9183	419555	4224746	3
56 Mineral Hot Springs (Spring C)	HS	Villa Grove	Saguache	12	SENE	45	N	9	E	N.M.P.M.	38	10	6	38.1683	105	55	11	-105.9197	419433	4224686	3
57 Mineral Hot Springs (Spring D)	HS	Villa Grove	Saguache	12	SENE	45	N	9	E	N.M.P.M.	38	10	4	38.1678	105	55	20	-105.9222	419213	4224626	3
58 Mt. Princeton Hot Springs (Spring A)	HS	Mount Antero	Chaffee	19	SWNW	15	S	78	W	SIXTH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
59 Mt. Princeton Hot Springs (Spring B)	HS	Mount Antero	Chaffee	19	SWNW	15	S	78	W	SIXTH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
60 Mt. Princeton Hot Springs (Spring D)	HS	Mount Antero	Chaffee	19	SWNW	15	S	78	W	SIXTH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
61 Mt. Princeton Hot Springs (Spring E)	HS	Mount Antero	Chaffee	19	SWNW	15	S	78	W	SIXTH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
62 Mt. Princeton Hot Springs (Spring F)	HS	Mount Antero	Chaffee	19	SWNW	15	S	78	W	SIXTH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
63 Mt. Princeton Hot Springs (Hortense)	HS	Mount Antero	Chaffee	24	SENW	15	S	79	W	SIXTH	38	43	57	38.7325	106	10	30	-106.1750	397869	4287540	1
64 Mt. Princeton Hot Springs (Hortense Well)	W	Mount Antero	Chaffee	24	SENW	15	S	79	W	SIXTH	38	43	58	38.7328	106	10	27	-106.1742	397941	4287570	3
65 Mt. Princeton Hot Springs (Woolmington well)	W	Mount Antero	Chaffee	24	SESW	15	S	79	W	SIXTH	38	43	24	38.7233	106	10	38	-106.1772	397662	4286526	3
66 Mt. Princeton Hot Springs (Wright well, east)	W	Mount Antero	Chaffee	24	SENE	15	S	79	W	SIXTH	38	43	56	38.7322	106	9	58	-106.1661	398641	4287500	3
67 Mt. Princeton Hot Springs (Wright well, west)	W	Mount Antero	Chaffee	24	SENW	15	S	79	W	SIXTH	38	43	56	38.7322	106	10	30	-106.1750	397868	4287510	3
68 Mt. Princeton Hot Springs (Young Life well)	W	Mount Antero	Chaffee	24	SENW	15	S	79	W	SIXTH	38	43	56	38.7322	106	10	32	-106.1756	397820	4287510	3
69 Orvis Hot Spring	HS	Dallas	Ouray	22	CSW	45	N	8	W	N.M.P.M.	38	8	0	38.1333	107	44	2	-107.7339	260379	4223934	1
70 Ouray (Wesbaden & Motel Spring A)	HS	Ouray	Ouray		Unsurveyed						38	1	16	38.0211	107	40	3	-107.6675	265841	4211310	2
71 Ouray (Wesbaden & Motel Spring B)	HS	Ouray	Ouray		Unsurveyed						38	1	16	38.0211	107	40	3	-107.6675	265841	4211310	2
72 Ouray (Wesbaden & Motel Spring C)	HS	Ouray	Ouray		Unsurveyed						38	1	16	38.0211	107	40	3	-107.6675	265841	4211310	2
73 Ouray (Pool Spring)	HS	Ouray	Ouray		Unsurveyed						38	1	6	38.0183	107	40	41	-107.6781	264906	4211029	3
74 Ouray (Uncompahgre Spring)	HS	Ouray	Ouray		Unsurveyed						38	1	25	38.0236	107	40	27	-107.6742	265264	4211605	4
75 Pagosa Springs (Big Spring)	HS	Pagosa Springs	Archuleta	13	SESW	35	N	2	W	N.M.P.M.	37	15	52	37.2644	107	0	37	-107.0103	321741	4125899	1
76 Pagosa Springs (Courthouse well)	W	Pagosa Springs	Archuleta	13	SWNE	35	N	2	W	N.M.P.M.	37	16	9	37.2692	107	0	33	-107.0092	321850	4126421	3
77 Pagosa Springs (Spa Motel well)	W	Pagosa Springs	Archuleta	13	NWSE	35	N	2	W	N.M.P.M.	37	15	57	37.2658	107	0	31	-107.0086	321892	4126050	4
78 Paradise Hot Spring	W	Groundhog Mountain	Doleres		Unsurveyed			0			37	45	15	37.7542	108	7	54	-108.1317	224091	4182954	1
79 Penny Hot Springs	W	Redstone	Pitkin	4	NENW	10	S	88	W	SIXTH	39	13	33	39.2258	107	13	29	-107.2247	307957	4343988	1
80 Penny Hot Springs (Granges Spring)	W	Redstone	Pitkin	33	SESW	9	S	88	W	SIXTH	39	13	50	39.2306	107	13	34	-107.2261	307850	4344515	2
81 Pinkerton (Spring A)	HS	Hermosa	La Plata	25	SWNE	37	N	9	W	N.M.P.M.	37	26	50	37.4472	107	48	17	-107.8047	251884	4147976	3
82 Pinkerton (Spring B)	HS	Hermosa	La Plata	25	NWNE	37	N	9	W	N.M.P.M.	37	26	54	37.4483	107	48	18	-107.8050	251863	4148100	4
83 Pinkerton (Mound Spring)	HS	Hermosa	La Plata	25	NWNE	37	N	9	W	N.M.P.M.	37	27	7	37.4519	107	48	20	-107.8056	251826	4148502	3
84 Pinkerton (Little Mound Spring)	HS	Hermosa	La Plata	25	NWNE	37	N	9	W	N.M.P.M.	37	27	9	37.4525	107	48	21	-107.8058	251803	4148565	3
85 Poncha Springs (Spring A)	HS	Poncha Pass	Chaffee	15	NWSW	38	N	8	E	N.M.P.M.	38	29	49	38.4969	106	4	37	-106.0769	406085	4261297	1
86 Poncha Springs (Spring B)	HS	Poncha Pass	Chaffee	15	NWSW	38	N	8	E	N.M.P.M.	38	29	49	38.4969	106	4	37	-106.0769	406085	4261297	1
87 Poncha Springs (Spring C)	HS	Poncha Pass	Chaffee	15	NWSW	38	N	8	E	N.M.P.M.	38	29	53	38.4981	106	4	34	-106.0761	406159	4261420	2
88 Poncha Springs (Spring D)	HS	Poncha Pass	Chaffee	15	NWSW	38	N	8	E	N.M.P.M.	38	29	53	38.4981	106	4	34	-106.0761	406159	4261420	2
89 Poncha Springs (Spring E)	HS	Poncha Pass	Chaffee	15	NWSW	38	N	8	E	N.M.P.M.	38	29	53	38.4981	106	4	34	-106.0761	406159	4261420	2
90 Rainbow	HS	South River Peak	Mineral		Unsurveyed			0			37	30	33	37.5092	106	52	28	-106.8744	334326	4152804	1
91 Ranger	HS	Cement Mountain	Gunnison	22	SWSE	14	S	85	W	SIXTH	38	48	47	38.8131	106	52	28	-106.8744	337252	4297493	1
92 Rhodes	HS	Fairplay West	Park	24	NWSW	10	S	78	W	SIXTH	38	9	49	38.1636	106	3	54	-106.0650	406700	4224298	1
93 Rico (Diamond drill hole)	W	Rico	Dolores		Unsurveyed						37	42	5	37.7014	108	1	45	-108.0292	232934	4176799	3
94 Rico (Big Geyser Warm Spring)	W	Rico	Dolores		Unsurveyed						37	42	0	37.7000	108	1	44	-108.0289	232954	4176644	3
95 Rico (Geyser Warm Spring)	W	Rico	Dolores		Unsurveyed						37	42	2	37.7006	108	1	44	-108.0289	232956	4176706	3

96	Rico (Little Spring)	W	Rico	Dolores		Unsurveyed						37	42	4	37.7011	108	1	44	-108.0289	232958	4176767	3
97	Routt [aka Strawberry] (Spring A)	HS	Rocky Peak	Routt	18	SWSE	7	N	84	W	SIXTH	40	33	34	40.5594	106	51	0	-106.8500	343372	4491287	1
98	Routt [aka Strawberry] (Spring B)	HS	Rocky Peak	Routt	18	SWSE	7	N	84	W	SIXTH	40	33	34	40.5594	106	51	0	-106.8500	343372	4491287	1
99	Routt [aka Strawberry] (Spring C)	HS	Rocky Peak	Routt	18	SWSE	7	N	84	W	SIXTH	40	33	34	40.5594	106	51	0	-106.8500	343372	4491287	1
100	Routt [aka Strawberry] (Spring D)	HS	Rocky Peak	Routt	18	SWSE	7	N	84	W	SIXTH	40	33	34	40.5594	106	51	0	-106.8500	343372	4491287	1
101	Sand Dune Pool	W	Deadman Camp	Saguache	27	NENE	41	N	10	E	N.M.P.M.	37	46	42	37.7783	105	51	20	-105.8556	424656	4181361	1
102	Shaws	HS	Twin Mountain SE	Saguache	33	SESE	41	N	6	E	N.M.P.M.	37	45	1	37.7503	106	19	1	-106.3169	383979	4178720	1
103	South Canyon Hot Springs (Spring A)	HS	Storm King Mountain	Garfield	2	SESW	6	S	90	W	SIXTH	39	33	11	39.5531	107	24	40	-107.4111	292836	4380720	3
104	South Canyon Hot Springs (Spring B)	HS	Storm King Mountain	Garfield	2	SESW	6	S	90	W	SIXTH	39	33	11	39.5531	107	24	40	-107.4111	292836	4380720	3
105	Splashland	W	Alamosa East	Alamosa	34	SESE	38	N	10	E	N.M.P.M.	37	29	19	37.4886	105	51	31	-105.8586	424093	4149220	3
106	Steamboat Springs (Heart Spring)	HS	Steamboat Springs	Routt	17	SENE	6	N	84	W	SIXTH	40	28	58	40.4828	106	49	37	-106.8269	345148	4482735	1
107	Steamboat Springs (Sulphur Cave Spring)	HS	Steamboat Springs	Routt	17	NWNW	6	N	84	W	SIXTH	40	29	3	40.4842	106	50	22	-106.8394	344092	4482911	1
108	Steamboat Springs (Steamboat Spring)	HS	Steamboat Springs	Routt	8	SWSW	6	N	84	W	SIXTH	40	29	20	40.4889	106	50	26	-106.8406	344009	4483438	1
109	Stinking Springs	HS	Chromo	Archuleta		Unsurveyed						37	2	6	37.0350	106	48	28	-106.8078	339214	4100080	1
110	Swissvale (Spring A)	HS	Wellsville	Fremont	20	SESW	49	N	10	E	N.M.P.M.	38	28	50	38.4806	105	53	26	-105.8906	422322	4259305	2
111	Swissvale (Spring F)	HS	Wellsville	Fremont	20	SESW	49	N	10	E	N.M.P.M.	38	28	50	38.4806	105	53	26	-105.8906	422322	4259305	2
112	Trimble	HS	Hermosa	La Plata	15	NWNW	36	N	9	W	N.M.P.M.	37	23	27	37.3908	107	50	52	-107.8478	247885	4141833	3
113	Tripp	HS	Hermosa	La Plata	15	NWNW	36	N	9	W	N.M.P.M.	37	23	28	37.3911	107	50	52	-107.8478	247886	4141863	3
114	Valley View (Orient) Hot Springs (Spring A)	HS	Valley View Hot Springs	Saguache	36	NWSE	46	N	10	E	N.M.P.M.	38	11	32	38.1922	105	48	49	-105.8136	428752	4227250	1
115	Valley View (Orient) Hot Springs (Spring B)	HS	Valley View Hot Springs	Saguache	36	NWSE	46	N	10	E	N.M.P.M.	38	11	31	38.1919	105	48	50	-105.8139	428727	4227219	1
116	Valley View (Orient) Hot Springs (Spring D)	HS	Valley View Hot Springs	Saguache	36	NWSE	46	N	10	E	N.M.P.M.	38	11	28	38.1911	105	48	33	-105.8092	429140	4227123	3
117	Wagon Wheel Gap (4UR Ranch Spring)	HS	Lake Humphreys	Mineral	2	NWNE	40	N	1	E	N.M.P.M.	37	44	55	37.7486	106	49	52	-106.8311	338675	4179297	4
118	Wagon Wheel Gap (CFI Spring)	HS	Lake Humphreys	Mineral	2	NWNE	40	N	1	E	N.M.P.M.	37	44	54	37.7483	106	49	50	-106.8306	338723	4179265	4
119	Waunita Hot Springs (Spring C)	HS	Pitkin	Gunnison	11	SWSW	49	N	4	E	N.M.P.M.	38	30	50	38.5139	106	30	27	-106.5075	368568	4263705	2
120	Waunita Hot Springs (Spring D)	HS	Pitkin	Gunnison	11	SWSW	49	N	4	E	N.M.P.M.	38	30	50	38.5139	106	30	27	-106.5075	368568	4263705	2
121	Waunita Hot Springs (Spring A)	HS	Pitkin	Gunnison	11	SWSW	49	N	4	E	N.M.P.M.	38	30	50	38.5139	106	30	27	-106.5075	368568	4263705	2
122	Waunita Hot Springs (Spring B)	HS	Pitkin	Gunnison	11	SWSW	49	N	4	E	N.M.P.M.	38	30	50	38.5139	106	30	27	-106.5075	368568	4263705	2
123	Lower Waunita Hot Springs (Spring A)	HS	Pitkin	Gunnison	10	SWSE	49	N	4	E	N.M.P.M.	38	31	1	38.5169	106	30	56	-106.5156	367871	4264055	3
124	Lower Waunita Hot Springs (Spring C)	HS	Pitkin	Gunnison	10	SWSE	49	N	4	E	N.M.P.M.	38	31	1	38.5169	106	30	55	-106.5153	367895	4264055	3
125	Lower Waunita Hot Springs (Spring B)	HS	Pitkin	Gunnison	10	SWSE	49	N	4	E	N.M.P.M.	38	31	0	38.5167	106	30	55	-106.5153	367895	4264024	3
126	Lower Waunita Hot Springs (Spring D)	HS	Pitkin	Gunnison	10	SWSE	49	N	4	E	N.M.P.M.	38	31	1	38.5169	106	31	0	-106.5167	367774	4264057	3
127	Wellsville	HS	Wellsville	Fremont	18	SWNW	49	N	10	E	N.M.P.M.	38	29	10	38.4861	105	54	45	-105.9125	420414	4259940	1

added 1 to old Perl Compilation

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Department of Natural Resources

1313 Sherman Street, Rm. 715
Denver, Colorado 80203
Phone (303) 866-2611
FAX (303) 866-2115

Howard Ross
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

April 30, 1993

RE: Geothermal project
Location data base

Dear Howard:

We have been pretty busy this month entering data from all the existing sources into our Quattro data bases. The enclosed preliminary location data base is complete and ready for your review and recommendations. For our own purposes we have entered the section, township and range; the latitude and longitude, both in degrees, minutes, and seconds, and in decimals of degrees (for GIS plotting); and the UTM coordinates. The last column is a location reliability indicator, with 1 being the highest and 6 being the lowest. The criterion for each class is listed below:

1 located on map within a pencil width, approximately 100'.
2 within 660' or quarter\quarter\quarter of a section.
3 within 1320' or quarter\quarter of a section.
4 within 2640' or quarter of a section.
5 within 5280' or a section.
6 worse than a section.

We have found and corrected many location errors in the CGS publications describing the state's geothermal resources. We plan to have a final quality control review of all the data bases before the project is complete in December.

Sincerely,

Jim

James A. Cappa
Chief, Minerals and Mineral Fuels

encl.

GEOTHERMAL PROJECT

TABLE 3: LOCATION OF GEOTHERMAL RESOURCES, COLORADO

HOT SPRINGS; SOURCE	QUADRANGLE	COUNTY	SECTION	QTR-QTR	TOWNSHIP	DIR	RANGE	DIR	PRINC. MERID	LAT-DEG	MIN	SEC	LON-DEG	MIN	SEC
Antelope Warm Spring															
Birdsie Warm Spring															
Brands Ranch well															
Brown´s Canon Warm Spring															
Brown´s Grotto Warm Spring															
Canon City Hot Spring (well)															
Cebolla "A", (Powderhorn)															
Cebolla "B", (Powderhorn)															
Cebolla "C", (Powderhorn)															
Cement Creek															
Clark Spring well															
Colonel Chinn well															
Conundrum															
Cottonwood															
Cottonwood (Jump Steady)															
Cottonwood (Merrifield well)															
Craig warm water well	Castor Gulch	Moffat	9	SESE	6	N	91	W	SIXTH	40	29	11	107	36	3
Dexter															
Don K well															
Dotsero															
Dotsero south															
Dunton															
Dutch Crowley well															
Eldorado Springs "A"															
Eldorado Springs "B"															
Eoff well															
Florence well															
Fremont Natatorium															
Fullinwider															
Geyser															
Glenwood Springs (Big Spring)															
Glenwood Springs (Drinking Spring)															
Glenwood Springs (Vapor Cave)															
Glenwood Springs (Graves Springs)															
Glenwood Springs (Spring A)															
Glenwood Springs (Spring B)															
Glenwood Springs (Spring C)															
Glenwood Springs (Spring D)															
Glenwood Springs (Railroad Spring)															
Hartsel (Sping A)															
Hartsel (Spring B)															
Haystack Butte well															
Hot Sulphur Springs (Spring A)															
Hot Sulphur Springs (Spring B)															
Hot Sulphur Springs (Spring C)															
Hot Sulphur Springs (Spring D)															
Idaho Springs (Spring A)															
Idaho Springs (Spring B)															
Idaho Springs (Spring C)															
Idaho Springs (Lodge well)															
Juniper Hot Springs	Juniper Hot Springs	Moffat	16	NESW	6	N	94	W	SIXTH	40	28	1	107	57	10

Lemon												
McIntyre												
Mineral Hot Springs (Spring A)												
Mineral Hot Springs (Spring B)												
Mineral Hot Springs (Spring C)												
Mineral Hot Springs (Spring D)												
Mt. Princeton Hot Springs (Spring A)												
Mt. Princeton Hot Springs (Spring B)												
Mt. Princeton Hot Springs (Spring D)												
Mt. Princeton Hot Springs (Spring E)												
Mt. Princeton Hot Springs (Spring F)												
Mt. Princeton Hot Springs (Hortense)												
Mt. Princeton Hot Springs (Hortense Well)												
Mt. Princeton Hot Springs (Woolmington well)												
Mt. Princeton Hot Springs (Wright well, east)												
Mt. Princeton Hot Springs (Wright well, west)												
Mt. Princeton Hot Springs (Young Life well)												
Orvis Hot Springs, (Ridgway)												
Ouray (Wesbaden & Motel Spring A)												
Ouray (Wesbaden & Motel Spring B)												
Ouray (Wesbaden & Motel Spring C)												
Ouray (Pool Spring)												
Ouray (Uncompahgre Spring)												
Pagosa Springs (Big Spring)												
Pagosa Springs (Courthouse well)												
Pagosa Springs (Spa Motel well)												
Paradise Hot Spring												
Penny Hot Springs												
Penny Hot Springs (Granges Spring)												
Pinkerton (Spring A)												
Pinkerton (Spring B)												
Pinkerton (Mound Spring)												
Pinkerton (Little Mound Spring)												
Poncha Springs (Spring A)												
Poncha Springs (Spring B)												
Poncha Springs (Spring C)												
Poncha Springs (Spring D)												
Poncha Springs (Spring E)												
Rainbow												
Ranger												
Rhodes												
Rico (Diamond drill hole)												
Rico (Big Geyser Warm Spring)												
Rico (Geyser Warm Spring)												
Rico (Little Spring)												
Routt [aka Strawberry] (Spring A)	Rocky Peak	Routt	18 SWSE	7 N	84 W	SIXTH	40	33	34	106	51	0
Routt [aka Strawberry] (Spring B)	Rocky Peak	Routt	18 SWSE	7 N	84 W	SIXTH	40	33	34	106	51	0
Routt [aka Strawberry] (Spring C)	Rocky Peak	Routt	18 SWSE	7 N	84 W	SIXTH	40	33	34	106	51	0
Routt [aka Strawberry] (Spring D)	Rocky Peak	Routt	18 SWSE	7 N	84 W	SIXTH	40	33	34	106	51	0
Sand Dunes Pool well												
Shaws												
South Canyon Hot Springs (Spring A)												
South Canyon Hot Springs (Spring B)												
Splashland well												
Steamboat Springs (Heart Spring)	Steamboat Springs	Routt	17 SENE	6 N	84 W	SIXTH	40	28	58	106	49	37
Steamboat Springs (Sulphur Cave Spring)	Steamboat Springs	Routt	17 NWNW	6 N	84 W	SIXTH	40	29	3	106	50	22

Steamboat Springs (Steamboat Spring)	Steamboat Springs	Routt	8 SWSW	6 N	84 W	SIXTH	40	29	20	106	50	26
Stinking Springs												
Swissvale (Spring A)												
Swissvale (Spring F)												
Trimble												
Tripp												
Valley View (Orient) Hot Springs (Spring A)												
Valley View (Orient) Hot Springs (Spring B)												
Valley View (Orient) Hot Springs (Spring D)												
Wagon Wheel Gap (4UR Ranch Spring)												
Wagon Wheel Gap (CFI Spring)												
Waunita Hot Springs (Spring C)												
Waunita Hot Springs (Spring D)												
Waunita Hot Springs (Spring A)												
Waunita Hot Springs (Spring B)												
Lower Waunita Hot Springs (Spring A)												
Lower Waunita Hot Springs (Spring C)												
Lower Waunita Hot Springs (Spring B)												
Lower Waunita Hot Springs (Spring D)												
Wellsville												

GEOTHERMAL PROJECT

TABLE 1: GEOTHERMAL RESOURCES IN COLORADO, GENERAL INFORMATION AND REFERENCES

ID	HOT SPRINGS, SOURCE	TYPE	TEMP. C	FLOW, GPM	T*F	REFERENCES
	Antelope	SW	32	3	96	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Birdsie		30	15	450	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Brands Ranch well		42	80	3360	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Browns Canon		25	1	25	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Brown's Grotto		23	5	115	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Canon City		40	3	120	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Cebolla "A", (Powderhorn)		40	3	120	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Cebolla "B", (Powderhorn)		38	1	38	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Cebolla "C", (Powderhorn)		40	1	40	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Cement Creek		26	66	1716	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Clark Spring well		25	12	300	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Colonel Chinn well		42	20	840	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Conundrum		38	50	1900	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Cottonwood		38	10	380	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Cottonwood (Jump Steady)		53	63	3339	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Cottonwood (Merrifield well)		46	1	46	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Craig well		39	24	936	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Dexter		20	50	1000	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Don K well		28	25	700	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Dotsero		31	610	18910	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Dotsero south		32	1000	32000	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Dunton		43	25	1075	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Dutch Crowley well		70	75	5250	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Eldorado Springs "A"		24	1	24	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Eldorado Springs "B"		25	1	25	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Eoff well		39	50	1950	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Florence well		28	130	3640	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Fremont Natatorium		35	19	665	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Fullinwider		18	11	198	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Geyser		28	140	3920	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Glenwood Springs (Big Spring)		50	2263	113150	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Glenwood Springs (Drinking Spring)		50	150	7500	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Glenwood Springs (Vapor Cave)		50	5	250	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Glenwood Springs (Graves Springs)		46	5	230	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Glenwood Springs (Spring A)		44	3	132	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Glenwood Springs (Spring B)		50	93	4650	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Glenwood Springs (Spring C)		46	3	138	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Glenwood Springs (Spring D)		50	74	3700	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Glenwood Springs (Railroad Spring)		51	75	3825	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Hartsel (Sping A)		52	1	52	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Hartsel (Spring B)		47	46	2162	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Haystack Butte well		28	4	112	Barrett and Pearl, 1976; Barrett and Pearl, 1978
	Hot Sulphur Springs (Spring A)		44	12	528	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Hot Sulphur Springs (Spring B)		41	1	41	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Hot Sulphur Springs (Spring C)		40	9	360	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Hot Sulphur Springs (Spring D)		40	23	920	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Idaho Springs (Spring A)		41	21	861	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Idaho Springs (Spring B)		24	1	24	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Idaho Springs (Spring C)		20	1	20	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Idaho Springs (Lodge well)		46	30	1380	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
	Juniper Hot Springs		36	16	576	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920

Lemon	32	10	320	Barrett and Pearl, 1976; Barrett and Pearl, 1978
McIntyre	14	5	70	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Mineral Hot Springs (Spring A)	60	108	6480	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mineral Hot Springs (Spring B)	51	1	51	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mineral Hot Springs (Spring C)	60	1	60	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mineral Hot Springs (Spring D)	60	5	300	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Spring A)	54	20	1080	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Spring B)	54	10	540	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Spring D)	44	10	440	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Spring E)	50	10	500	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Spring F)	49	12	588	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Hortense)	82	18	1476	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Hortense Well)	82	5	410	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Woolmington well)	39	5	195	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Wright well, east)	67	5	335	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Wright well, west)	72	5	360	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Mt. Princeton Hot Springs (Young Life well)	66	5	330	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Orvis Hot Springs, (Ridgway)	52	1	52	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Ouray (Wesbaden & Motel Spring A)	53	1	53	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Ouray (Wesbaden & Motel Spring B)	30	2	60	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Ouray (Wesbaden & Motel Spring C)	42	12	504	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Ouray (Pool Spring)	69	128	8832	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Ouray (Uncompahgre Spring)	49	5	245	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Pagosa Springs (Big Spring)	56	248	13888	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Pagosa Springs (Courthouse well)	56	30	1680	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Pagosa Springs (Spa Motel well)	53	1	53	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Paradise Hot Spring	42	30	1260	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Penny Hot Springs	44	10	440	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Penny Hot Springs (Granges Spring)	56	12	672	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Pinkerton (Spring A)	32	54	1728	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Pinkerton (Spring B)	33	20	660	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Pinkerton (Mound Spring)	29	6	174	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Pinkerton (Little Mound Spring)	26	2	52	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Poncha Springs (Spring A)	70	200	14000	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Poncha Springs (Spring B)	66	30	1980	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Poncha Springs (Spring C)	63	3	189	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Poncha Springs (Spring D)	56	2	112	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Poncha Springs (Spring E)	60	2	120	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Rainbow	40	45	1800	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Ranger	27	195	5265	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Rhodes	25	200	5000	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Rico (Diamond drill hole)	44	15	660	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Rico (Big Geyser Warm Spring)	35	10	350	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Rico (Geyser Warm Spring)	38	14	532	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Rico (Little Spring)	39	14	546	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Routt [aka Strawberry] (Spring A)	64	36	2304	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Routt [aka Strawberry] (Spring B)	62	30	1860	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Routt [aka Strawberry] (Spring C)	54	2	108	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Routt [aka Strawberry] (Spring D)	51	2	102	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Sand Dunes Pool well	44	1	44	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Shaws	30	40	1200	Barrett and Pearl, 1976; Barrett and Pearl, 1978
South Canyon Hot Springs (Spring A)	48	11	528	Barrett and Pearl, 1976; Barrett and Pearl, 1978
South Canyon Hot Springs (Spring B)	48	1	48	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Splashland well	40	1	40	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Steamboat Springs (Heart Spring)	39	140	5460	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Steamboat Springs (Sulphur Cave Spring)	20	10	200	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920

Steamboat Springs (Steamboat Spring)	26	20	520	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Stinking Springs	27	24	648	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Swissvale (Spring A)	28	125	3500	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Swissvale (Spring F)	20	20	400	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Trimble	36	1	36	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Tripp	44	1	44	Barrett and Pearl, 1976; Barrett and Pearl, 1978
Valley View (Orient) Hot Springs (Spring A)	36	60	2160	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Valley View (Orient) Hot Springs (Spring B)	32	1	32	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Valley View (Orient) Hot Springs (Spring D)	35	90	3150	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Wagon Wheel Gap (4UR Ranch Spring)	57	30	1710	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Wagon Wheel Gap (CFI Spring)	50	36	1800	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Waunita Hot Springs (Spring C)	78	45	3510	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Waunita Hot Springs (Spring D)	54	1	54	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Waunita Hot Springs (Spring A)	76	1	76	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Waunita Hot Springs (Spring B)	78	1	78	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Lower Waunita Hot Springs (Spring A)	70	75	5250	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Lower Waunita Hot Springs (Spring C)	70	8	560	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Lower Waunita Hot Springs (Spring B)	70	23	1610	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Lower Waunita Hot Springs (Spring D)	62	1	62	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920
Wellsville	30	178	5340	Barrett and Pearl, 1976; Barrett and Pearl, 1978; George, 1920

2a

HOT SPRINGS; SOURCE HOT SPRINGS; SOURCE Date Sampled As,ug/l B,ug/l Cd, ug/l Ca, mg/l Cl, mg/l F, mg/l Fe, ug/l Li,ug/l Mg, mg/l Mn,ug/l Hg, ug/l N, mg/l
GEOTHERMAL PROJECT GEOTHERMAL PROJECT
TABLE 2: GEOCHEMICAL ANALYSES OF GEOTHERMAL STABLE 2: GEOCHEMICAL ANALYSES OF GEOTHERMAL SOURCES, COLORADO

HOT SPRINGS; SOURCE	HOT SPRINGS; SOURCE	Date Sampled	As,ug/l	B,ug/l	Cd, ug/l	Ca, mg/l	Cl, mg/l	F, mg/l	Fe, ug/l	Li,ug/l	Mg, mg/l	Mn,ug/l	Hg, ug/l	N, mg/l
Antelope Warm Spring	Antelope Warm Spring	Aug., 1975	0	130	0	4	2.8	2	20	10	0.3	0	0	0
Antelope Warm Spring	Antelope Warm Spring	Oct., 1975	0	130	0	1.7	3.5	1.6	60	8	0.6	0	0	0
Birdsie Warm Spring	Birdsie Warm Spring	?, 1975												
Brands Ranch well	Brands Ranch well	?, 1975												
Brown's Canon Warm Spring	Brown's Canon Warm Spring	?, 1975												
Brown's Grotto Warm Spring	Brown's Grotto Warm Spring	?, 1975												
Canon City Hot Spring	Canon City Hot Spring	?, 1920				169.4	184.1				53.58			
Canon City Hot Spring	Canon City Hot Spring	Sept., 1975	11	190	0	190	180	1.5	30	230	62	10	0	0.55
Canon City Hot Spring	Canon City Hot Spring	Jan., 1976		200		190	190	1.5	30		55	10		0.65
Canon City Hot Spring	Canon City Hot Spring													
Cebolla Hot Springs A	Cebolla Hot Springs A													
Cebolla Hot Springs B	Cebolla Hot Springs B													
Cebolla Hot Springs C	Cebolla Hot Springs C													
Cement Creek	Cement Creek													
Clark Spring well	Clark Spring well													
Colonel Chinn well	Colonel Chinn well													
Conundrum	Conundrum													
Cottonwood	Cottonwood													
Cottonwood (Jump Steady)	Cottonwood (Jump Steady)													
Cottonwood (Merrifield well)	Cottonwood (Merrifield well)													
Craig warm water well	Craig warm water well	Jan., 1976	ND	210	ND	5.8	4.1	3.1	60	ND	0.9	ND	ND	0.04
Craig warm water well	Craig warm water well	Nov., 1992		250	ND	4.31	4.9	3.03	ND	80	0.4	ND		
Dexter	Dexter													
Don K well	Don K well													
Dotsero	Dotsero													
Dotsero south	Dotsero south													
Dunton	Dunton													
Dutch Crowley well	Dutch Crowley well													
Eldorado Springs "A"	Eldorado Springs "A"													
Eldorado Springs "B"	Eldorado Springs "B"													
Eoff well	Eoff well													
Florence well	Florence well													
Fremont Natatorium	Fremont Natatorium													
Fullinwider	Fullinwider													
Geyser	Geyser													
Glenwood Springs (Big Spring)	Glenwood Springs (Big Spring)													
Glenwood Springs (Drinking Spring)	Glenwood Springs (Drinking Spring)													
Glenwood Springs (Vapor Cave)	Glenwood Springs (Vapor Cave)													
Glenwood Springs (Graves Springs)	Glenwood Springs (Graves Springs)													
Glenwood Springs (Spring A)	Glenwood Springs (Spring A)													
Glenwood Springs (Spring B)	Glenwood Springs (Spring B)													
Glenwood Springs (Spring C)	Glenwood Springs (Spring C)													
Glenwood Springs (Spring D)	Glenwood Springs (Spring D)													
Glenwood Springs (Railroad Spring)	Glenwood Springs (Railroad Spring)													
Hartsel (Sping A)	Hartsel (Sping A)													
Hartsel (Spring B)	Hartsel (Spring B)													
Haystack Butte well	Haystack Butte well													
Hot Sulphur Springs (Spring A)	Hot Sulphur Springs (Spring A)													
Hot Sulphur Springs (Spring B)	Hot Sulphur Springs (Spring B)													
Hot Sulphur Springs (Spring C)	Hot Sulphur Springs (Spring C)													

HOT SPRINGS: SOURCE	HOT SPRINGS; SOURCE	Date Sampled	As,ug/l	B,ug/l	Cd, ug/l	Ca, mg/l	Cl, mg/l	F, mg/l	Fe, ug/l	Li,ug/l	Mg, mg/l	Mn,ug/l	Hg, ug/l	N, mg/l
Hot Sulphur Springs (Spring D)	Hot Sulphur Springs (Spring D)													
Idaho Springs (Spring A)	Idaho Springs (Spring A)													
Idaho Springs (Spring B)	Idaho Springs (Spring B)													
Idaho Springs (Spring C)	Idaho Springs (Spring C)													
Idaho Springs (Lodge well)	Idaho Springs (Lodge well)													
Juniper Hot Springs	Juniper Hot Springs	July, 1975	0	540	1	3.7	94	4	10	170	0.8	10	0.2	0.05
Juniper Hot Springs	Juniper Hot Springs	Oct., 1975	1	550	0	2.9	93	3.1	10	250	0.4	10	0	0.01
Juniper Hot Springs	Juniper Hot Springs	Jan., 1976	ND	480	ND	3.9	89	3.3	10	ND	0.3	0	ND	0.1
Juniper Hot Springs	Juniper Hot Springs	April, 1976	ND	520	ND	3.3	90	3.3	20	ND	0.3	0	ND	0.01
Juniper Hot Springs	Juniper Hot Springs	Nov., 1992	ND	630	ND	2.56	79	2.73	70	150	ND	ND		
Lemon	Lemon													
McIntyre	McIntyre													
Mineral Hot Springs (Spring A)	Mineral Hot Springs (Spring A)													
Mineral Hot Springs (Spring B)	Mineral Hot Springs (Spring B)													
Mineral Hot Springs (Spring C)	Mineral Hot Springs (Spring C)													
Mineral Hot Springs (Spring D)	Mineral Hot Springs (Spring D)													
Mt. Princeton Hot Springs (Spring A)	Mt. Princeton Hot Springs (Spring A)													
Mt. Princeton Hot Springs (Spring B)	Mt. Princeton Hot Springs (Spring B)													
Mt. Princeton Hot Springs (Spring D)	Mt. Princeton Hot Springs (Spring D)													
Mt. Princeton Hot Springs (Spring E)	Mt. Princeton Hot Springs (Spring E)													
Mt. Princeton Hot Springs (Spring F)	Mt. Princeton Hot Springs (Spring F)													
Mt. Princeton Hot Springs (Hortense)	Mt. Princeton Hot Springs (Hortense)													
Mt. Princeton Hot Springs (Hortense Well)	Mt. Princeton Hot Springs (Hortense Well)													
Mt. Princeton Hot Springs (Woolmington well)	Mt. Princeton Hot Springs (Woolmington well)													
Mt. Princeton Hot Springs (Wright well, east)	Mt. Princeton Hot Springs (Wright well, east)													
Mt. Princeton Hot Springs (Wright well, west)	Mt. Princeton Hot Springs (Wright well, west)													
Mt. Princeton Hot Springs (Young Life well)	Mt. Princeton Hot Springs (Young Life well)													
Orvis Hot Springs, (Ridgway)	Orvis Hot Springs, (Ridgway)													
Ouray (Wesbaden & Motel Spring A)	Ouray (Wesbaden & Motel Spring A)													
Ouray (Wesbaden & Motel Spring B)	Ouray (Wesbaden & Motel Spring B)													
Ouray (Wesbaden & Motel Spring C)	Ouray (Wesbaden & Motel Spring C)													
Ouray (Pool Spring)	Ouray (Pool Spring)													
Ouray (Uncompahgre Spring)	Ouray (Uncompahgre Spring)													
Pagosa Springs (Big Spring)	Pagosa Springs (Big Spring)													
Pagosa Springs (Courthouse well)	Pagosa Springs (Courthouse well)													
Pagosa Springs (Spa Motel well)	Pagosa Springs (Spa Motel well)													
Paradise Hot Spring	Paradise Hot Spring													
Penny Hot Springs	Penny Hot Springs													
Penny Hot Springs (Granges Spring)	Penny Hot Springs (Granges Spring)													
Pinkerton (Spring A)	Pinkerton (Spring A)													
Pinkerton (Spring B)	Pinkerton (Spring B)													
Pinkerton (Mound Spring)	Pinkerton (Mound Spring)													
Pinkerton (Little Mound Spring)	Pinkerton (Little Mound Spring)													
Poncha Springs (Spring A)	Poncha Springs (Spring A)													
Poncha Springs (Spring B)	Poncha Springs (Spring B)													
Poncha Springs (Spring C)	Poncha Springs (Spring C)													
Poncha Springs (Spring D)	Poncha Springs (Spring D)													
Poncha Springs (Spring E)	Poncha Springs (Spring E)													
Rainbow	Rainbow													
Ranger	Ranger													
Rhodes	Rhodes													
Rico (Diamond drill hole)	Rico (Diamond drill hole)													
Rico (Big Geyser Warm Spring)	Rico (Big Geyser Warm Spring)													
Rico (Geyser Warm Spring)	Rico (Geyser Warm Spring)													
Rico (Little Spring)	Rico (Little Spring)													

HOT SPRINGS; SOURCE	HOT SPRINGS; SOURCE	Date Sampled	As,ug/l	B,ug/l	Cd, ug/l	Ca, mg/l	Cl, mg/l	F, mg/l	Fe, ug/l	Li,ug/l	Mg, mg/l	Mn,ug/l	Hg, ug/l	N, mg/l
Routt [aka Strawberry] (Spring A)	Routt [aka Strawberry] (Spring A)	Nov., 1992		ND	ND	6.74	114	16.5	ND	270	ND	ND		
Routt [aka Strawberry] (Spring B)	Routt [aka Strawberry] (Spring B)													
Routt [aka Strawberry] (Spring C)	Routt [aka Strawberry] (Spring C)													
Routt [aka Strawberry] (Spring D)	Routt [aka Strawberry] (Spring D)													
Sand Dunes Pool well	Sand Dunes Pool well													
Shaws	Shaws													
South Canyon Hot Springs (Spring A)	South Canyon Hot Springs (Spring A)													
South Canyon Hot Springs (Spring B)	South Canyon Hot Springs (Spring B)													
Splashland well	Splashland well													
Steamboat Springs (Heart Spring)	Steamboat Springs (Heart Spring)	Nov., 1992	ND	780	ND	16.01	312	8.7	ND	300	0.53	ND		
Steamboat Springs (Sulphur Cave Spring)	Steamboat Springs (Sulphur Cave Spring)													
Steamboat Springs (Steamboat Spring)	Steamboat Springs (Steamboat Spring)													
Stinking Springs	Stinking Springs													
Swissvale (Spring A)	Swissvale (Spring A)													
Swissvale (Spring F)	Swissvale (Spring F)													
Trimble	Trimble													
Tripp	Tripp													
Valley View (Orient) Hot Springs (Spring A)	Valley View (Orient) Hot Springs (Spring A)													
Valley View (Orient) Hot Springs (Spring B)	Valley View (Orient) Hot Springs (Spring B)													
Valley View (Orient) Hot Springs (Spring D)	Valley View (Orient) Hot Springs (Spring D)													
Wagon Wheel Gap (4UR Ranch Spring)	Wagon Wheel Gap (4UR Ranch Spring)													
Wagon Wheel Gap (CFI Spring)	Wagon Wheel Gap (CFI Spring)													
Waunita Hot Springs (Spring C)	Waunita Hot Springs (Spring C)													
Waunita Hot Springs (Spring D)	Waunita Hot Springs (Spring D)													
Waunita Hot Springs (Spring A)	Waunita Hot Springs (Spring A)													
Waunita Hot Springs (Spring B)	Waunita Hot Springs (Spring B)													
Lower Waunita Hot Springs (Spring A)	Lower Waunita Hot Springs (Spring A)													
Lower Waunita Hot Springs (Spring C)	Lower Waunita Hot Springs (Spring C)													
Lower Waunita Hot Springs (Spring B)	Lower Waunita Hot Springs (Spring B)													
Lower Waunita Hot Springs (Spring D)	Lower Waunita Hot Springs (Spring D)													
Wellsville	Wellsville													

Geochem 2b

HOT SPRINGS; SOURCE PO4,mg/l K, mg/l Se, mg/l SiO2, mg/l Na, mg/l SO4, mg/l Zn, ug/l Alkal. CaCO3 Alkal. HCO3 Hard., mg/l Cond., mmohs TDS, mg/l pH, field Disc., gpm Temp. deg.C Al, ppm Sr,ppm

GEOTHERMAL PROJECT
TABLE 2: GEOCHEMICAL ANALYSES OF GEOTHERMAL S

HOT SPRINGS; SOURCE	PO4,mg/l	K, mg/l	Se, mg/l	SiO2, mg/l	Na, mg/l	SO4, mg/l	Zn, ug/l	Alkal. CaCO3	Alkal. HCO3	Hard., mg/l	Cond., mmohs	TDS, mg/l	pH, field	Disc., gpm	Temp. deg.C	Al, ppm	Sr,ppm
Antelope Warm Spring	0	0.1	0	41	44	2.2	30	90	110	11	180	151	NA	3	32		
Antelope Warm Spring	0.02	0.3	0	39	43	3.2	0	95	77	7	160	150	8.9	3	32		
Birdsie Warm Spring											200		8.6	15	30		
Brands Ranch well											405		6.0	42	30		
Brown's Canon Warm Spring											775		8.0	1	25		
Brown's Grotto Warm Spring											720		7.0	5	23		
Canon City Hot Spring		33.2		28.1	180.8	111.9			803.8					NA	34.6		
Canon City Hot Spring	1.46	15	1	22	190	130	10	728	887	730	1900	1230	6.3	5	40		
Canon City Hot Spring	0.02	16		21	180	130		728	888	700	2010	1220	6.2	1	40		
Canon City Hot Spring																	
Cebolla Hot Springs A																	
Cebolla Hot Springs B																	
Cebolla Hot Springs C																	
Cement Creek																	
Clark Spring well																	
Colonel Chinn well																	
Conundrum																	
Cottonwood																	
Cottonwood (Jump Steady)																	
Cottonwood (Merrifield well)																	
Craig warm water well	0.16	4.1	ND	19	360	6.7	ND	819	998	18	1440	896	8.2	24	39		
Craig warm water well	ND	3.68		80.83	347.01	ND	130	ND	996		1350	860	8.2	20	36	ND	0.2
Dexter																	
Don K well																	
Dotsero																	
Dotsero south																	
Dunton																	
Dutch Crowley well																	
Eldorado Springs "A"																	
Eldorado Springs "B"																	
Eoff well																	
Florence well																	
Fremont Natatorium																	
Fullinwider																	
Geyser																	
Glenwood Springs (Big Spring)																	
Glenwood Springs (Drinking Spring)																	
Glenwood Springs (Vapor Cave)																	
Glenwood Springs (Graves Springs)																	
Glenwood Springs (Spring A)																	
Glenwood Springs (Spring B)																	
Glenwood Springs (Spring C)																	
Glenwood Springs (Spring D)																	
Glenwood Springs (Railroad Spring)																	
Hartsel (Sping A)																	
Hartsel (Spring B)																	
Haystack Butte well																	
Hot Sulphur Springs (Spring A)																	
Hot Sulphur Springs (Spring B)																	
Hot Sulphur Springs (Spring C)																	

HOT SPRINGS, SOURCE	PO4,mg/l	K, mg/l	Se, mg/l	SiO2, mg/l	Na, mg/l	SO4, mg/l	Zn, ug/l	Alkal. CaCO3	Alkal. HCO3	Hard., mg/l	Cond., mmohs	TDS, mg/l	pH, field	Disc., gpm	Temp. deg.C	Al, ppm	Sr,ppm
Hot Sulphur Springs (Spring D)																	
Idaho Springs (Spring A)																	
Idaho Springs (Spring B)																	
Idaho Springs (Spring C)																	
Idaho Springs (Lodge well)																	
Juniper Hot Springs	0.04	2.3	0	33	460	12	0	902	1100	13	1900	1150	7.8	13	38		
Juniper Hot Springs	0.04	2	0	29	480	8.3	10	894	1090	9	1900	1160	8	14	33		
Juniper Hot Springs	0.12	2.2	ND	31	470	20	ND	894	1090	11	1800	1160	8.2	13	37		
Juniper Hot Springs	0.12	2.1	ND	32	460	13	ND	902	1100	9	1850	1150	7.9	18	36		
Juniper Hot Springs	ND	2.6		71.61	387.26	14	180		934		1550	980	8.26	15	31	ND	0.21
Lemon																	
McIntyre																	
Mineral Hot Springs (Spring A)																	
Mineral Hot Springs (Spring B)																	
Mineral Hot Springs (Spring C)																	
Mineral Hot Springs (Spring D)																	
Mt. Princeton Hot Springs (Spring A)																	
Mt. Princeton Hot Springs (Spring B)																	
Mt. Princeton Hot Springs (Spring D)																	
Mt. Princeton Hot Springs (Spring E)																	
Mt. Princeton Hot Springs (Spring F)																	
Mt. Princeton Hot Springs (Hortense)																	
Mt. Princeton Hot Springs (Hortense Well)																	
Mt. Princeton Hot Springs (Woolmington well)																	
Mt. Princeton Hot Springs (Wright well, east)																	
Mt. Princeton Hot Springs (Wright well, west)																	
Mt. Princeton Hot Springs (Young Life well)																	
Orvis Hot Springs, (Ridgway)																	
Ouray (Wesbaden & Motel Spring A)																	
Ouray (Wesbaden & Motel Spring B)																	
Ouray (Wesbaden & Motel Spring C)																	
Ouray (Pool Spring)																	
Ouray (Uncompahgre Spring)																	
Pagosa Springs (Big Spring)																	
Pagosa Springs (Courthouse well)																	
Pagosa Springs (Spa Motel well)																	
Paradise Hot Spring																	
Penny Hot Springs																	
Penny Hot Springs (Granges Spring)																	
Pinkerton (Spring A)																	
Pinkerton (Spring B)																	
Pinkerton (Mound Spring)																	
Pinkerton (Little Mound Spring)																	
Poncha Springs (Spring A)																	
Poncha Springs (Spring B)																	
Poncha Springs (Spring C)																	
Poncha Springs (Spring D)																	
Poncha Springs (Spring E)																	
Rainbow																	
Ranger																	
Rhodes																	
Rico (Diamond drill hole)																	
Rico (Big Geyser Warm Spring)																	
Rico (Geyser Warm Spring)																	
Rico (Little Spring)																	

HOT SPRINGS; SOURCE	PO4,mg/l	K, mg/l	Se, mg/l	SiO2, mg/l	Na, mg/l	SO4, mg/l	Zn, ug/l	Alkal. CaCO3	Alkal. HCO3	Hard., mg/l	Cond., mmohs	TDS, mg/l	pH, field	Disc., gpm	Temp. deg.C	Al, ppm	Sr,ppm
Routt [aka Strawberry] (Spring A)	ND	7.4		467.26	146.09	41	ND	ND	119		700	446	8.00	60	54	ND	0.24
Routt [aka Strawberry] (Spring B)																	
Routt [aka Strawberry] (Spring C)																	
Routt [aka Strawberry] (Spring D)																	
Sand Dunes Pool well																	
Shaws																	
South Canyon Hot Springs (Spring A)																	
South Canyon Hot Springs (Spring B)																	
Splashland well																	
Steamboat Springs (Heart Spring)	ND	6.36		125.98	278.09	141	ND		107		1450	872	8.2	75	36.4	ND	0.68
Steamboat Springs (Sulphur Cave Spring)																	
Steamboat Springs (Steamboat Spring)																	
Stinking Springs																	
Swissvale (Spring A)																	
Swissvale (Spring F)																	
Trimble																	
Tripp																	
Valley View (Orient) Hot Springs (Spring A)																	
Valley View (Orient) Hot Springs (Spring B)																	
Valley View (Orient) Hot Springs (Spring D)																	
Wagon Wheel Gap (4UR Ranch Spring)																	
Wagon Wheel Gap (CFI Spring)																	
Waunita Hot Springs (Spring C)																	
Waunita Hot Springs (Spring D)																	
Waunita Hot Springs (Spring A)																	
Waunita Hot Springs (Spring B)																	
Lower Waunita Hot Springs (Spring A)																	
Lower Waunita Hot Springs (Spring C)																	
Lower Waunita Hot Springs (Spring B)																	
Lower Waunita Hot Springs (Spring D)																	
Wellsville																	

GEOTHERMAL PROJECT

TABLE 2: GEOCHEMICAL ANALYSES OF GEOTHERMAL S

HOT SPRINGS; SOURCE	Ag, ppm	Au,ppm	Ba, ppm	Be, ppm	Bi, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Mo, ppm	Ni, ppm	Pb, ppm	Sn, ppm	Sb, ppm	Te, ppm	Th, ppm	Ti, ppm	U, ppm	V, ppm	W, ppm	Zr, ppm
Antelope Warm Spring																					
Antelope Warm Spring																					
Birdsie Warm Spring																					
Brands Ranch well																					
Brown's Canon Warm Spring																					
Brown's Grotto Warm Spring																					
Canon City Hot Spring																					
Canon City Hot Spring																					
Canon City Hot Spring																					
Canon City Hot Spring																					
Cebolla Hot Springs A																					
Cebolla Hot Springs B																					
Cebolla Hot Springs C																					
Cement Creek																					
Clark Spring well																					
Colonel Chinn well																					
Conundrum																					
Cottonwood																					
Cottonwood (Jump Steady)																					
Cottonwood (Merrifield well)																					
Craig warm water well																					
Craig warm water well	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dexter																					
Don K well																					
Dotsero																					
Dotsero south																					
Dunton																					
Dutch Crowley well																					
Eldorado Springs "A"																					
Eldorado Springs "B"																					
Eoff well																					
Florence well																					
Fremont Natatorium																					
Fullinwider																					
Geyser																					
Glenwood Springs (Big Spring)																					
Glenwood Springs (Drinking Spring)																					
Glenwood Springs (Vapor Cave)																					
Glenwood Springs (Graves Springs)																					
Glenwood Springs (Spring A)																					
Glenwood Springs (Spring B)																					
Glenwood Springs (Spring C)																					
Glenwood Springs (Spring D)																					
Glenwood Springs (Railroad Spring)																					
Hartsel (Sping A)																					
Hartsel (Spring B)																					
Haystack Butte well																					
Hot Sulphur Springs (Spring A)																					
Hot Sulphur Springs (Spring B)																					
Hot Sulphur Springs (Spring C)																					

HOT SPRINGS; SOURCE	Ag, ppm	Au,ppm	Ba, ppm	Be, ppm	Bi, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Mo, ppm	Ni, ppm	Pb, ppm	Sn, ppm	Sb, ppm	Te, ppm	Th, ppm	Ti, ppm	U, ppm	V, ppm	W, ppm	Zr, ppm
Hot Sulphur Springs (Spring D)																					
Idaho Springs (Spring A)																					
Idaho Springs (Spring B)																					
Idaho Springs (Spring C)																					
Idaho Springs (Lodge well)																					
Juniper Hot Springs																					
Juniper Hot Springs																					
Juniper Hot Springs																					
Juniper Hot Springs																					
Juniper Hot Springs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lemon																					
McIntyre																					
Mineral Hot Springs (Spring A)																					
Mineral Hot Springs (Spring B)																					
Mineral Hot Springs (Spring C)																					
Mineral Hot Springs (Spring D)																					
Mt. Princeton Hot Springs (Spring A)																					
Mt. Princeton Hot Springs (Spring B)																					
Mt. Princeton Hot Springs (Spring D)																					
Mt. Princeton Hot Springs (Spring E)																					
Mt. Princeton Hot Springs (Spring F)																					
Mt. Princeton Hot Springs (Hortense)																					
Mt. Princeton Hot Springs (Hortense Well)																					
Mt. Princeton Hot Springs (Woolmington well)																					
Mt. Princeton Hot Springs (Wright well, east)																					
Mt. Princeton Hot Springs (Wright well, west)																					
Mt. Princeton Hot Springs (Young Life well)																					
Orvis Hot Springs, (Ridgway)																					
Ouray (Wesbaden & Motel Spring A)																					
Ouray (Wesbaden & Motel Spring B)																					
Ouray (Wesbaden & Motel Spring C)																					
Ouray (Pool Spring)																					
Ouray (Uncompahgre Spring)																					
Pagosa Springs (Big Spring)																					
Pagosa Springs (Courthouse well)																					
Pagosa Springs (Spa Motel well)																					
Paradise Hot Spring																					
Penny Hot Springs																					
Penny Hot Springs (Granges Spring)																					
Pinkerton (Spring A)																					
Pinkerton (Spring B)																					
Pinkerton (Mound Spring)																					
Pinkerton (Little Mound Spring)																					
Poncha Springs (Spring A)																					
Poncha Springs (Spring B)																					
Poncha Springs (Spring C)																					
Poncha Springs (Spring D)																					
Poncha Springs (Spring E)																					
Rainbow																					
Ranger																					
Rhodes																					
Rico (Diamond drill hole)																					
Rico (Big Geyser Warm Spring)																					
Rico (Geyser Warm Spring)																					
Rico (Little Spring)																					

HOT SPRINGS; SOURCE	Ag, ppm	Au,ppm	Ba, ppm	Be, ppm	Bi, ppm	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm	Mo, ppm	Ni, ppm	Pb, ppm	Sn, ppm	Sb, ppm	Te, ppm	Th, ppm	Ti, ppm	U, ppm	V, ppm	W, ppm	Zr, ppm
Routt [aka Strawberry] (Spring A)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Routt [aka Strawberry] (Spring B)																					
Routt [aka Strawberry] (Spring C)																					
Routt [aka Strawberry] (Spring D)																					
Sand Dunes Pool well																					
Shaws																					
South Canyon Hot Springs (Spring A)																					
South Canyon Hot Springs (Spring B)																					
Splashland well																					
Steamboat Springs (Heart Spring)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.52	ND	ND	ND	ND	ND	ND	ND	ND	ND
Steamboat Springs (Sulphur Cave Spring)																					
Steamboat Springs (Steamboat Spring)																					
Stinking Springs																					
Swissvale (Spring A)																					
Swissvale (Spring F)																					
Trimble																					
Tripp																					
Valley View (Orient) Hot Springs (Spring A)																					
Valley View (Orient) Hot Springs (Spring B)																					
Valley View (Orient) Hot Springs (Spring D)																					
Wagon Wheel Gap (4UR Ranch Spring)																					
Wagon Wheel Gap (CFI Spring)																					
Waunita Hot Springs (Spring C)																					
Waunita Hot Springs (Spring D)																					
Waunita Hot Springs (Spring A)																					
Waunita Hot Springs (Spring B)																					
Lower Waunita Hot Springs (Spring A)																					
Lower Waunita Hot Springs (Spring C)																					
Lower Waunita Hot Springs (Spring B)																					
Lower Waunita Hot Springs (Spring D)																					
Wellsville																					

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Department of Natural Resources

1313 Sherman Street, Rm. 715
Denver, Colorado 80203
Phone (303) 866-2611
FAX (303) 866-2115

Roy Romer
Governor

Ken Salazar
Executive Director

Wm. "Pat" Rogers
Acting Director &
State Geologist

Howard Ross
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

February 23, 1993

RE: Update on Geothermal project

Dear Howard:

I've been pretty busy on oil and gas and mineral related issues and problems ever since early December. At last, I have a good stretch of time ahead of me to work on the geothermal project. This letter is to serve as an interim quarterly report to bring you up to date on our activities since November. I still plan to write an official quarterly report at the end of March.

During the first week in November, I visited some selected geothermal sites in the northwest part of the state including, Routt, Moffat, and Delta Counties. I sampled four sites for chemical analysis:

1) Strawberry Hot Springs (aka Routt Hot Springs), Routt Co.
2) Heart Springs, Steamboat Springs, Routt Co.
3) Juniper Hot Springs, Moffat Co.
4) Craig warm water well, Moffat Co.

These water samples were filtered, acidified, and submitted to the UURI lab as per Ruth Kroneman's instructions. The results have been received and are shown on the accompanying spreadsheets.

At all the sites visited during November I tried to obtain information concerning the current use of the geothermal resource. This information will be delivered in the final report at the end of the year. I am using a Hanna water tester to obtain site information on pH, temperature, oxidation reduction potential, and dissolved solids content.

Preliminary data bases were designed in December using the spreadsheet format in Quattro Pro 4. I have included three spreadsheets for your review. The three spreadsheets are; Table 1: General information and references; Table 2: Geochemical analyses of geothermal sources; and Table 3: Location of geothermal sources.

I have a few questions on the geochemical spreadsheet. Should we use one measurement system such as ppm, as opposed to ug/l and mg/l event though they are reported in those different ways? Should we include geothermometer model estimates for reservoir temperature? I have entered several generations of geochemical data, some going back to the 1920's, on these preliminary data sheets just to give you an indication of the wide variety of information that is available for Colorado.

I am be looking forward to your comments on these preliminary data sheets.

Sincerely,

James A. Cappa
Chief, Minerals and Mineral Fuels

enclosures

EXAMPLE BUDGET FORMAT

LOW TEMPERATURE PROGRAM

Budget:

Salaries:

Professional	$ xxxxx	
Support Staff	$ xxxxx	
Research Assistants	$ xxxxx	

Other Personnel Expenses:

Benefits (Prof. & Support) @ xx.x%	$ xxxxx
Benefits (Research Asst.) @ xx.x%	$ xxxxx

Direct Costs:

Subcontracts - (type)	$ xxxxx
Travel - (see detail)	$ xxxxx
Conferences	$ xxxxx
Supplies - Laboratory	$ xxxxx
Supplies - field	$ xxxxx
Supplies - Computer	$ xxxxx
Reproductions	$ xxxxx

Indirect Costs @ xx%	$ xxxxx
G & A Costs @ xx%	$ xxxxx
Fixed Fee @ xx% (if applicable)	$ xxxxx
Total	$ xxxxx

Distribution by Tasks

		Hours	Salary	Travel	Total
Task 1	Resource Inventory	xxxxxx	xxxxxx	xxxxxx	xxxxx
Task 2	Fluid Geochemistry	xxxxxx	xxxxxx	xxxxxx	xxxxx
Task 3	Database Listing	xxxxxx	xxxxxx	xxxxxx	xxxxx
Task 4	Review Collocation	xxxxxx	xxxxxx	xxxxxx	xxxxx
Task 5	Prioritize Resources	xxxxx	xxxxxx	xxxxxx	xxxxx

Proposed Manpower

	Months (hours)
xxxxxxxx	xxx
xxxxxxxx	xxx
xxxxxxxx	xxx
xxxxxxxx	xxx
Secretary	xxx
Drafting	xxx
Research Assistants	xxx

LOWTEMP. CO

Changes made June 25, 1992

ADDENDUM TO STANDARD CONTRACT AGREEMENT
for
STATE GEOTHERMAL ENERGY RESEARCH,DEVELOPMENT, AND DATABASE COMPILATION

between

THE OREGON STATE SYSTEM OF HIGHER EDUCATION
OREGON INSTITUTE OF TECHNOLOGY

and

THE COLORADO GEOLOGICAL SURVEY

STATEMENT OF WORK

1.0 INTRODUCTION

The United States Department of Energy - Geothermal Division (DOE/GD) supports the development of indigenous and environmentally advantageous energy alternatives to the traditional fuels. There is a very large, nearly unused supply of low- and moderate-temperature geothermal resources in the United States that could be brought on line over the next decade. The increased use of Geothermal Heat Pumps (GHPs) could also reduce the need for traditional fossil fuel consumption for space heating and cooling.

The U.S. Congress has appropriated funds for a program of Low-Temperature Geothermal Resources and Technology Transfer and DOE/GD has ~~contracted~~ with the ~~Colorado~~ Institute of Technology - Geo-Heat Center (OIT-GHC), the Idaho Water Resources Research Institute (IWRRI) and the University of Utah Research Institute (UURI) to implement this program.

funded EG&G, Idaho to establish contracts — Oregon

Important parts of this program are to bring the inventory of the nation's low- and moderate-temperature resources up to date, to complete a collocation study of these resources and communities and other potential users, and to collect and disseminate information necessary to expand the use of GHPs. OIT-GHC will have the lead role in the collocation study and will establish subcontracts with the state resource teams. UURI will work with the State Teams on gathering, documenting, and assembly of low- and moderate-temperature hydrothermal resource data and will assist in technical monitoring of the State Team efforts and publications. IWRRI will be responsible for establishing the hydrothermal resource data for Idaho and for performing geothermal reservoir evaluations throughout the western United States.

The technical tasks described herein may be considered Phase I of the Low-Temperature Geothermal Resources and Technology Transfer program. If Phase I proves successful, and additional funds are appropriated by Congress, the program may be expanded and continued. Phase II would likely include detailed resource evaluations of priority areas identified in Phase I.

Funding for the Low-Temperature Geothermal Resources and Technology Transfer Program is limited, and the success and continuation of the program is dependent upon a productive Phase I effort. Participating State Teams are encouraged to seek state or organization cost shares (in cost or in-kind) to enhance this contract effort.

2.0 TECHNICAL TASKS

The following technical tasks will be accomplished under this subcontract.

2.1 Complete an updated inventory of low- and moderate-temperature resources for the State of Colorado, current to June 1, 1992. Review drilling records and other information to identify new resources and verify temperatures and flow rates of springs and wells which may have changed substantially since the previous statewide geothermal resource inventory. Identify geological, geophysical, geochemical, and hydrologic studies which relate to these resources. The minimum temperature for a low-temperature resource is defined to be 10°C above the mean annual air temperature at the surface and should increase by 25°C/km. Occurrences to 150°C will be included.

2.2 Conduct a fluid geochemistry study of the more important resource areas for which existing data are questionable or unavailable. UURI will provide up to ten (10) quantitative fluid chemical analyses for each state in support of this study.

2.3 Complete a computer database listing compatible with Lotus 123 format tabulating for each occurrence: name, location (T,R,S), county, longitude, latitude, depth, flow, temperature, chemistry, and other data as appropriate and available.

2.4 Review OIT-GHC geothermal resource and demographic data for the State of Colorado for accuracy and completeness, as part of the collocation study.

2.5 Assist OIT-GHC, UURI, and IWRRI in studies to prioritize low- and moderate-temperature resource areas for new development. Develop conceptual geologic models and groundwater data for selected resources.

3.0 REPORTS, DATA, AND OTHER DELIVERABLES

3.1 A geothermal database listing in hardcopy and diskette form will be submitted to UURI. The listing will include all known low- and moderate- temperature spring and well occurrences in the State of Colorado. Principal facts will include location, depth (well), flow rate (if known), etc.

3.2 Letter reports and memoranda reviewing collocation data and priority rankings will be submitted to OIT-GHC and UURI.

3.3 A final summary report, not to exceed 50 pages, describing all tasks and their results, and documenting any new temperature, geologic, geochemical or geophysical data will be submitted to UURI, OIT-GHC, and IWRRI. This report may incorporate interim letter reports and memoranda as appendices. The report will include a geothermal resource occurrence map of the state, black and white, scale 1:1,000,000 or acceptable alternative.

3.4 Interim progress reports will be submitted to UURI quarterly.
and OIT

4.0 SCHEDULE OF PERFORMANCE AND REPORTING

4.1 The period of performance for this agreement will ~~be 24 months~~ terminate December 31, 1993, unless modified by letter agreement and signed by the Colorado Geological Survey, OIT-GHC, and UURI.

4.2 A review of the OIT-GHC collocation study will be completed and a letter report or memorandum of comment submitted to OIT-GHC and UURI within one month after receipt of the draft document from OIT-GHC.

4.3 A preliminary database listing of geothermal resource occurrences will be submitted to UURI within ~~three~~ four months after the execution of this agreement.

4.4 A final database listing of geothermal resource occurrences will be submitted to UURI within twelve months after the execution of this agreement.

4.5 A final report documenting all new data and activities completed under this agreement will be submitted to UURI ~~within 24 months after the execution of this agreement.~~ not later than December 31, 1993.

5.0 RESPONSIBLE PARTIES

5.1 The Principal Investigator for this agreement will be ~~John W. Rold~~ James A. Cappa, Colorado Geological Survey.

5.2 The Technical Project Managers for this agreement~~, representing DOE/GD,~~ will be Howard P. Ross, UURI and Paul J. Lienau, OIT-GHC.

5.3 The Contracting Officer for this agreement will be Douglas Yates, OIT.

6.0 FUNDING

This contract agreement provides for funding not to exceed $35,000.00 for the completion of all technical tasks and submittal of all required deliverables.

HR 09

STATE OF COLORADO

ROY R. ROMER
GOVERNOR

JOHN W. ROLD
DIRECTOR

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING — 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 866-2611

June 23, 1992

Howard Ross
University of Utah Research Institute
Earth Science Laboratory
391 Chipeta Way, Suite C
Salt Lake City, UT 84109-1295

Dear Howard:

The materials you had requested from the Colorado Geological Survey for the Colorado portion of the Statement of Work for the Low-Temperature Resources and Technology Transfer are enclosed. The material includes the following:

1) Geothermal Project Budget
2) Geothermal Project Task Plan
3) Geothermal Project Travel Events
4) Colorado Dept. of Natural Resources Indirect Cost Negotiation Agreement (the current fee of 8.05% is being negotiated and may possibly be lowered slightly in the near future)
5) State of Colorado Fiscal Rules on Travel
6) Resume of James A. Cappa, the new Principal Investigator on the project.

According to the Controller of the Department of Natural Resources, Rich Adamich, the Colorado Geological Survey has been audited once as part of an overall audit of the Department of Natural Resources. The audit was completed on August 30, 1989 by the Environmental Protection Agency in conjunction with CERCLA funds distributed to various state agencies within the Department of Natural Resources. The auditor was:

Truman R. Beeler
Office of the Inspector General for Audits
Western Division, Environmental Protection Agency
211 Main St., Ste. 220
San Francisco, CA 94105
(415) 974-7084

I hope the included data meets all of your requirements, and I am looking forward to working with you on this geothermal project. If you do have any questions please don't hesitate to call me.

Sincerely,

James A. Cappa
Chief, Mineral and Mineral Fuels Section

encl.

GEOTHERMAL PROJECT 92-93 BUDGET

PERSONNEL	HOURS	RATE	TOTAL
PRINCIPAL INVESTIGATOR	500	$22.62	$11,310.00
PHYS. SCIENCE TECH.	415	$10.89	$4,519.35
CLERICAL	64	$14.19	$908.16
CLERICAL	40	$7.73	$309.20
PERSONNEL BENEFITS			
PRINCIPAL INVESTIGATOR	500	$2.98	$1,490.00
PHYS. SCIENCE TECH.	415	$1.99	$825.85
CLERICAL	64	$1.55	$99.20
CLERICAL	40	$1.04	$41.60
PERSONNEL TOTAL			$19,503.36
PERSONNEL INDIRECT (.0805)			$1,570.02
GRAND TOTAL PERSONNEL			$21,073.38
TRAVEL			$1,960.00
CONFERENCE			$300.00
FIELD SUPPLIES/LITERATURE			$151.00
OFFICE SUPPLIES			$88.75
XEROX COPIES			$40.00
PHONE/ LONG DISTANCE			$175.00
GRAND TOTAL			$23,788.13

GEOTHERMAL PROJECT 93-94 BUDGET

PERSONNEL	HOURS	RATE	TOTAL
PRINCIPAL INVESTIGATOR	280	$22.62	$6,333.60
CLERICAL	80	$14.19	$1,135.20
PERSONNEL BENEFITS			
PRINCIPAL INVESTIGATOR	280	$4.14	$1,159.20
CLERICAL	80	$1.55	$124.00
PERSONNEL TOTAL			$8,752.00
PERSONNEL INDIRECT (.0805)			$704.54
GRAND TOTAL PERSONNEL			$9,456.54
TRAVEL			$1,420.00
FIELD SUPPLIES/LITERATURE			$50.33
OFFICE SUPPLIES			$80.00
XEROX COPIES			$30.00
PHONE/ LONG DISTANCE			$175.00
GRAND TOTAL			$11,211.87
PROJECT GRAND TOTAL			$35,000.00

TRAVEL COSTS: $60/NIGHT LODGING; $26/DAY PER DIEM MEALS; $.25/MILE VEHICLE
HIGH RENT CITIES SUCH AS SAN FRANCISCO; LODGING AT COST, $34/DAY PER DIEM MEALS

GEOTHERMAL PROJECT FY 92-93 TASK PLAN

TASKS	1st QUARTER, FY92	2nd QUARTER, FY92	3rd QUARTER, FY93	4th QUARTER, FY93
INVENTORY GEOTH. RESOURC., REV. DRILL. RCDS	PI 160 HOURS	PI 164 HOURS		
DESIGN DATA BASE, COMPL. PRELIM. DATA BASE	PI 36 HOURS	CLERIC. 40 HOURS		
COND. FLUID GEOCHEMICAL SAMPLING PROG.		PI 40 HOURS	CLERIC. 64 HOURS	
COMPLETE LOTUS DATA BASE		PI 40 HOURS	PI 40 HOURS, SUPV.	PI 20 HOURS, SUPV.
COMPLETE LOTUS DATA BASE			TECH 415 HOURS	
TRAVEL	A) IN STATE 5 DAYS B) OUT STATE 3 DAYS	C) IN STATE 5 DAYS	D) OUT STATE 5 DAYS	

GEOTHERMAL PROJECT FY 93-94 TASK PLAN

TASKS	1st QUARTER, FY93	2nd QUARTER, FY93
REV. OIT-GHC GEOTH. RES. AND DEMOG.DATA	PI 80 HOURS	
ASSIST OIT-GHC, ETC. IN PRIORITY STUD.		PI 40 HOURS
COMPL. FINAL SUMMARY REPORT		PI 160 Hours
COMPL. FINAL SUMMARY REPORT		CLERIC. 80 HOURS
TRAVEL		E) OUT STATE 3 DAYS

PI = PRINCIPAL INVESTIGATOR
TECH = PHYSICAL SCIENCE TECHNICIAN
CLERIC = CLERICAL STAFF

GEOTHERMAL PROJECT TRAVEL EVENTS

EVENT	DEPARTURE	DESTINATION	TRAVELLERS	VEHICLE MILES	NO. DAYS	REASON
A	DENVER	PAGOSA SPRINGS	1	600	5	VISIT GEOTHERMAL AREAS
B	DENVER	SALT LAKE CITY	1	AIR CARRIER	3	CONFER WITH UURI, PLANNING
C	DENVER	GLENWOOD SPRINGS	1	800	5	SAMPLE NEW SPRINGS
D	DENVER	SAN FRANCISCO	1	AIR CARRIER	5	GRC CONFERENCE
E	DENVER	SALT LAKE CITY	1	AIR CARRIER	3	CONFER WITH UURI, PRIOR.STUDY

United States Department of the Interior

OFFICE OF INSPECTOR GENERAL

CENTRAL REGION
134 UNION BLVD., SUITE 510
LAKEWOOD, COLORADO 80228

September 11, 1991

Office of Grant/Contract
Financial Management
U.S. Department of Health
and Human Services
ATTN: Edward Tracy
200 Independence Ave., S.W.
H.H. Humphrey Bldg., Room 544G
Washington, D.C. 20201

Subject: Colorado Dept. of Natural Resources

Dear Mr. Tracy:

Attached are two copies of the subject Indirect Cost Negotiation Agreement. These copies are being forwarded to you for reproduction and distribution in accordance with the FMC 74-4 (currently OMB Circular A-87) committee agreement.

Sincerely,

Delbert J. Fickas
Audit Supervisor

Attachments (2)

STATE AND LOCAL DEPARTMENT/AGENCY
INDIRECT COST NEGOTIATION AGREEMENT

INSTITUTION:

Colorado Department of Natural Resources
1313 Sherman Street, Room 718
Denver, CO. 80203

DATE: September 11, 1991

FILING REF: This replaces Negotiation Agreement dated May 21, 1990.
91-P-1342

The indirect cost rate(s) contained herein are for use on grants and contracts with the Federal Government to which OMB Circular A-87 applies subject to the limitations contained in the circular and in Section II A below. The rate(s) were negotiated by the U.S. Department of the Interior, Office of Inspector General and the Colorado Department of Natural Resources in accordance with the authority contained in Attachment A, Section J.4.b. of the Circular.

Section I: Rates

Type	Effective Period From	To	Rate*	Locations	Applicable to
Fixed Carryforward	7-1-91	6-30-92	8.05%	All	All Programs

*Base: Total direct salaries and wages plus applicable fringe benefits.

Treatment of fringe benefits: Fringe benefits applicable to direct salaries and wages are treated as direct costs; fringe benefits applicable to indirect salaries and wages are treated as indirect costs.

SECTION II: GENERAL

A. LIMITATIONS: Use of the rate(s) contained in this agreement is subject to any applicable statutory limitations. Acceptance of the rate(s) agreed to herein is predicated upon the conditions: (1) that no costs other that those incurred by the grantee/contractor were included in its indirect cost rate proposal and that such costs are legal obligations of the grantee/contractor, (2) that the same costs that have been treated as indirect costs have not been claimed as direct costs, and (3) that similar types of costs have been accorded consistent treatment.

B. AUDIT: Adjustments to amounts resulting from audit of the cost allocation plan of indirect cost rate proposal upon which the negotiation of this agreement was based will be compensated for in a subsequent negotiation.

C. CHANGES: If a fixed with carry-forward or predetermined rate(s) is contained in this agreement it is based on the organizational structure and the accounting system in effect at the time the proposal was submitted. Changes in the organizational structure or in the method of accounting for cost which affect the amount of reimbursement resulting from the use of the rate(s) in this agreement, require the prior approval of the authorized representative of the responsible negotiation agency. Failure to obtain such approval may result in subsequent audit disallowances.

D. THE FIXED WITH CARRY-FORWARD RATE(S): Contained in this agreement, if any, is based on an estimate of the cost which will be incurred during the period for which the rate applies. When that actual costs for such period have been determined an adjustment will be made in the negotiation following such determination to compensate for the difference between that cost used to establish the fixed rate and that which would have been used were the actual costs known at the time.

E. BILLING RATE: In accordance with the agreement allocating costs of central services provided by others, adjustments have been made to properly reflect costs of central services billed and also allocated to this department.

F. NOTIFICATION TO FEDERAL AGENCIES: Copies of this document may be provided to other Federal offices as a means of notifying them of the agreement contained herein.

ACCEPTANCE

By the State Department/Agency:

Ken Salazar /s/

KEN SALAZAR
Name (Print or Type)

EXECUTIVE DIRECTOR -
Title (Print or Type)
DEPT NATURAL RESOURCES

AUGUST 30, 1991
Date (Print or Type)

By the Responsible Agency
for the Federal Government
U.S. Department of Interior:

Delbert J. Fickas /s/

Delbert J. Fickas
Name

Audit Supervisor
Title

Department of Interior
Office of Inspector General
Agency

September 11, 1991
Date

Ray Macy
Negotiated by

Telephone: (303) 236-9243

EXHIBIT 1

COLORADO DEPARTMENT OF NATURAL RESOURCES
FY 1992 Indirect Cost Proposal
FY 1992 Carry-forward Computation and Rate Calculation
For the Period July 1, 1991, through June 30, 1992

		FY 1990	FY 1992
A)	Fixed Rate per Negotiation		
	Agreement A/B computed as follows:	6.0%	8.05%
	Direct Cost Base (B)	$44,191,079	$50,696,366
	Indirect Cost Pool: (A)		
	Indirect Costs Proposed	$2,539,748	$2,913,196
	SWCAP	713,308	1,371,411
	Carryforward	(603,862)	(202,100)
	Total Indirect Cost Pool	$2,649,194	$4,082,507
B)	Actual Costs Negotiated Computed as follows:		
	Actual Direct Cost Base	$49,948,574	
	Actual Indirect Cost Pool:		
	Indirect Costs Allowed	$2,685,368	
	SWCAP	713,308	
	Carryforward	(603,862)	
	Total Indirect Cost Pool	$2,794,814	
C)	Carry-forward Computation:		
	Amount Recovered:		
	(Actual Direct Costs x Fixed Rate)		
	49,948,57 x 6.0% (C)	$2,996,914	
	Should have Recovered:		
	Actual Indirect Costs for FY 1990	$2,794,814	
	Carry-Forward to FY 1992 (D-C) (over-recovery)	($202,100)	

EXHIBIT 2

COLORADO DEPARTMENT OF NATURAL RESOURCES
FY 1992 INDIRECT COST PROPOSAL
FY 1992 DIRECT COST BASE
For the Period July 1, 1991 through June 30, 1992

PROGRAM	PROPOSED/ACCEPTED
Division of Wildlife	$29,169,608
Land Board	1,169,694
Water Conservation	1,354,075
Water Resources	8,853,957
Soil Conservation	249,487
Division of Mines	124,042
Oil & Gas Commission	920,716
Geological Survey	792,388
Division of Parks	5,844,760
Mined Land-Reclamation	1,941,658
DOW ADP Personnel	120,475
JRP	43,439
CERCLA	112,067
TOTAL DIRECT COST BASE	$50,696,366

EXHIBIT 3

COLORADO DEPARTMENT OF NATURAL RESOURCES
FY 1992 INDIRECT COST PROPOSAL
FY 1992 INDIRECT COST POOL
For the Period July 1, 1991 through June 30, 1992

LINE ITEM	PROPOSED/ACCEPTED
Personnel Services	$2,338,569
Health & Life	55,506
Merit Increase	4,130
Workman's Compensation	13,320
Operating Expense	100,842
Legal Services	2,748
Automation Initiative	50,000
ADP Equipment Maintenance	141,751
GGCC Computer	63,645
Audit Charges	40,000
Equipment Use	68,023
Capital Outlay	20,701
Short-term Disability	9,016
Risk Management	4,945
TOTAL INDIRECT COST POOL	$2,913,196

JAMES A. CAPPA

CHRONOLOGICAL SUMMARY OF PROFESSIONAL EXPERIENCE

AUGUST, 1991 - PRESENT: Colorado Geological Survey, Denver, Colorado; Chief, Mineral and Mineral Fuels Section.
Advise the public and state agencies concerning mineral and mineral fuel resources. Conduct survey on possible drainage of oil and gas on state lands by adjacent production. Initiate and conduct study of the carbon dioxide resources of the Paradox Basin. Supervise staff project activities, 2 petroleum and 1 mineral geologist.

JUNE, 1991 - JULY, 1991: Nassau Ltd., Reno, Nevada; contract geologist
Conducted a reverse circulation drilling program on a precious metal prospect in Macedonia, Yugoslavia.

APRIL, 1981 - JANUARY, 1991: FMC Gold Co., Denver, Colorado; District Geologist
Managed eastern USA gold exploration program. Designed, implemented and managed a $1M gold exploration program in Turkey. Evaluated precious metal and industrial mineral opportunities in the Rocky Mountain region and various foreign countries.
Implemented and managed a $3.5M trona exploration drilling program in Spain.
Investigated other worldwide trona occurrences. Evaluated several other industrial mineral opportunities, including kaolin, barite and lithium.

JANUARY, 1977 - APRIL, 1981: Houston International Minerals Corp., Denver, Colorado; Geologist.
Conducted uranium exploration in New Mexico and Canada. Explored for cobalt, nickel, tin and molybdenum in the eastern USA and several western states.

SEPTEMBER, 1975 - JANUARY, 1977: AMOCO Oil Co., Denver, Colorado;; Geologist
Conducted oil and gas exploration in Wyoming and Cook Inlet region of Alaska.

MAY, 1974 - SEPTEMBER, 1974: Watts, Griffis and McQuat, Inc., Anchorage, Alaska; Assistant Project Geologist (summer job).
Conducted and partially managed a base metal, stream sediment exploration program in the Brooks Range of Alaska.

JANUARY, 1972 - JANUARY, 1973: US Forest Service, Goleta, California; Geologist.
Conducted environmental geology studies on erosion risk. Mapped 60 square miles of the Coast Ranges in order to determine lithological parameters for erosion potential.

MARCH, 1969 - AUGUST, 1971: Anglo American Corp., Lusaka, Zambia; Staff Geologist.
Conducted exploration for copper in the Zambian Copperbelt and in the Zambezi Escarpment region. Utilized geochemical prospecting, pit and trench mapping and sampling, and core drilling on favorable targets.

SEPTEMBER, 1967 - OCTOBER, 1968: US Forest Service, Goleta, California; Geologist.
Conducted erosion studies after wildfires. Conducted joint studies with soil scientists on effects of recreational vehicles on soil compaction and erosion.
Sited and logged water wells.

PROFESSIONAL ASSOCIATIONS

Society of Economic Geologists, Fellow
Geological Society of America, Member
Society for Mining, Metallurgy, and Exploration, Member
American Institute of Professional Geologists

EDUCATION

University of California @ Santa Barbara, B.A. Geology, 1967. Santa Barbara, California.

New Mexico Institute of Mining and Technology, M.S. Geology, 1975. Socorro, New Mexico.

.01 Departmental Business

a. The use is consistent with the policies of the institution.

b. Use of the State automobile is approved, in writing, by an academic department head or administrative head of a nonacademic unit.

.02 Student Organizations

a. The organization is officially recognized by the institution.

b. The organization must be financed in part by mandatory student fees.

c. The use is consistent with the policies of the institution.

d. Funds must be on deposit with the institution.

e. The organization is subject to budgetary control and other institutional procedures.

f. Reimbursement is made for the use of the State-owned automobiles.

g. A full time State classified or exempt employee accompanies the students on any trips outside the institutional area, unless approved otherwise by the governing board of the institution.

h. Student use of State automobiles is in line with the goals of each individual organization.

.03 State-owned Automobiles May Not be Used

a. For political, personal, or non-state employer business, or religious purposes.

b. For personal benefit of any person.

1.28 Agency Liability for Damage to Capitol Complex Motor Pool Vehicles

Whenever a vehicle is damaged through negligence or misconduct of the vehicle operator, or through the negligence or misconduct of any other official or employee of the agency employing the vehicle operator, all costs incurred in the removal and repair or, in the case of total loss, the replacement of the vehicle, including travel and other costs attributable to the accident, shall be chargeable to the agency employing the operator thereof.

1.29 Travel Incentives and Awards

Incentive awards, coupons, or rebates received by employees for air flights, car rentals, lodging, or other State incurred business related expenditures become the property of the State.

1.30 REIMBURSEMENTS

1.31 Expense Reimbursements Not to Exceed Meal Allowance Plus Actual Cost of Lodging

.01 When Travel Extends Beyond One Calendar Day - the traveler may claim the actual cost of lodging not to exceed the stated maximums, (see Section 1.32 for maximums) plus the State allowance for meals which would normally be eaten during the time the individual was in a travel status. No reimbursement may be claimed for meals furnished at no additional cost to the traveler. Receipts for lodging shall be obtained and submitted with the travel expense voucher when requesting reimbursement. Reimbursement for lodging shall be limited to commercial establishments. Receipts for meals are not required.

.02 Travel wholly within a single day - If Travel is wholly within a single day, reimbursement for lunch while away from the duty station will not be allowed. If, however, an employee leaves his home on official business prior to 5:00 a.m. and/or remains away from his home after 8:00 p.m. and the official business requires the employee to extend the workday, the agency head may allow meal allowance for breakfast and/or dinner for the traveler.

.03 Travel not solely for State business or travel with spouse, relative, or friend - If a lower travel rate is generated because a State employee extends a trip for personal reasons, the lower travel rate will be applied to the business part of the trip.

The State shall not reimburse the cost of an employee's spouse or other person accompanying the State employee on a business trip (see exception for Governor of the State, Section 1.21.02). Conversely, the State shall not receive benefit from a lower travel fare resulting from the spouse of a State employee or other person accompanying the employee on a business trip.

Sufficient documentation of the cost of the State portion of the business trip must be included with the travel reimbursement voucher.

1.32 Lodging and Per Diem Allowances

Employees authorized to travel on official business shall be entitled to reimbursement within a reasonable time period, generally considered no greater than thirty (30) days following the submission of a correctly completed reimbursement voucher for the following:

.01 Domestic Rates The following shall apply for all travel destinations within the Continental United States including the District of Columbia (except high cost metropolitan areas under 1.32.02):

a. Lodging - Actual cost of reasonable accommodations. Lodging costs in excess of $60.00 must be approved by the approving authority. Employees may be required to use designated lodging facilities in high cost areas to assist the agency in controlling the cost.

b. Per Diem -- A per meal allowance including tax and tip and incidential expenses not included under Section 1.38:

Regular Rates

July 1, 1989		July 1, 1990	
Breakfast	$ 5.50	Breakfast	$ 5.50
Lunch	6.00	Lunch	6.00
Dinner	14.50	Dinner	14.50
	$26.00		$26.00

.02 High Cost Metropolitan Areas High Cost Metropolitan Areas Are as Follows:

State	Key City[1]	County/Other[2,3] Location
California	Death Valley	Inyo,
	Los Angeles	Los Angeles, Kern, Orange, Ventura, Edwards AFB, Naval Weapons Center and Ordinance Test Station, China Lake
	Oakland	Alameda, Contra Costa, Marin
	Palm Springs	Riverside
	Sacramento	Sacramento
	San Diego	San Diego
	San Francisco	San Francisco
	San Jose	Santa Clara
	San Luis Obispo	San Luis Obispo
	San Mateo	San Mateo
	Santa Barbara	Santa Barbara
	Santa Cruz	Santa Cruz
	South Lake Tahoe	El Dorado
	Tahoe City	Placer
	Yosemite National Park	Mariposa
Colorado	Aspen	Pitkin
	Boulder	Boulder
	Denver	Denver, Adams, Araphaoe, Jeferson
	Keystone/ Silverthorne	Summit
	Vail	Eagle
District of Columbia	Washington, D.C.	
Florida	Key West	Monroe
	Miami	Dade
	West Palm Beach	Palm Beach

TITLE TRAVEL

State	Key City[1]	County/Other Location[2,3]
Georgia	Atlanta	Clayton, DeKalb, Fulton, Cobb
Illinois	Chicago	DuPage, Cook, Lake
Louisiana	New Orleans	Jefferson, Orleans Plaquermines St. Bernard
Maryland	Annapolis	Anne-Ariundel
	Baltimore	Baltimore, Hartford
	Columbia	Howard
	Ocean City	Worcester
Massachusets	Andover	Essex
	Boston	Suffolk
	Lowell	Middlesex
	Martha's Vineyard/ Nantucket	Dukes, Nantucket
	Quincy	Norfolk
Michigan	Detroit	Wayne
Nevada	Las Vegas	Clark, Nellis AFB
New Jersey	Atlantic City	Atlantic
	Eatontown	Monmouth, Fort Monmouth
	Edison	Middlesex
	Newark	Bergen, Essex, Hudson, Passaic Union
	Ocean City	Cape May
	Princeton/Trenton	Mercer
New Mexico	Cloudcroft	Otero
	Santa Fe	Santa Fe

State	Key City[1]	County/Other Location[2,3]
New York	Monticello	Sullivan
	New York City	Bronx, Brooklyn, Manhattan, Queens, Staten Island Nassau, Suffolk
	Saratoga Springs	Saratoga
	White Plains	Westchester
Ohio	Cleveland	Cuyahoga
Pennsylvania	Chester	Delaware
	King of Prussia	Montgomery
	Philadelphia	Philadelphia
	Valley Forge	Chester
Rhode Island	Newport	Newport
So. Carolina	Hilton Head	Beaufort
Texas	Dallas/Ft. Worth	Dallas/Tarrant
	Houston	Harris, L.B. Johnson Space Center, Ellington AFB
Virginia	Williamsburg	Williamsburg
Washington	Seattle	King

[1]Unless otherwise specified, the locality is defined as "all locations within, or entirely surrounded by, the corporate limits of the key city, including independent entities located within those boundaries."
[2]Localities with county definition shall include "all locations within, or entirely surrounded by, the corporate limits of the key city as well as the boundaries of the listed counties, including independent entities located within the boundaries of the key city and the listed counties."
[3]Military installations of Government-related facilities (whether or not specifically named) that are located partially within the city or county boundary shall include "all locations that are geographically part of the military installation of Government-related facility, even though part(s) of such activities may be located outside the defined locality."

a. Lodging - Actual cost of reasonable accommodations.

b. Per Diem - A per meal allowance, including tax and tip and incidental expenses not included in Section 1.38:

High Rent Districts

July 1, 1989		July 1, 1990	
Breakfast	$ 7.50	Breakfast	$ 7.50
Lunch	8.00	Lunch	8.00
Dinner	18.50	Dinner	18.50
	$34.00		$34.00

.03 Required Receipts

Receipts for lodging are to be furnished and attached to the travel reimbursement voucher.

Receipts are not required for meals.

.04 Reimbursement Claimed for Meal Allowance

In no case shall an employee be reimbursed more than the meal allowance provided by this section. However, an employee, at his discretion, may claim less than the per meal allowance provided by this section.

.05 See exceptions at Section 1.35 and 1.37.

1.33 Miscellaneous Allowance - Board or Commission Members

Board or commission members who donate their services to the State are entitled to actual reasonable or necessary costs of travel expenses as provided by statute. The test for reasonable or necessary shall be the reimbursement rates contained in these fiscal rules. Costs in excess of these reimbursement rates are allowable if adequately documented and justified.

Board or commission members may be reimbursed for child care services. The department executive director shall determine the need for child care reimbursement. Reimbursement may not be made to a family member and receipts must be furnished.

1.34 Lodging and Per Diem Allowances for Travel Outside the Continental United States.

The current per diem rate established by the Federal Government will be allowed for authorized travel outside the continental United States. These per diem rates apply upon departure from and until return to the United States. Current rates may be obtained from the Traffic and Travel Services Unit of the United States Government, General Services Administration, Denver, Colorado.

1.35 Alternative Plan When Employees Furnish Their Own Lodging and Meals

When an employee furnishes his or her own lodging and/or meals (such as cabin, travel trailer, or camping equipment owned by the employee; or furnishes own food for cooking) in conjunction with travel that extends beyond one calendar day, the following allowances shall be authorized:

.01 a. Food Allowance - employee furnishing own meals

July 1, 1989		July 1, 1990	
Breakfast	$ 3.50	Breakfast	$ 3.50
Lunch	4.50	Lunch	4.50
Dinner	9.50	Dinner	9.50
	$17.50		$17.50

b. Food allowance if employee eats in a commercial establishment shall be the same as prescribed in Chapter 1, Section 1.32.

.02 In lieu of lodging reimbursement, an employee will be given the following allowance to cover the costs of cooking, heating, laundry, and other utilities incidental to the use of a cabin, trailer, camper, or similar facility owned by the employee:

July 1, 1989 - $15.00 per day
July 1, 1990 - $15.00 per day

Post-it® Fax Note 7671	Date 9/30 # of pages ▶ 1
To Howard Ross	From Jim Cappa
Co./Dept. UURI	Co. CGS
Phone # 801 584 4444	Phone # 303 866 3293
Fax # 801 584 4453	Fax # 303 866 2461

Howard – it's kinda long but shorten it for your needs

JAMES A. CAPPA

EDUCATION

Bachelor of Arts degree in Geology from the University of California at Santa Barbara in 1967.
Master of Science degree in Geology from the New Mexico Institute of Mining and Technology in 1975.

EMPLOYMENT

Jim's first job was as an engineering geologist for the U. S. Forest Service in Santa Barbara, California.
In 1969, he took a position as an geologist on a copper exploration program for Anglo American Corporation in Zambia before returning to graduate school in 1973.
While a graduate student he spent a summer on a base metal exploration program for WGM, Inc. in the Brooks Range of Alaska.
After leaving graduate school in 1975 Jim spent one year with Amoco Production Company in Denver, Colorado as a petroleum geologist.
Jim went to work for Houston International Minerals in early 1977 exploring for uranium, tin, and cobalt in the USA and Canada.
In 1981, Jim went to work for FMC Corporation where he conducted and managed gold and industrial mineral exploration programs in the USA, and several overseas locations such as Spain, Brazil, Chile, Turkey, Greece, Italy, Yugoslavia, and Australia.
Since 1991, Jim has been with the Colorado Geological Survey where he is the head of the Mineral and Mineral Fuels Section.

1992-1993 LOW-TEMPERATURE GEOTHERMAL ASSESSMENT PROGRAM, COLORADO

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December 30, 1993

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Abstract

Previous assessments of Colorado's low-temperature geothermal resources were completed by the Colorado Geological Survey in 1920 and in the mid- to late- 1970's. The purpose of the 1992-1993 low-temperature geothermal resource assessment is to update the earlier physical, geochemical, and utilization data and compile computerized databases of the location, chemistry, and general information of the low-temperature geothermal resources in Colorado. The main sources of the data included published data from the Colorado Geological Survey, the U. S. Geological Survey WATSTOR database, and the files of the State Division of Water Resources.

The staff of the Colorado Geological Survey in 1992 and 1993 visited most of the known geothermal sources that were recorded as having temperatures greater than 30° C. Physical measurements of the conductivity, pH, temperature, flow rate, and notes on the current geothermal source utilization were taken. Ten new geochemical analyses were completed on selected geothermal sites. The results of the compilation and field investigations are compiled into the four enclosed Quattro Pro 4 databases.

For the purposes of this report a geothermal area is defined as a broad area, usually less than three square miles in size, that may have several wells or springs. A geothermal site is an individual well or spring within a geothermal area. The 1992-1993 assessment reports that there are 93 geothermal areas in the Colorado, up from the 56 reported in 1978; there are 157 geothermal sites up from the 125 reported in 1978; and a total of 382 geochemical analyses are compiled, up from the 236 reported in 1978.

Six geothermal areas are recommended for further investigation: Trimble Hot

Springs, Orvis Hot Springs, an area southeast of Pagosa Springs, the eastern San Luis Valley, Rico and Dunton area, and Cottonwood Hot Springs.

1. Introduction

The first assessment of the geothermal resources of the State of Colorado was completed in 1920 by the Colorado Geological Survey with the publication of Colorado Geological Survey Bulletin 11, Mineral Waters of Colorado. Bulletin 11 contains chemical analyses of the state's mineral waters including the known geothermal waters and, also, has a section describing the utilization of the mineral waters.

Low-temperature geothermal resources are defined as those having a surface temperature of 20° to 100° C. The first modern low-temperature geothermal assessment for the state of Colorado was completed during a period of time from about 1976 to 1983. That assessment was carried out by the Colorado Geological Survey through a funding program with the U. S. Department of Energy and the U. S. Geological Survey. The 1976 survey involved a sampling program conducted over an approximate 12 month period of 125 geothermal sources from 56 geothermal areas and resulted in the 1976 publication of Colorado Geological Survey Information Series 6, Hydrogeochemical Data of Thermal Springs and Wells in Colorado (revised 1993).

In 1978, the Colorado Geological Survey published Bulletin 39, An Appraisal of Colorado's Geothermal Resources, which contained descriptive information on the sites, including location, current usage, geological setting and an analysis of various geothermometers for each of the 56 geothermal areas of the state. Bulletin 39 utilized the analytical geochemical information presented in Information Series 6.

Several other site-specific geological and geophysical studies were performed by the Colorado Geological Survey up to 1983. Economic evaluations regarding the utilization of geothermal heat and energy for various sites were also completed during this time. The U. S. Department of Energy was the primary funding agency. All the pertinent publications are listed in the Reference chapter of this report.

The need for a new geothermal assessment is evidenced by the results of the current 1992-1993 low-temperature geothermal assessment. In Bulletin 39 which was published in 1978, there are 56 geothermal areas and 125 geothermal sites. The 1992-1993 survey lists 93 geothermal areas and 157 geothermal sites throughout the state. Over 380 chemical analyses were compiled from various sources in the construction of the database. Utilization of geothermal resources has changed over years. In some cases flow rates and temperature of the geothermal sources have changed since prior assessments. Several errors in location and description of geothermal springs from both the above described Colorado Geological Survey publications and the U. S. Geological Survey WATSTOR database were corrected.

The data collected and compiled for this survey are recorded in four computer databases. A 1:1,000,000 scale map of the state (Plate 1) shows the location and ID number of each of the geothermal areas.

The 1992-1993 low-temperature geothermal assessment for Colorado was initiated in the fall of 1992 by the Colorado Geological Survey. The scheduled completion date is December, 1993. Funding for this survey was provided by the U. S. Department of Energy.

The program was administered by the University of Utah Research Institute in Salt Lake City, Utah and the Geo Heat Center at the Oregon Institute of Technology, Klamath Falls, Oregon.

2. Data Sources

Data were compiled from a variety of sources including unpublished materials. The most important unpublished sources were the Colorado Department of Water Resources well permit files, the U. S. Geological Survey WATSTOR database, and analytical reports from private laboratories given to the principal investigator by geothermal source owners and operators.

The most important published source material includes: George et al., 1920, Colorado Geological Survey Bulletin 11; Barrett and Pearl, 1976, Colorado Geological Survey Information Series 6; and Barrett and Pearl, 1978, Colorado Geological Survey Bulletin 39.

The University of Utah Research Institute provided 10 new water analyses for each state for the current low-temperature geothermal assessment program. All 10 new analyses were completed for the Colorado portion of the program.

All geochemical data which maintained a cation-anion charge balance of ± 15% were entered into the databases. Geothermal sources with only one analysis were entered regardless of the charge balance. All data entries, especially those with significant cation-anion charge balance errors, were checked by two separate operators. References for each analysis are recorded in the GTHCHM1 database.

3. Data Format

The data collected during this assessment has been distributed into four Quattro Pro 4 spread sheets on the enclosed diskette. For purposes of this program a geothermal area is defined as a geologically cohesive land area that may or may not contain several geothermal wells or hot springs. Generally an area is less than approximately three square miles. A site is defined as an individual geothermal well or hot spring within an area.

Each geothermal area within the database has a unique ID number. Different sites within a geothermal area have unique area-site numbers. All the tables list the ID number, Site number, and Geothermal Source (Name).

Table 1 is a location database (GTHLOC); it describes the county, quadrangle map, section, township, range, latitude and longitude, and Universal Transverse Mercator grid references.

Table 2 contains the long form of the geochemical database(GTHCHEM1). All the geochemical and sample data collected during this survey is stored in this Table. There can be multiple entries of geochemical data for each site.

Table 3 is the short form of the geochemical database(GTHCHEM2). It contains an abbreviated element list and has only one entry per site. Where multiple chemical analyses were available all the results were averaged to make just a single entry.

Table 4 contains the general information database (GTHGEN). It has information such as temperature, flow rate, type, references, and current usage for each geothermal site.

All the data in the project databases were entered by hand. Much of the data resided in Colorado Geological Survey Bulletins and Information Series and had never been entered into a computerized database before. The only other computerized database used in this project was the WATSTOR database compiled by the U. S. Geological Survey; however, all of this data was entered manually.

The enclosed diskette contains all the database files in a Quattro Pro 4 format. These files can easily be transformed into Lotus 1-2-3 or other database manager files. The following table lists all the important computer database information for the databases.

TABLE	DATABASE NAME	INFORMATION	NO. OF FIELDS	NO. OF BYTES
Table 1	GTHLOC	Location	24	84,936
Table 2	GTHCHEM1	Chemistry, long list	59	385,444
Table 3	GTHCHEM2	Chemistry, short list	22	84,670
Table 4	GTHGEN	General information	8	29,316

Table A: List of pertinent computer file data for the low-temperature geothermal assessment databases. All databases are in Quattro Pro 4 format (WQ1 suffix).

4. Fluid Chemistry

The University of Utah Research Institute (UURI) provided 10 new water analyses for each state as part of the low-temperature geothermal assessment program. Because of time constraints a lower limit of 30° C was set on any geothermal spring or well to be visited in the field. Almost all of the geothermal sources greater than 30° C were visited. A few that would have required a full day to walk in to were not visited. The temperature, pH, conductivity, flow rate and current usage for each site were recorded. Sites for a complete water analysis were selected on a subjective criteria of developmental significance and lack of recent or quality geochemical data. The 10 sites selected for new water analyses in Colorado are:

Craig Warm Water Well
Desert Reef (Florence)
Dotsero, South
Mt. Princeton (Hortense Well)
Ouray (Pool or Box Canyon Spring)
Routt (aka Strawberry)
Steamboat Springs (Heart Spring)
Waunita Hot Springs
Juniper Hot Springs

Pagosa Hot Springs (Big Spring)

The results of the new samples are included in Table 2 and have a reference number of 3. There were no new results that had serious implications for the prior known geochemistry of the geothermal areas.

Other sources of geochemical information were utilized in compiling the database. The most significant source of geochemical data was the DOE supported studies performed by the CGS in the late 1970's. The reference for each analysis is listed in Table 2. Any geochemical analysis that had a cation-anion balance error greater than 15% was discarded except for the case described below.

Geochemical data derived from the U. S. Geological Survey WATSTOR database was entered into the current database; unfortunately, most of those reports do not have an analysis for HCO_3^- or CO_3^{-2} which causes severe errors in the cation-anion balance. As most of these analyses are the only one for that particular site they have been retained in the database even though they do not balance within the specified limits.

5. Discussion

The location of all the geothermal sites compiled during this assessment program is shown on Figure 1. The accompanying Plate 1 shows the location and geothermal area ID number. A frequency plot of all the geothermal temperatures from each site is shown in Figure 2. The greatest number of temperature measurements fall in the 25° to 40° C categories. There is another peak in the 51° to 55° C range.

The following section contains a brief discussion of the sites that were visited during the 1992-1993 geothermal assessment program. All the geothermometer estimates in the following section are derived from discussions and tables in Barrett and Pearl (1978).

Antelope Warm Spring, Mineral County

The Antelope Warm Spring was visited in June of 1993. The spring issues into a concrete-lined cistern approximately 6 feet by 4 feet at ground level and 5 feet deep. The spring is 20 feet north of wooden building shaped like a quonset hut. Inside this building is a 20 foot by 30 foot swimming pool. Water from the spring was used to fill the pool.

Mr. Larry (Sonny) Dickerson, longtime owner of the property around the spring, indicated the pool had not been used for several years. The pool was used by family and friends, never commercially. Currently, the swimming pool building is used for storage by Mr. Dickerson. The pool is covered by a tarp and is nearly empty. Water from the Antelope Warm Spring is diverted into the pasture surrounding the spring. A valve and pipe system (in an advanced state of disrepair) can still divert most of the spring flow into the swimming pool if desired.

Flow from the spring was measured at 50 liters per minute which was four (4) times the rate measured by Barrett and Pearl (1976) in 1975. Mr. Dickerson is of the opinion that during the last five years flow from the spring has noticeably increased.

The most reasonable estimate of the subsurface reservoir temperature from a

Colorado Geothermal Springs and Wells - Figure 1

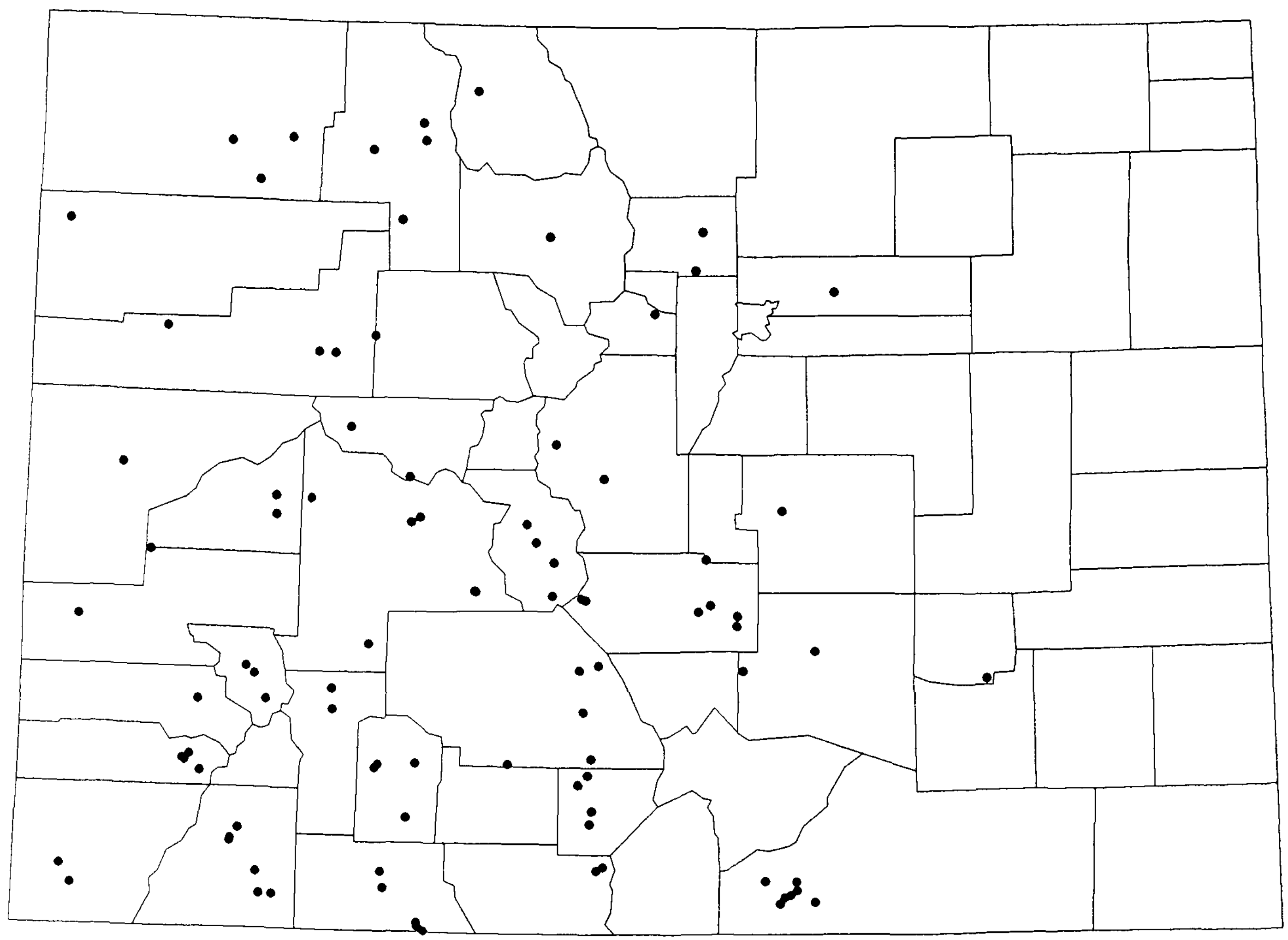
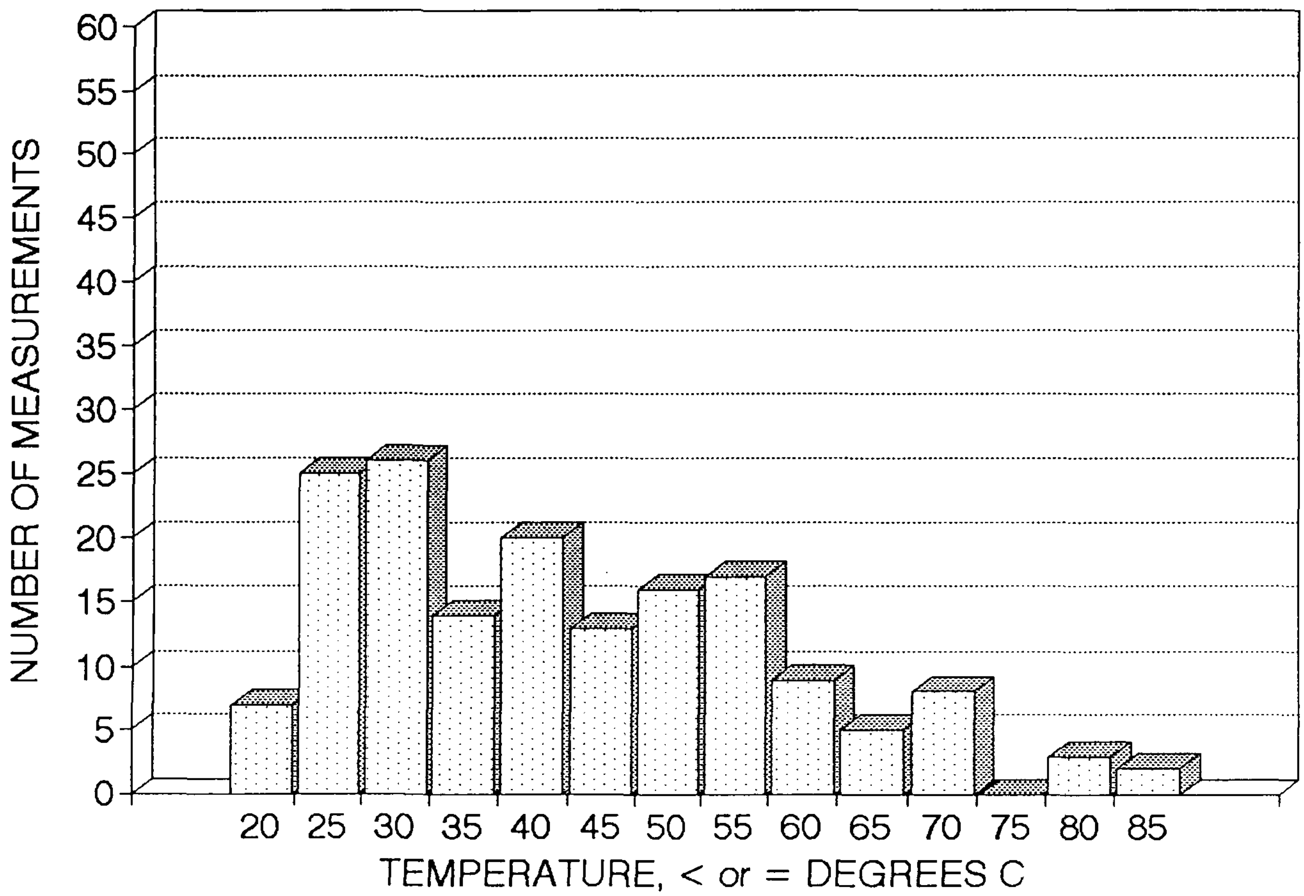


Figure 2: FREQUENCY DISTRIBUTION COLORADO GEOTHERMAL SOURCES



combination of geothermometers is 35° to 52° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Steven and Ratte, 1973).

Birdsie Warm Spring, Mineral County

There are five springs that issue from the toe of the slope just north of the road. All the flow enters a culvert and flows out to the Rio Grande. The most reasonable estimate of the subsurface reservoir temperature from a combination of geothermometers is 35° to 52° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Steven and Ratte, 1973).

Brands Ranch Artesian Well, Jackson County

The Brands Ranch Artesian Well was visited in May, 1993. There is no longer any physical evidence of the well mentioned in Barrett and Pearl, 1978. The spring bubbles up into a 15 feet diameter, 2.5 foot deep pool. There are no facilities in this somewhat remote area. The pool appears to get some occasional use from hunters, campers, fisherman and local people.

The collapsed well that makes the hot spring is the Horton 2 Brands well drilled in 1953 to a total depth of 1,075 feet. The lowest formation penetrated is the Morrison Formation. The hot waters probably come from the Dakota Sandstone. The most reasonable estimate of the subsurface reservoir temperature from a combination of geothermometers is 42° to 55° C (Hail, 1965; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Browns Canyon Warm Springs, Chaffee County

An attempt to visit this site was made in July, 1993. Several minor seeps were noted in the area described by Dick (1976) and Barrett and Pearl (1978); however, these seeps had a temperature less than 20° C (Scott et al., 1975; Barrett and Pearl, 1976; Dick, 1976; Barrett and Pearl, 1978).

Canon City Hot Springs, Fremont County

Canon City Hot Springs emerges from a corroded casing in the northeast corner of the front yard of a house that faces the nearby Arkansas River. Nothing remains of the "classy" thirty-eight room Royal Gorge Hotel and Spa built adjacent to the Spring in the 1870's. Fifteen years ago the current owner of the property filled in the swimming pool supplied by the spring.

Water from the spring is now used to irrigate some of the owner's and a neighbor's front yard landscape shrubs. When the spring was visited in June of 1993 the temperature of the spring was 40° C. The flow varied from 9 to 142 liters per minute (George et al., 1920; Taylor et al., 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Cebolla Hot Springs, Gunnison County

The Cebolla Hot Springs near the village of Powderhorn was visited in May, 1993. The cabins and bath houses appeared to be still in useable and working condition; however, there was no one around to give us any information about present day usage. There are still two bath houses (George et al., 1920; Hedlund and Olson, 1975; Barrett and Pearl, 1976;

Barrett and Pearl, 1978).

Cement Creek Warm Springs, Gunnison County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60° C (Barrett and Pearl, 1978).

Clark Artesian Well, Pueblo County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 25° to 60° C (Barrett and Pearl, 1978).

Colonel Chinn Hot Water Well, Delta County

This well was visited in November, 1992. The well water is piped through a closed wellhead to a manifold and then to stock tanks about 200 feet away. An accurate indication of the temperature could not be obtained; however, the property owner indicated that the water flows all the year without freezing (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Hail, 1972).

Conundrum Hot Springs, Pitkin County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50° C (Barrett and Pearl, 1978)

Cottonwood Hot Springs, Chaffee County

At the time of our visit in May, 1993, the Jump Steady Resort was renamed to the Cottonwood Hot Springs Inn. The Inn has guest cabins and hot spring spas in a somewhat rustic environment. Hot water which is used for bathing, domestic heating, and drinking purposes comes from an enclosed cistern.

Another set of nearby springs and a well are used by the Merrifield family for a greenhouse complex, domestic heating and bathing, and drinking.

The Cottonwood Hot Springs is located at the contact of the Tertiary Mount Princeton Quartz Monzonite and Precambrian migmatitic gneisses to the south. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 150° to 200° C (George et al., 1920; Scott, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Craig Warm Water Well, Moffat County

The Craig Warm Water Well is mislocated in Colorado Geological Survey Bulletin 39. The correct location is shown in Table 1 of the current reinvestigation of the geothermal resources of Colorado. The Craig Warm Water Well was visited in November, 1992. At that time the wellhead was in poor condition with hot water leaking from various places. There was no evidence of any activity or recent use of the well. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 70° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Crowley Ranch Reserve Well, Archuleta County

The Crowley Ranch Reserve Well was drilled as an oil and gas test by the Phillips Oil Company in 1943. The well intersected the Dakota Formation at 240 feet, Morrison Formation at 520 feet, Todilto Limestone at 1,200 feet, Wingate Sandstone at 1,308 feet, Chinle Formation at 1,508 feet and Precambrian quartzite at 1,515 feet. The well is reported to have begin flowing hot water at 1,558 feet. The well was abandoned at 1,625 feet and deeded to the Crowley's for irrigation purposes.

There is no longer any physical evidence of the well. Water bubbles up into 8 foot in diameter, 5 foot deep pool. During a visit to the site by CGS personnel in June, 1993, all the water from the well was diverted to the east into an irrigation ditch. Three hundred feet from the well some of the water is taken from the ditch to fill a just constructed hot tub. The remainder of the water in the ditch is allowed to flow into the Jaw Bone Canyon.

From 1943 until within the last year the 48° C well water was used for pasture irrigation. Now, 534 acres of the Crowley family holdings around the well are in a just developed recreational community called the Crowley Ranch Reserve. The Reserve is made up of 19 one to three acre parcels on the 534 acres. Property owners are given common ownership of a great amount of the Reserve's land. One of the amenities touted by the developers of the property is the geothermal hot tub referred to in the above paragraph. Just on the market, only two lots have been sold and as yet no homes have been built.

Deganahl Warm Water Well, Routt County

The Deganahl warm water well was drilled as an oil test in Cretaceous rocks by Fullerton Leasing Company of California in October, 1967. Because the well encountered only warm water, the company turned the well over to the land owner, Mr. Deganahl. He completed the well at a total depth of 2,500 feet in January, 1968 as a warm water well. The original flow of the well was some 11,900 liters per minute at the time of drilling . Caving problems while installing the casing reduced the well flow to 4,800 liters per minute. The temperature of the water is 43° C and the well had a shut in pressure of 200 psi.

In 1981, the Colorado Division of Wildlife applied for a permit to drill a geothermal well at their Finger Rocks Trout Hatchery facility three miles east of the Deganahl well. The permit application was denied by the State Water Engineer. The analyses of the Deganahl well water included in Table 2 were performed as part of the Division of Wildlife's feasability study on the proposed project.

The Deganahl well was visited in May, 1993. The owners of the well make only occasional use of the well for bathing purposes. The hot water is flowing at approximately 1,500 liters per minute out of the wellhead and into Watson Creek. A second well is located at a bearing of S33E and a distance of 225 feet from the original well. The conductivity, pH, and temperature of the water from the second well are similar to the original well. There is no record of the depth or history of the second well, according to a member of the Deganahl family. The flow rate of the second well is only about 100 liters per minute.

The geothermal waters are accounted for by a normal geothermal gradient and probably issue from either the Dakota Sandstone or sandstones within the Frontier

Formation. The well was spudded into The Mancos Shale (Kucera, 1962).

Desert Reef (Florence), Fremont County

The Desert Reef Beach Club is a "Natural Outdoor Hot Springs". The facilities consist of a changing house and a 20 foot by 30 foot bathing pool fed by an old oil test well, the Conoco Huffman No. 1 well drilled in 1966. The well was drilled into Precambrian granite at 3,948 feet and has a total depth of 4,240 feet. Later the well was plugged back to 1,096 feet and produces 54° C water at a permitted flow of 1,100 liters per minute from the Morrison and Dakota sandstones.

Dexter Warm Springs, Conejos County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 20° to 50° C (Barrett and Pearl, 1978).

Dotsero Warm Springs, Eagle County

The Dotsero Warm Springs were visited in May, 1993. The springs and adjacent buildings described and pictured by Barrett and Pearl, 1978 on the northwest side of the Colorado River are no more. Construction activities on Interstate Highway 70 have destroyed the old buildings and the hot springs have been covered over by fill material for the new highway. There are some monitor wells in the area of the old springs at the river's edge; however, there was no sign of flow from these springs.

The springs on the south-east side of the river are still intact and flowing directly into the Colorado River at the base of a fill for the railroad tracks. The outflow quantity is impossible to measure; however, the waters were very saline to the taste. A sample of the water was taken for chemical analysis. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 32° to 45° C (George et al., 1920; Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Dunton Hot Springs, Dolores County

Dunton Hot Springs is near the old mining town of Dunton. There are several old cabins around the Dunton Hot Springs. In the past few years a private group has tried to run a primitive resort around the Hot Springs. Unfortunately, they are no longer in business and all the cabins, lodge, and bathhouse are falling into disrepair. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 50° to 70° C (Bush and Bromfield, 1966; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Dutch Crowley Artesian Well, Archuleta County

The Dutch Crowley Artesian well was visited during June of 1993. The site's 70° C water is flowing from the top of surface casing which extends about 2 feet above ground level.

The well was spudded as an oil and gas test in July 1951 by a J. R. Butler from Houston Texas. The wildcat encountered two gas-and-water zones at approximately 800 and 1,200 feet in the Morrison Formation. The gas rate from the 800 foot sand and/or sands was estimated by the well-site geologist (Mr. Walt Osterhoudt) to be about 300,000 cubic feet per day. The well intersected the Entrada Sandstone at 1,500 feet and flowed fresh water with a temperature of 48° C. The well was bottomed at 1,741 feet. The hole was deeded by the operator to the Crowleys for a water well.

Barrett and Pearl's narrative on how to get to the well in their 1978 CGS Bulletin 39 is not accurate. The correct instructions are to read; proceed 3.8 miles southeast from the Chromo Post Office on US Highway 49 to where a dirt road leads east. Turn left on this road and drive about 1/8 of a mile. The well is about 3/4 of a mile due east of this parking spot on the south side of a boggy meadow.

Mr. Donny Shayhan, a Crowley family son-in-law who lead this investigator (H. T. Hemborg) to the well, indicated that he is considering piping water from the well to his ranch house located 1 1/4 miles west of the well. Up to now this well has only been used for pasture irrigation.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 80° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Osterhoudt, 1978).

Eldorado Springs, Boulder County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 26° to 40° C (Barrett and Pearl, 1978).

Eoff Artesian Well, Archuleta County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 60° C (Barrett and Pearl, 1978).

Florence Artesian Well, Fremont County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 34° to 50° C (Barrett and Pearl, 1978).

Fremont Natatorium Well, Fremont County

The 70 by 150 foot swimming pool supplied by the warm water well is now used only by the owners. The pool and concrete decking is in disrepair. The owner indicated that he and his wife closed the pool for public bathing 30 years ago because they could not afford to be in compliance with newly enacted public swimming pool water standards for chlorination. When this site was visited during June of 1993 the owner was using a portion of the warm well water to irrigate a sizeable vegetable and berry garden.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50° C (Barrett and Pearl, 1976; Scott, 1977; Barrett and Pearl, 1978).

Geyser Warm Springs, Dolores County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 60° to 120° C (Barrett and Pearl, 1978).

Glenwood Springs area, Garfield County

The Glenwood Springs area is the state's premier bathing spa area. There are several hot springs in the area around Glenwood Springs but only those on the north side of the Colorado River have been developed. No new analyses were taken from the Glenwood Springs area during this study. The Vapor Caves Spa donated a copy of a private laboratory report on the chemistry of their waters (George et al., 1920; Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

The chemistry of the geothermal waters in the Glenwood Springs area is too complex for an accurate estimate of subsurface reservoir temperatures. The subsurface temperature is, probably, not much higher than the surface temperature of the hot springs, approximately 45° to 50° C (Barrett and Pearl, 1978).

Hartsel Hot Springs, Park County

The remains of the Hartsel Hot Springs were visited in May, 1993. The bath house that is pictured in Barrett and Pearl, 1978 is no longer standing, though some flow from the hot springs is still coming out of a pipe from the building's foundation. All the facilities of the Hartsel Hot Springs are unused and in a state of decay and disrepair. The flow was difficult to measure but it appears to be greater than 300 liters per minute.

There is a popular opinion based upon rumor and general tourist literature that the geothermal water from the Hartsel Hot Springs is highly radioactive (Cahill, 1983). This opinion appears to based upon an article (Howland, 1936) which describes a barite occurrence in the Pennsylvanian-Permian Maroon Formation about two miles southwest of Hartsel Hot Springs. The author states that there is an unusual blue-colored barite at this locality and he conjectures that the blue coloration was caused by radiation damage. As further evidence for his thesis, Howland states without providing any data or analysis that the Hartsel Hot Springs are highly radioactive based upon analyses done by the Colorado Geological Survey (George et al., 1920). The mean of 60 hot springs (>20° C) analyzed in the 1920 CGS study is 0.139 picocuries Ra per liter. The values range from a trace, 0.001, to 2.64 picocuries Ra per liter. The value for the Hartsel Hot Springs is 0.154 picocuries Ra per liter, only slightly above the mean.

A more recent study of the uranium concentration in natural waters of South Park (Sharp and Aamodt, 1976) indicates that the uranium concentration, as analyzed by fluorometric methods, in a filtered and acidified water sample from the Hartsel Hot Springs was 0.30 parts per billion (ppb) uranium. Two other analyses of the untreated sample were 0.98 and 0.10 ppb uranium. Samples from 16 springs in the South Platte drainage area within the South Park region which includes the Hartsel Hot Springs had values that ranged from 0.21 to 292 ppb uranium with an average of 22.6 ppb uranium. The average of 35 surface water samples in the same drainage area is 3.3 ppb uranium. The uranium concentrations of 0.3 ppb at the Hartsel Hot Springs is well below the regional average, 22.6

ppb, for the South Platte drainage in South Park.

It appears that the hot springs at Hartsel are associated with the South Park or Santa Maria Faults and\or the contact of the Morrison Formation and Precambrian crystalline rocks. Precambrian granites in the region around Hartsel are known to possess anomalously high geothermal gradients. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 55° to 85° C (George et al., 1920; Ettinger, 1964; Barrett and Pearl, 1976; Barrett and Pearl, 1978; McCarthy et al., 1982[b]).

Haystack Butte Warm Water Well, Boulder County

This well and surrounding area was visited in May, 1993. Warm water is still flowing from the wellhead into a 25 foot diameter pool which at the present time is used mostly by game birds as a watering and bathing pool. The pool is undeveloped and a significant amount of discarded machinery and other junk surround it. The temperature of the well has declined from 28° C in 1976 (Barrett and Pearl, 1976) to 20° C in May, 1993. The source of the hot water is conjectural; however, the location of the well on the Haystack Mountain Anticline indicates that structures along the axis of the anticline probably helped in circulating waters through the underlying Pierre Shale to depths adequate enough for heating to the observed temperatures (Trimble, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

The estimate of the subsurface reservoir temperature made by Barrett and Pearl (1978) from a variety of geothermometers was 50° C. The surface temperature of the spring has declined almost 30% since 1978. It may be reasonable to expect a similar decline in the subsurface reservoir temperature estimate to approximately 35° to 40° C.

Hooper Aquaculture Well, Alamosa County

Access to the Hooper Aquaculture Well is south from Hooper on Colorado Highway 17 for 2.7 miles to the intersection with Nine Mile Lane. Turn left (east) on this road and proceed for 0.2 miles to the site.

The subject well was drilled as an irrigation well by E. F. Lambert in 1963. Total depth of the well was 2,063 feet. A 12 3/4 inch casing was run from surface to 922 feet and 9 5/8 inch casing was run from 922 to 2,063 feet. The well casing is perforated from 1,242 feet to total depth. The driller's log indicates the perforated section is an interbedded mixture of sand, gravel and brown clay. The well according to State of Colorado Division of Water Resources records initially flowed 8,955 liters per minute.

About ten years ago Mr. Erwin Young of Alamosa bought 80 acres of land comprising the north half of the northwest quarter of Section 22, T40N, R10E. The Lambert (nee) Hooper Aquaculture well is located in the NW NW NW of this section was included in the purchase. After the purchase Mr. Young developed his acreage into a fish and alligator farm. The "geothermal" Hooper Aquaculture Well which now flows at about 2,600 liters per minute at a temperature between 30.2° to 31.3° C is about the perfect water temperature for the African perch or "Tilipia" that he is rearing at the site.

During our visit to the site in June of 1993, water leaking around the casing of the Hooper well was measured at 31.3° C. Currently, all the commercial fish growing ponds are out of doors. Mr. Young, however, is in the middle of a project to enclose a number of tanks inside a metal shed to increase production in winter months. He also is developing an additional Tilipia rearing unit near Alamosa whose ponds will be supplied from a couple of (unknown) geothermal wells of a temperature nearly matching the Hooper Well.

Hot Sulphur Springs, Grand County

The Hot Sulphur Springs Resort is now only open during the summer and fall months. At the time of our visit in June, 1993 the resort complex was for sale. The springs appear to be controlled by a north-south trending fault in the Dakota Formation and the Middle Park Formation.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 75° to 150° C (George et al., 1920; Izett, 1968; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Idaho Hot Springs, Clear Creek County

This site was not visited during this program. The chemistry of the geothermal waters in the Idaho Springs area is too complex for an accurate estimate of subsurface reservoir temperatures.

Juniper Hot Springs, Moffatt County

Juniper Hot Springs was visited in November, 1992. At that time the buildings and other facilities associated with the resort were severely run down and in a general state of disrepair. Hunters who were camped there informed me that the resort was closed in 1989, more or less permanently, by the elderly owner who lives in nearby Craig. The source springs are enclosed in a locked building. A one-inch pipe carries hot water from the building for a distance of about eight feet and discharges into a pool. The sample for this study was taken at the discharge point.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 50° to 75° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Lemon Hot Springs, San Miguel County

The Lemon Hot Springs consists of a small, 20 foot diameter, pond at the mouth of an old adit. Several buildings having the appearance of private residences surround the pool and tunnel. The waters feeding the hot springs pool are draining from the tunnel. At the time of my visit in July, 1993, the pool was choked with weeds and algae. The owners of the hot springs could not be contacted concerning the status of the pool and springs (George et al., 1920; Bush et al., 1959; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Mineral Hot Springs, Saguache County

An attempt to visit this site was made in June, 1993; however, we were denied access to the area. According to the guard at the site the owner is planning on developing the area and is very secretive about his plans. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 90° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Mount Princeton Hot Springs, Chaffee County

Because of the presence of hot geothermal water, the area around Mount Princeton Hot Springs has been heavily developed since the turn of the century and has been the site of various resorts, hotels, homes, and youth camps. The springs around Mount Princeton are the hottest in the state. The Hortense Hot Spring which services the Silver Cliff Ranch, a Christian youth camp, has a temperature of 85° C. The water is used for bathing, domestic uses and drinking purposes. A resort, several residences, youth camps, and a greenhouse utilize the hot water from several springs and wells in the area. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 150° to 200° C.

The state Division of Wildlife has a trout rearing unit at the Chalk Cliffs hatchery some two miles east of the Mt. Princeton Hot Springs. This unit was purchased by the state in 1948 but has been in existence since the 1920's. The 18° C water in the Chalk Creek is used in the trout rearing unit to advantage. Growth times for rainbow trout from fingerlings to a stocking length of 10 inches are decreased from a normal 18 to 22 month period to 12 months because of the warm water (George et al., 1920; Scott et al., 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Mullenville Warm Spring, Park County

The area around this spring, also known as Rhodes Warm Spring in the earlier literature, has been developed as a subdivision called "Warm Springs Ranch". Below the springs the outflow has been channelized by a boulder and cobble drain. The warm water goes to some fishing ponds on the subdivision. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 25° to 35° C (Tweto, 1974; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Orvis Hot Springs (Ridgeway), Ouray County

The Orvis Hot Springs resort utilizes geothermal water from a tufa mound just to the southeast of the resort buildings, from a well pit dug in 1991, and from springs which feed directly into a 35 foot diameter natural pool. The natural pool, used mostly for bathing in the 41° C water has a privacy fence and is surrounded with a wooden deck. The resort also has private rooms for bathing and massage and hydrotherapy sessions.

Part of the hot water from the tufa mound is being diverted to a greenhouse and aquaculture project about 1,000 feet to the south. The owner has ambitious plans to develop this project but at this writing, July, 1993, it is still under construction (George et al., 1920; Luedke and Burbank, 1962; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Ouray, Ouray County

The City of Ouray has taken an active role in developing the geothermal resources of the immediate vicinity. In 1989, the City drilled two shallow wells, OX-2 and OX-6, in the City Park just to the south of the City Swimming Pool (Formerly known as the Radium Hot Springs Pool). These two wells are 90 feet deep and produce 48° C water which goes directly to the pool. At the time of my visit in July, 1993 one of the wells was temporarily shut-in. The pool still gets the bulk of its hot water via a pipeline from the Box Canyon Hot Springs.

Three motels in the City of Ouray are using geothermal waters from various sources for spas and space heating. The Twin Falls and Box Canyon motels are using geothermal waters from springs located at the motel sites, and the Manganese Mine at the mouth of Box Canyon, and from hot springs in Box Canyon. The Weisbaden Motel uses geothermal waters for its pool and space heating from a hot spring reservoir under the motel and from an underground Vapor Cave which has three natural hot springs issuing into it. The waste geothermal water from the Weisbaden Motel is used to heat the sidewalks and driveways of the City of Ouray municipal buildings about 200 feet down the hill.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 90° C (George et al., 1920; Luedke and Burbank, 1962; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Pagosa Springs, Archuleta County

These springs were visited during June of 1993. The main spring, Great Pagosa, situated a few hundred feet southwest of the Spring Inn is enclosed by a fence and posted with "No Trespassing" signs. The City of Pagosa Springs has recently built a viewing area on the east side of the spring which provides a good place to observe and photograph the spring. The city has placed four poster boards in the viewing area which describe the: (1) History of the Great Pagosa Hot Springs, (2) Geologic Requirements for a Hot Spring, (3) The Stratigraphic Section at Pagosa Springs, and (4) Distribution of the Pagosa Springs Geothermal Heating System. The poster boards are of good graphic quality and the historical and scientific information is accurate and well written for lay person understanding.

The Spring Inn is in the final phase of a major alteration of their pool area. When finished they will have a cluster of seven soaking pools of different sizes and water temperature ranging from about 35° to 45° C. Individual pools will be able to comfortably accommodate from 8 to 30 bathers.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 80° to 150° C (George et al., 1920; Hail, 1971; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Paradise Hot Spring, Dolores County

This hot spring is located 2.5 miles south of the Dunton Hot Springs along the West Dolores River. At the time of my visit in July, 1993, the springs were not open to the public. The owner of the property uses the warm springs and bath house for his own purposes which is no change from the previous inventory in 1976 (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Penney Hot Springs, Pitkin County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 60° to 90° C (Barrett and Pearl, 1978).

Pinkerton Hot Springs, La Plata County

The rerouting of the U. S. Highway 550 has destroyed two of the four hot springs that made up the Pinkerton Hot Springs. The two remaining springs, the Mound Spring and the Little Mound Spring, are located on the west side of the highway just a few feet from the pavement. The hot water from both springs is piped out to a drain along side of the highway and then to the natural drainage system. There has been some limonite-stained tufa build up at the site of the two remaining springs. The destruction of the two remaining springs has left the Colorado Timberline Academy (formerly the Golden Horseshoe Resort mentioned in Barrett and Pearl, 1978) without hot water for its pool.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 75° to 125°C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Poncha Springs, Chaffee County

The Poncha Hot Springs were visited in May, 1993. The facilities around the springs are currently maintained by the City of Salida. Since 1938 most of the water from the springs is transported by pipeline to the municipal swimming pool in Salida. The inlet temperature of the pool is approximately 47 to 50° C. Currently, the Boy Scouts of America use the facility heavily in the summer months as a base camp. There is no longer any commercial usage of the facilities.

According to the caretaker at the site there are numerous springs which over the years have fallen into a state of disrepair. Currently, there are efforts to find and repair some of the old cisterns and pipelines in order to improve the quantity and temperature of the flow.

The Poncha Hot Springs area is marked by the presence of several fossil and a few active tufa mounds that are associated with the hot springs. There are significant aprons of travertine that occur downslope of the area of hot springs.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 115° to 145° C (George et al., 1920; Van Alstine, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Rainbow Hot Springs, Mineral County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50° C (Barrett and Pearl, 1978).

Ranger Warm Springs, Gunnison County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60° C (Barrett and Pearl, 1978).

Rico, Dolores County

Two of the four diamond drill holes noted by Barrett and Pearl, 1978 are still uncapped and flowing hot water. The Geyser Hot Water Well is flowing and bubbling with a slight geyser effect. It has built a substantial tufa mound, approximately 6 feet high, and an semi-circle shaped apron, approximately 25 feet in diameter, around the drill hole. Limonite staining is prominent in the tufa. The waters remain unused. The chemistry of the geothermal waters in the Rico area is too complex for an accurate estimate of subsurface reservoir temperatures (George et al., 1920; McKnight, 1974; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Routt [aka Strawberry] Hot Springs, Routt County

The Strawberry Hot Springs is in the process of development as a commercial enterprise. Don Johnson of Steamboat Springs has owned the property since 1982. In the ten years since Johnson has owned the property he has deepened four of the pools and imported sand for the bottoms, built wooden decks and walkways, built four rustic cabins, and hired a gardener. At the time of my visit in November, 1992, a massage house; a bath house with showers, toilets, and heat; and another cabin were under construction.

Recent geological mapping (Snyder, 1980) demonstrates that the Strawberry Hot Springs are hosted by an Proterozoic felsic gneiss and amphibolite. Younger granitic pegmatites are also found in the immediate area. A north-trending normal fault with an adjacent zone of pervasive epidote-chlorite alteration also occurs in the immediate area.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 125° to 175° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Snyder, 1980; Pearl et al., 1983).

Sand Dunes Pool Hot Water Well, Saguache County

Hot water for the swimming pool comes from a 4,400 foot deep well located just to the south of the pool. The pool is no longer open to the public; however, it is in good shape and is used by the family living on the premises. An experimental project for growing catfish using the geothermal water has been abandoned for many years (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Shaws Warm Spring, Saguache County

The site was visited during June of 1993. I could not gain access to spring. Sampling and measuring of water was achieved where the spring waters leave swimming pool.
The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60° C (Barrett and Pearl, 1976; Lipman, 1976; Barrett and Pearl, 1978; Bond, 1981).

South Canyon Hot Springs, Garfield County

These three undeveloped springs were visited in May, 1993. The hot springs have had several periods of usage and limited development followed by a closing of the primitive facilities by local governments. At the present time the hot springs are channeled into two pools dug into the dirt. There is obvious evidence of usage of the springs by bathers. The hot waters are associated with the Dakota Sandstone. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 100° to 130° C (Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Splashland Hot Water Wells, Alamosa County

The Splashland Pool is served by two wells that are 40 feet apart and 2,800 feet deep just to the west of the pool. In the winter when the pool is closed, the flow of the wells is used for space heating and domestic hot water in the surrounding ranch buildings. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 100° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Steamboat Springs, Routt County

Although there are several springs in the vicinity of the town of Steamboat Springs, only the Heart Spring has been used as a commercial hot bathing spring. The other springs in this area, which include the famous Steamboat Spring, have temperatures which vary from 14° to 19° C, too low to be considered as a geothermal resource in this study.

The Heart Spring is currently used for bathing within the larger Steamboat Springs Health and Recreation Association facility, a modern well appointed health club which includes an olympic size lap pool, tennis courts, weight room and exercise areas. It is impossible to obtain a good temperature measurement at the spring outlet; however, the Heart Pool had a temperature of 36.4° C at the time of my visit in November, 1992. According to the Office Manager, Linda Johnson, the flow rate varies from about 300 to 750 liters per minute. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 125° to 130° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978; Snyder, 1980; McCarthy et al., 1982(a); Pearl et al., 1983).

Stinking Springs, Archuleta County

Stinking Springs was visited in June of 1993. Warm water emerges in several places in a 1,500 foot stretch along the south bank of the Navajo River and north of the graded dirt road that parallels the river from Chromo to the springs and beyond. This area is very marshy and individual flows from points of emergence is very small.

The spring with the largest flow is south of the road. Barrett and Pearl (1976) sampled the water from this "main" Stinking Spring source in 1975 and found the temperature to be 27° C with a flow of 106 liters per minute. Our visit in 1993 found the temperature to be 25.4° C with a flow rate of 132 liters per minute.

The main spring bubbles up into a 20 foot diameter by 3 foot deep pool. This "soaking pool" seems to be a recent development or alteration to the spring. The spring is on *property is owned by a newly (1992) formed recreational housing development called* Crowley Ranch Reserve. It is assumed that they are responsible for the pool construction at this previously undeveloped and unused spring. Based on the lack of trash and foot prints around this newly dug out soaking pool, usage so far is judged to minimal.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 60° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Swissvale Warm Spring, Fremont County

This site was visited during June of 1993. Barrett and Pearl (1978) described the springs as being unused in 1978 and that is still the case. Sometime in the interim between the two site visits a 25 foot x 15 foot x 4 foot deep soaking pool was dug about 50 feet from where Spring F issues at the surface. All the flow from this spring was diverted to the pool before running into the nearby Arkansas River. The pool is now filled with moss and algae. It would appear no one has used this pool for soaking recently. The spring is on private property and posted for no trespassing. No one currently resides on the property.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Trimble Hot Springs, La Plata County

The Trimble Hot Springs lies within the well developed Trimble Hot Springs resort complex. The actual springs now have only a meager flow of 8 to 12 liters per minute. The resort pools and spas are served by a well [mistakenly called the Tripp Hot Springs well in Barrett and Pearl (1978) and Barrett and Pearl (1976)] which is 150 feet deep and contains a submersible pump at 35 feet. The well is pumping at about 1,000 liters per minute. A new bath house complex was built in 1988. The grounds around the pools are well maintained. At the time of our visit in July, 1993 the resort had a good crowd.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 45° to 70° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Tripp Hot Springs, La Plata County

The Tripp Hot Spring was mistakenly located at a well site 200 feet north of the Trimble Hot Spring by Barrett and Pearl (1978). The actual Tripp Hot Spring is located about 3/4 mile north of Trimble, near the mouth of Tripp Gulch and consists of a small natural pool, 25 feet x 10 feet x 5 feet deep. It is in the backyard of a private residence and has not been used for many years. The water currently flows off the property into a culvert (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Valley View Hot Springs, Saguache County

This site was visited during June of 1993. The site characterization in Cahill (1983) essentially catches the ambiance of this site. The amenities are about as he described in 1982 with the added note that the shower and bathroom facilities are now completed and that the site now has telephone service. The springs serve five soaking pools and one swimming pool.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Cahill, 1983).

Wagon Wheel Gap Hot Springs, Mineral County

Barrett and Pearl (1978) lists the location of the Wagon Wheel Gap Hot Springs as being in the SESE of Section 35, T41N, R1E; Spar City 7.5' quadrangle map. In actuality, the Wagon Wheel Gap 4UR Hot Spring is in the NWNE of Section 2, T40, R1E; Lake Humphreys 7.5' quadrangle map. The Wagon Wheel Gap CFI Hot Spring is in the SWNE of Section 2, T40, R1E; Lake Humphreys 7.5' quadrangle map.

During a site visit on June of 1993, the 4UR Dude and Guest Ranch ownership was building a new deck and swimming pool north of the old bath house which will utilize waters from the 4UR Hot Springs.

The CFI Spring is unused unless you count the old bath tub that is by the spring which guests or employees of the ranch can fill with a bucket. The 65° C spring water must be mixed with the icy water from the adjacent Goose Creek to achieve the right temperature for a soak.

The chemistry of the geothermal waters in the Wagon Wheel Gap area is too complex for an accurate estimate of subsurface reservoir temperatures (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Waunita Hot Springs, Gunnison County

The Waunita Hot Springs was visited in May, 1993. The upper Waunita Hot Springs is a well-developed and appealing guest ranch. Waunita Hot Springs has been a popular tourist attraction since the turn of the century and still is even to this day. The waters from the springs are used in the swimming pool, space heating for the ranch and guest cabins, and for drinking purposes. The waters at Waunita are among the hottest in the state with an immersed temperature of the spring "A" in the gazebo of 77° C. A sample of the water from the gazebo spring was taken for chemical analysis. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 175° to 225° C.

The lower Waunita Hot Springs are approximately a half mile from the upper Waunita Hot Springs. All the bath houses, gazebos, cisterns, and springs at the lower springs are unused and in a bad state of disrepair. There is only a foot path to the lower Waunita Hot Springs. The water temperature, apparent quality (conductivity), and flow are about the same as seen at the upper springs. The most reasonable estimate of the subsurface reservoir temperature of the lower Waunita Hot Springs is 110° to 160° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978; Zacharakis, 1981).

Wellsville Warm Spring, Fremont County

This spring was visited during June of 1993. The concrete ponds supplied by the Wellsville Warm Spring were used for the raising of tropical fish starting some time around the middle 60's. They are still in good condition and filled with warm spring water. However, the business was closed six years ago because of the failing health of the owner who had run the fish farm for some 20 years. This gentleman passed away about 5 years ago.

An elderly brother-in-law of the fish farmer now lives on the property. He indicated the only use now of ponds supplied by the spring was for bathing and swimming by his grandchildren and his sister's grandchildren.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

6. Summary

The 1992-1993 low-temperature geothermal assessment program added 10 new chemical analyses to the geochemical database of the state's geothermal waters. Other sources of geochemical data were reviewed and all good quality, that is less than 15% cation-anion balance error, geochemical analyses were entered into the long form geochemical database, Table 2. Certain areas with higher than 15% cation-anion balance were left in the database because they were the only analysis for an area or site. Usually the most significant errors in the cation-anion balance were found in the U. S. Geological Survey WATSTOR database and are due to a missing HCO_3 analysis.

Several corrections were made to locations and names of hot springs and wells described in the older literature. The Colorado Geological Survey Information Series 6 (1976) was updated during 1993 and the correct locations were entered into the revised publication and the database for this assessment. Corrections were also made to several location entries in the U. S. Geological Survey WATSTOR database.

A summary of the results of the 1992-1993 geothermal assessment and a comparison to the the 1976-1978 geothermal assessment are shown in the following table:

ITEM	1993 ASSESSMENT	1976-78 ASSESSMENT	% CHANGE
GEOTHERMAL AREAS	93	56	+66%
GEOTHERMAL SITES	157	125	+26%
GEOCHEMICAL ANALYSES	382	236	+62%
SITES OF DIRECT HEAT UTILIZATION	64	64	0
SITES OF DISTRICT HEAT USE	20	?	
SITES OF GREENHOUSES, AQUACULTURE	4	?	

Table B: Summary of the results of the 1993 Low-Temperature Geothermal Assessment Program compared to the 1976-1978 geothermal assessment.

7. Recommendations

The current assessment indicates that several areas in the state continue a long history of substantial utilization of their geothermal resources. The prime areas include Glenwood Springs, Idaho Springs, Steamboat Springs, Pagosa Springs, Mount Princeton, and Ouray. All of these areas, at the minimum, utilize the geothermal resources for swimming pools and spas. Some areas such as Ouray and Pagosa Springs utilize geothermal heat for space heating in municipal and other private buildings.

There are other areas in the state that are collocated with or near population centers and are on the fringe of geothermal development. That is, they have had some development of their geothermal resources; however, there are indications that geological and geophysical studies may be used in a Second Phase geothermal assessment to increase the geothermal area and spur development in these areas. The geothermal areas that are candidates for a Second Phase are (not listed in any order of importance):

1) Trimble Hot Springs, La Plata County.
2) Orvis Hot Springs, Ouray County.
3) A large area southeast of Pagosa Springs along the Archuleta Antiform, Archuleta County.
4) Eastern San Luis Valley, Saguache and Alamosa Counties.
5) Rico and Dunton Hot Springs, Dolores County.
6) Cottonwood Hot Springs, Chaffee County.

Other areas that are geologically significant but far from a center of population are:

1) Deganahl well, Routt County.
2) Brands Ranch well, Jackson County.
3) Craig warm water well, Moffatt County.
4) Hartsel Hot Springs, Park County.

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Open File Report 95-1

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DISCLAIMER

CONTENTS

FIGURES

TABLES

PLATE

APPENDIX

Tables 1,3, and 4 printout of diskette database.

DISKETTE

Database on 3.5 in. HD DOS diskette.

Table 1.	Location of geothermal sources in Colorado.
Table 2.	Geochemical analysis of geothermal sources in Colorado (long list) (milligrams/liter).
Table 3.	Geochemical analysis of geothermal sources in Colorado (short list) (milligrams/liter).
Table 4.	General information of geothermal sources in Colorado.

ABSTRACT

Previous assessments of Colorado's low-temperature geothermal resources were completed by the Colorado Geological Survey in 1920 and in the mid- to late-1970s. The purpose of the 1992–1993 low-temperature geothermal resource assessment is to update the earlier physical, geochemical, and utilization data and compile computerized databases of the location, chemistry, and general information of the low-temperature geothermal resources in Colorado. The main sources of the data included published data from the Colorado Geological Survey, the U.S. Geological Survey WATSTOR database, and the files of the State Division of Water Resources. The staff of the Colorado Geological Survey in 1992 and 1993 visited most of the known geothermal sources that were recorded as having temperatures greater than 30°C. Physical measurements of the conductivity, pH, temperature, flow rate, and notes on the current geothermal source utilization were taken. Ten new geochemical analyses were completed on selected geothermal sites. The results of the compilation and field investigations are compiled into the four enclosed Quattro Pro 4 databases.

For the purposes of this report a geothermal area is defined as a broad area, usually less than 3 sq mi in size, that may have several wells or springs. A geothermal site is an individual well or spring within a geothermal area. The 1992–1993 assessment reports that there are 93 geothermal areas in the Colorado, up from the 56 reported in 1978; there are 157 geothermal sites up from the 125 reported in 1978; and a total of 382 geochemical analyses are compiled, up from the 236 reported in 1978.

Six geothermal areas are recommended for further investigation: Trimble Hot Springs, Orvis Hot Springs, an area southeast of Pagosa Springs, the eastern San Luis Valley, Rico and Dunton area, and Cottonwood Hot Springs.

INTRODUCTION

The first assessment of the geothermal resources of the State of Colorado was completed in 1920 by the Colorado Geological Survey with the publication of Colorado Geological Survey Bulletin 11, *Mineral Waters of Colorado*. Bulletin 11 contains chemical analyses of the state's mineral waters including the known geothermal waters and, also, has a section describing the utilization of the mineral waters.

All of Colorado's geothermal resources are considered to be low-temerature, that is, less than 90°C. The lower temperature is defined by the U.S. Department of Energy as 10°C above the mean annual air temperture at the surface (Reed, 1983). For this report a lower limit of 20°C was selected. The first modern low-temperature geothermal assessment for the state of Colorado was completed during a period of time from about 1976 to 1983. That assessment was carried out by the Colorado Geological Survey through a funding program with the U.S. Department of Energy and the U.S. Geological Survey. The 1976 survey involved a sampling program conducted over an approximate 12 month period of 125 geothermal sources from 56 geothermal areas and resulted in the 1976 publication of Colorado Geological Survey Information Series 6, *Hydrogeochemical Data of Thermal Springs and Wells in Colorado* (revised 1993).

In 1978, the Colorado Geological Survey published Bulletin 39, *An Appraisal of Colorado's Geothermal Resources*, which contained descriptive information on the sites, including location, current usage, geological setting and an analysis of various geothermometers for each of the 56 geothermal areas of the state. Bulletin 39 utilized the analytical geochemical information presented in Information Series 6.

Several other site-specific geological and geophysical studies were performed by the Colorado Geological Survey up to 1983. Economic evaluations regarding the utilization of geothermal heat and energy for various sites were also completed during this time. All the pertinent publications are listed in the Reference chapter of this report.

The need for a new geothermal assessment is evidenced by the results of the current 1992–1993 low-temperature geothermal assessment. In Bulletin 39 which was published in 1978, there are 56 geothermal areas and 125 geothermal sites. The 1992–1993 survey lists 93 geothermal areas and 157 geothermal sites throughout the state. Over 380 chemical analyses, up from the 236 reports in 1976, were compiled from various sources in the construction of the database. Utilization of geothermal resources has changed over years. In some cases flow rates and temperature of the geothermal sources have changed since prior assessments. Several errors in location and description of geothermal springs from both the above described Colorado Geological Survey publications and the U.S. Geological Survey WATSTOR database were corrected.

The data collected and compiled for this survey are listed in Tables 1 through 4 and are recorded in four computer databases. A 1:1,000,000 scale map of the state (Plate 1) shows the location and ID number of each of the geothermal areas.

The 1992–1993 low-temperature geothermal assessment for Colorado was initiated in the fall of 1992 by the Colorado Geological Survey. Funding for this survey was provided by the U.S. Department of Energy. The program was administered by the University of Utah Research Institute in Salt Lake City, Utah and the Geo Heat Center at the Oregon Institute of Technology, Klamath Falls, Oregon.

DATA SOURCES

Data were compiled from a variety of sources including unpublished materials. The most important unpublished sources were the Colorado Department of Water Resources well permit files, the U.S. Geological Survey WATSTOR database, and analytical reports from private laboratories given to the principal investigator by geothermal source owners and operators.

The most important published source material includes: George et al., 1920, Colorado Geological Survey Bulletin 11; Barrett and Pearl, 1976, Colorado Geological Survey Information Series 6; and Barrett and Pearl, 1978, Colorado Geological Survey Bulletin 39.

The University of Utah Research Institute provided 10 new water analyses for each state for the current low-temperature geothermal assessment program. All 10 new analyses were completed for the Colorado portion of the program.

All geochemical data which maintained a cation-anion charge balance of ± 15% were entered into the databases. Geothermal sources with only one analysis were entered regardless of the charge balance. All data entries, especially those with significant cation-anion charge balance errors, were checked by two separate operators. References for each analysis are recorded in the GTHCHM1 database.

DATA FORMAT

The data collected and compiled during this assessment is recorded on the enclosed diskette in Lotus 1-2-3, Dbase, and Arc Export formats. For loading and other information refer to the Read Me file on the diskette. For purposes of this program a geothermal area is defined as a geologically cohesive land area that may or may not contain several geothermal wells or hot springs. Generally an area is less than approximately 3 sq mi. A site is defined as an individual geothermal well or hot spring within an area.

Each geothermal area within the database has a unique ID number. Different sites within a geothermal area have unique area-site numbers. All the tables list the ID number, Site number, and Geothermal Source (Name). (See Appendix.)

Table 1 is a location database (GTHLOC); it describes the county, quadrangle map, section, township, range, latitude and longitude, and Universal Transverse Mercator grid references.

Table 2 contains the long form of the geochemical database(GTHCHEM1). All the geochemical and sample data collected during this survey is stored in this Table. There can be multiple entries of geochemical data for each site. Table 2 is not included in the Appendix because of its size. It is only available on the enclosed diskette.

Table 3 is the short form of the geochemical database(GTHCHEM2). It contains an abbreviated element list and has only one entry per site. Where multiple chemical analyses were available all the results were averaged to make just a single entry.

Table 4 contains the general information database (GTHGEN). It has information such as temperature, flow rate, type, references, and current usage for each geothermal site.

All the data in the project databases were entered by hand. Much of the data resided in Colorado Geological Survey Bulletins and Information Series and had never been entered into a computerized database before. The only other computerized database used in this project was the WATSTOR database compiled by the U.S. Geological Survey; however, all of this data was entered manually.

The enclosed diskette contains all the database files in a various formats. These files can easily be exported to several database manager applications. The following table lists all the important computer database information for the databases.

Table A. List of pertinent computer file data for the low-temperature geothermal assessment databases.

Table	Database Name	Information	No. of Fields	No. of Bytes
1	GTHLOC	Location	24	84,936
2	GTHCHEM1	Chemistry, long list	59	385,444
3	GTHCHEM2	Chemistry, short list	22	84,670
4	GTHGEN	General information	8	29,316

FLUID CHEMISTRY

The University of Utah Research Institute (UURI) provided 10 new water analyses for each state as part of the low-temperature geothermal assessment program. Because of time constraints a lower limit of 30°C was set on any geothermal spring or well to be visited in the field. Almost all of the geothermal sources greater than 30°C were visited. The temperature, pH, conductivity, flow rate and current usage for each site were recorded. Sites for a complete water analysis were selected on a subjective criteria of developmental significance and lack of recent or quality geochemical data. The 10 sites selected for new water analyses in Colorado are:

- Craig Warm Water Well
- Desert Reef (Florence)
- Dotsero, South
- Mt. Princeton (Hortense Well)
- Ouray (Pool or Box Canyon Spring)
- Routt (Strawberry)
- Steamboat Springs (Heart Spring)
- Waunita Hot Springs
- Juniper Hot Springs
- Pagosa Hot Springs (Big Spring)

The results of the new samples are included in Table 2 and have a reference number of 3. There were no new results that had serious implications for the prior known geochemistry of the geothermal areas.

Geochemical data derived from the U.S. Geological Survey WATSTOR database was entered into the current database; unfortunately, most of those reports do not have an analysis for HCO_3^{-1} or CO_3^{-2} which causes severe errors in the cation-anion balance. As most of these analyses are the only one for that particular site they have been retained in the database even though they do not balance within the specified limits.

DISCUSSION

The location of all the geothermal sites compiled during this assessment program is shown on Figure 1. The accompanying Plate 1 shows the location and geothermal area ID number. A frequency plot of all the geothermal temperatures from each site is shown in Figure 2. The greatest number of temperature measurements fall in the 25° to 40°C categories. There is another peak in the 51° to 55°C range.

The following section contains a brief discussion of the sites that were visited during the 1992–1993 geothermal assessment program. All the geothermometer estimates in the following section are derived from discussions and tables

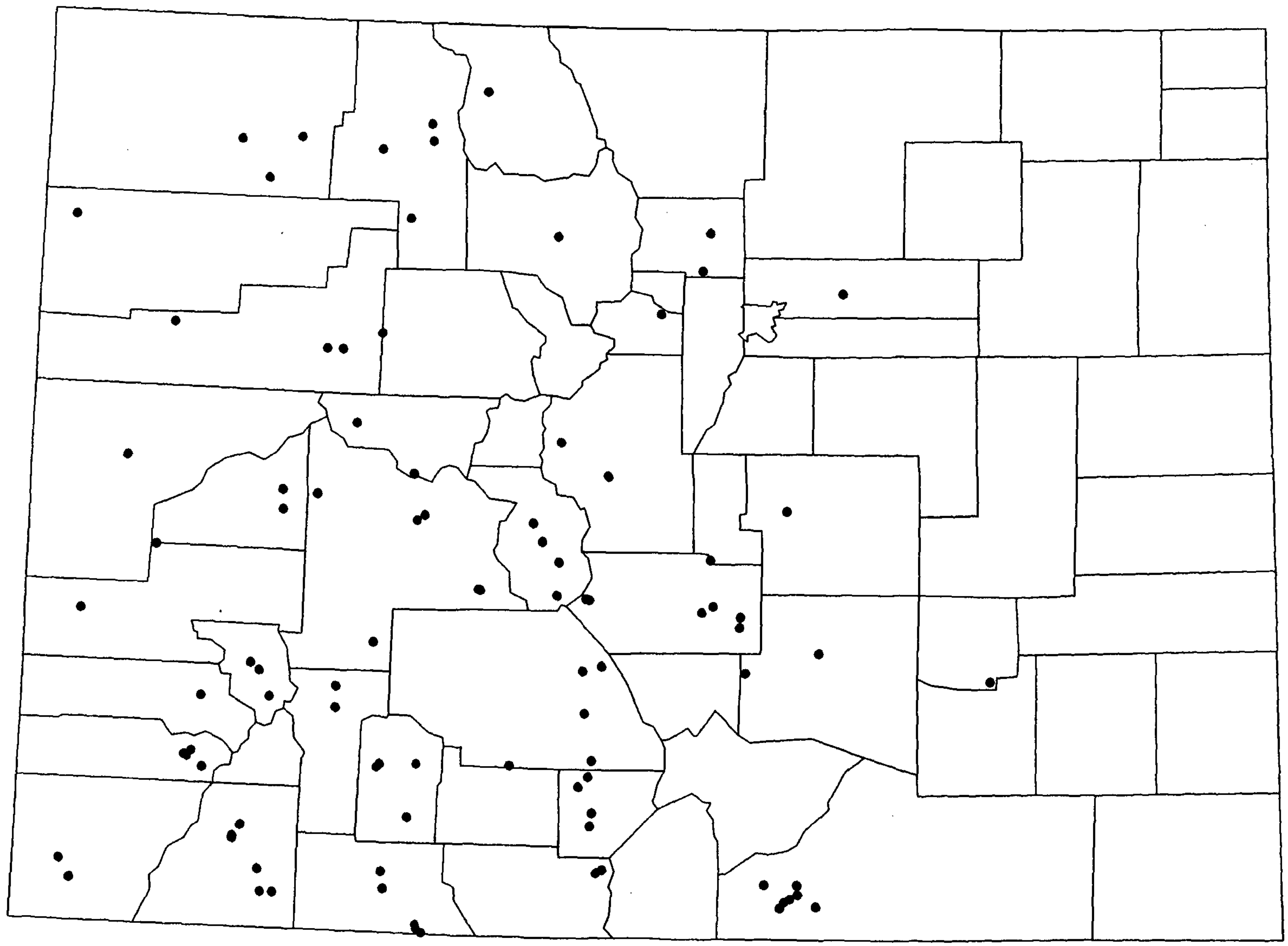

Figure 1. Geothermal springs and wells in Colorado.

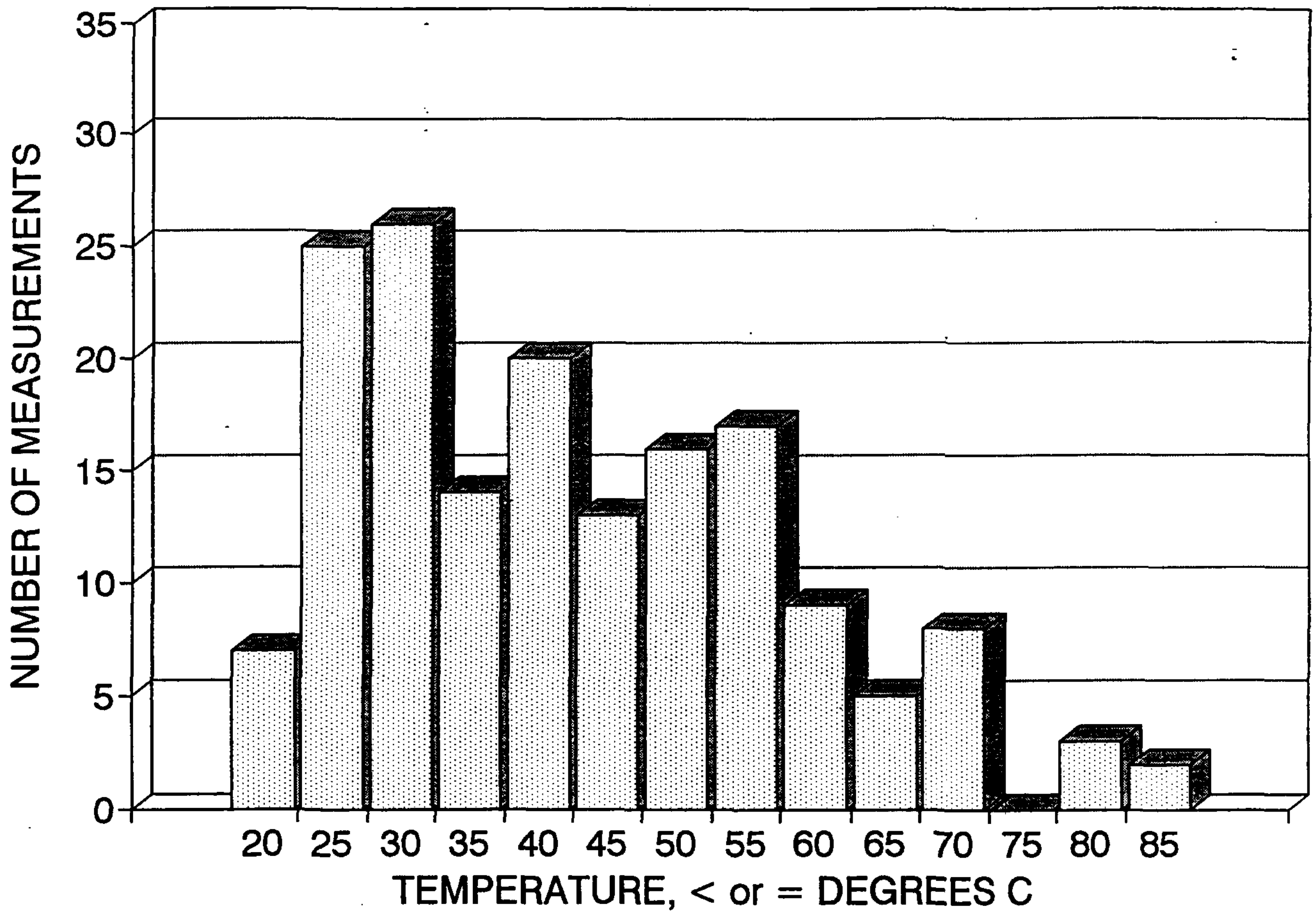

Figure 2. Frequency distribution of Colorado geothermal sources.

in Barrett and Pearl (1978). Some modification of suspect geothermometer estimates was made using the methods described by Michael Adams of UURI (personal communication, 1993).

ANTELOPE WARM SPRING, MINERAL COUNTY

The Antelope Warm Spring was visited in June of 1993. The spring issues into a concrete-lined cistern approximately 6 ft by 4 ft at ground level and 5-ft deep. The spring is 20 ft north of wooden building shaped like a quonset hut. Inside this building is a 20 ft by 30 ft swimming pool. Water from the spring was used to fill the pool.

Mr. Larry (Sonny) Dickerson, longtime owner of the property around the spring, indicated the pool had not been used for several years. The pool was used by family and friends, never commercially. Currently, the swimming pool building is used for storage by Mr. Dickerson. The pool is covered by a tarp and is nearly empty. Water from the Antelope Warm Spring is diverted into the pasture surrounding the spring. A valve and pipe system (in an advanced state of disrepair) can still divert most of the spring flow into the swimming pool if desired.

Flow from the spring was measured at 50 liters per minute which was four (4) times the rate measured by Barrett and Pearl (1976) in 1975. Mr. Dickerson is of the opinion that during the last five years flow from the spring has noticeably increased.

The most reasonable estimate of the subsurface reservoir temperature from a combination of geothermometers is 35° to 52°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Steven and Ratte, 1973).

BIRDSIE WARM SPRING, MINERAL COUNTY

There are five springs that issue from the toe of the slope just north of the road. All the flow enters a culvert and flows out to the Rio Grande. The most reasonable estimate of the subsurface reservoir temperature from a combination of geothermometers is 35° to 52°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Steven and Ratte, 1973).

BRANDS RANCH ARTESIAN WELL, JACKSON COUNTY

The Brands Ranch Artesian Well was visited in May, 1993. There is no longer any physical evidence of the well mentioned in Barrett and Pearl, 1978. The spring bubbles up into a 15-ft diameter, 2.5-ft deep pool. There are no facilities in this somewhat remote area. The pool appears to get some occasional use from hunters, campers, fisherman and local people.

The collapsed well that makes the hot spring is the Horton 2 Brands well drilled in 1953 to a total depth of 1,075 ft. The lowest formation penetrated is the Morrison Formation. The hot waters probably come from the Dakota Sandstone. The most reasonable estimate of the subsurface reservoir temperature from a combination of geothermometers is 42° to 55°C (Hail, 1965; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

BROWNS CANYON WARM SPRINGS, CHAFFEE COUNTY

An attempt to visit this site was made in July, 1993. Several minor seeps were noted in the area described by Dick (1976) and Barrett and Pearl (1978); however, these seeps had a temperature less than 20°C (Scott et al., 1975; Barrett and Pearl, 1976; Dick, 1976; Barrett and Pearl, 1978).

CANON CITY HOT SPRINGS, FREMONT COUNTY

Canon City Hot Springs emerges from a corroded casing in the northeast corner of the front yard of a house that faces the nearby Arkansas River. Nothing remains of the "classy" thirty-eight room Royal Gorge Hotel and Spa built adjacent to the Spring in the 1870s. Fifteen years ago the current owner of the property filled in the swimming pool supplied by the spring.

Water from the spring is now used to irrigate some of the owner's and a neighbor's front yard landscape shrubs. When the spring was visited in June of 1993 the temperature of the spring was 40° C. The flow varied from 9 to 142 liters per minute (George et al., 1920; Taylor et al., 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

CEBOLLA HOT SPRINGS, GUNNISON COUNTY

The Cebolla Hot Springs near the village of Powderhorn was visited in May 1993. The cabins and bath houses appeared to be still in useable and working condition; however, there was no one around to give us any information about present day usage. There are still two bath houses (George et al., 1920; Hedlund and Olson, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

CEMENT CREEK WARM SPRINGS, GUNNISON COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60°C (Barrett and Pearl, 1978).

CLARK ARTESIAN WELL, PUEBLO COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 25° to 60°C (Barrett and Pearl, 1978).

COLONEL CHINN HOT WATER WELL, DELTA COUNTY

This well was visited in November, 1992. The well water is piped through a closed wellhead to a manifold and then to stock tanks about 200 ft away. An accurate indication of the temperature could not be obtained; however, the property owner indicated that the water flows all the year without freezing (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Hail, 1972).

CONUNDRUM HOT SPRINGS, PITKIN COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50°C (Barrett and Pearl, 1978)

COTTONWOOD HOT SPRINGS, CHAFFEE COUNTY

At the time of our visit in May 1993, the Jump Steady Resort was renamed to the Cottonwood Hot Springs Inn. The Inn has guest cabins and hot spring spas in a rustic environment. Hot water which is used for bathing, domestic heating, and drinking purposes comes from an enclosed cistern.

Another set of nearby springs and a well are used by the Merrifield family for a greenhouse complex, domestic heating and bathing, and drinking.

The Cottonwood Hot Springs is located at the contact of the Tertiary Mount Princeton Quartz Monzonite and Precambrian migmatitic gneisses to the south. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 100° to 110°C (George et al., 1920; Scott, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

CRAIG WARM WATER WELL, MOFFAT COUNTY

The Craig Warm Water Well is mislocated in Colorado Geological Survey Bulletin 39. The correct location is shown on Plate 1 and listed in Table 1 of this report. The Craig Warm Water Well was visited in November 1992. At that time the wellhead was in poor condition with hot water leaking from various places. There was no evidence of any activity or recent use of the well. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is approximately 100°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

CROWLEY RANCH RESERVE WELL, ARCHULETA COUNTY

The Crowley Ranch Reserve Well was drilled as an oil and gas test by the Phillips Oil Company in 1943. The well intersected the Dakota Formation at 240 ft, Morrison Formation at 520 ft, Todilto Limestone at 1,200 ft, Wingate Sandstone at 1,308 ft, Chinle Formation at 1,508 ft and Precambrian quartzite at 1,515 ft. The well is reported to have begin flowing hot water at 1,558 ft. The well was abandoned at 1,625 ft and deeded to the Crowley's for irrigation purposes.

There is no longer any physical evidence of the well. Water bubbles up into an 8 ft diameter, 5-ft deep pool. During a visit to the site by CGS personnel in June, 1993, all the water from the well was diverted to the east into an irrigation ditch. Three hundred feet from the well some of the water is taken from the ditch to fill a just constructed hot tub. The remainder of the water in the ditch is allowed to flow into the Jaw Bone Canyon.

From 1943 until 1992 the 48°C well water was used for pasture irrigation. Now, 534 acres of the Crowley family holdings around the well are in a developed recreational community called the Crowley Ranch Reserve. Property owners are given common ownership of a proportion of the Reserve's land. One of the amenities touted by the developers of the property is the geothermal hot tub referred to in the above paragraph.

DEGANAHL WARM WATER WELL, ROUTT COUNTY

The Deganahl warm water well was drilled as an oil test in Cretaceous rocks by Fullerton Leasing Company of California in October, 1967. Because the well encountered only warm water, the company turned the well over to the land owner, Mr. Deganahl. He completed the well at a total depth of 2,500 ft in January, 1968 as a warm water well. The original flow of the well was some 11,900 liters per minute at the time of drilling . Caving problems while installing the casing reduced the well flow to 4,800 liters per minute. The temperature of the water is 43°C and the well had a shut in pressure of 200 psi.

In 1981, the Colorado Division of Wildlife applied for a permit to drill a geothermal well at their Finger Rocks Trout Hatchery facility 3 mi east of the Deganahl well. The permit application was denied by the State Water Engineer. The analyses of the Deganahl well water included in Table 2 were performed as part of the Division of Wildlife's feasability study on the proposed project.

The Deganahl well was visited in May, 1993. The owners of the well make only occasional use of the well for bathing purposes. The hot water is flowing at approximately 1,500 liters per minute out of the wellhead and into Watson Creek. A second well is located at a bearing of S33E and a distance of 225 ft from the original well. The conductivity, pH, and temperature of the water from the second well are similar to the original well. There is no information on the depth or history of the second well. The flow rate of the second well is about 100 liters per minute.

The geothermal waters are accounted for by a normal geothermal gradient and probably issue from either the Dakota Sandstone or sandstones within the Frontier Formation. The well was spudded into the Mancos Shale (Kucera, 1962).

DESERT REEF (FLORENCE) HOT SPRINGS, FREMONT COUNTY

The Desert Reef Beach Club is a "Natural Outdoor Hot Springs". The facilities consist of a changing house and a 20 ft by 30 ft bathing pool fed by an old oil test well, the Conoco Huffman No. 1 well drilled in 1966. The well penetrated Precambrian granite at 3,948 ft and has a total depth of 4,240 ft. Later the well was plugged back to 1,096 ft and produces 54°C water at a permitted flow of 1,100 liters per minute from the Morrison and Dakota sandstones.

DEXTER WARM SPRINGS, CONEJOS COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 20° to 50°C (Barrett and Pearl, 1978).

DOTSERO WARM SPRINGS, EAGLE COUNTY

The Dotsero Warm Springs were visited in May, 1993. The springs and adjacent buildings described and pictured by Barrett and Pearl, 1978 on the northwest side of the Colorado River are no more. Construction activities on Interstate Highway 70 have destroyed the old buildings and the hot springs have been covered over by fill material for the new highway. There are some monitor wells in the area of the old springs at the river's edge; however, there was no sign of flow from these springs.

The springs on the south-east side of the river are still intact and flowing directly into the Colorado River at the base of a fill for the railroad tracks. The outflow quantity is impossible to measure; however, the waters were very saline to the taste. A sample of the water was taken for chemical analysis. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is approximately 100°C (George et al., 1920; Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

DUNTON HOT SPRINGS, DOLORES COUNTY

Dunton Hot Springs is near the old mining town of Dunton. There are several old cabins around the Dunton Hot Springs. In the past few years a private group has tried to run a primitive resort around the Hot Springs. Unfortunately, they are no longer in business and all the cabins, lodge, and bathhouse are falling into disrepair. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 50° to 70°C (Bush and Bromfield, 1966; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

DUTCH CROWLEY ARTESIAN WELL, ARCHULETA COUNTY

The Dutch Crowley Artesian well was visited during June of 1993. The site's 70°C water is flowing from the top of surface casing which extends about 2 ft above ground level.

The well was spudded as an oil and gas test in July 1951 by a J. R. Butler from Houston, Texas. The wildcat encountered two gas-and-water zones at approximately 800 and 1,200 ft in the Morrison Formation. The well intersected the Entrada Sandstone at 1,500 ft and flowed fresh water with a temperature of 48°C. The well was bottomed at 1,741 ft (Osterhoudt, 1978). The hole was deeded by the operator to the Crowleys for a water well.

Barrett and Pearl's narrative on how to get to the well in their 1978 CGS Bulletin 39 is not accurate. The correct instructions are to read; proceed 3.8 mi southeast from the Chromo Post Office on U.S. Highway 49 to where a dirt road leads east. Turn left on this road and drive about 1/8 of a mile. The well is about 3/4 of a mile due east of this parking spot on the south side of a boggy meadow.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 80°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Osterhoudt, 1978).

ELDORADO SPRINGS, BOULDER COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geotherm-ometers is 26° to 40°C (Barrett and Pearl, 1978).

EOFF ARTESIAN WELL, ARCHULETA COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 60°C (Barrett and Pearl, 1978).

FLORENCE ARTESIAN WELL, FREMONT COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 34° to 50°C (Barrett and Pearl, 1978).

FREMONT NATATORIUM WELL, FREMONT COUNTY

The 70 by 150 ft swimming pool supplied by the warm water well is now used only by the owners. The pool and concrete decking is in disrepair. The owner indicated that he and his wife closed the pool for public bathing 30 years ago because they could not afford to be in compliance with newly enacted public swimming pool water standards for chlorination. When this site was visited during June of 1993 the owner was using a portion of the warm well water to irrigate a sizeable vegetable and berry garden.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50°C (Barrett and Pearl, 1976; Scott, 1977; Barrett and Pearl, 1978).

GEYSER WARM SPRINGS, DOLORES COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 60° to 120°C (Barrett and Pearl, 1978).

GLENWOOD SPRINGS AREA, GARFIELD COUNTY

The Glenwood Springs area is the state's premier bathing spa area. There are several hot springs in the area around Glenwood Springs but only those on the north side of the Colorado River have been developed. No new analyses were taken from the Glenwood Springs area during this study. The Vapor Caves Spa donated a copy of a private laboratory report on the chemistry of their waters (George et al., 1920; Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

The chemistry of the geothermal waters in the Glenwood Springs area is too complex for an accurate estimate of subsurface reservoir temperatures. The subsurface temperature is, probably, not much higher than the surface temperature of the hot springs, approximately 45° to 50°C (Barrett and Pearl, 1978).

HARTSEL HOT SPRINGS, PARK COUNTY

The remains of the Hartsel Hot Springs were visited in May 1993. The bath house that is pictured in Barrett and Pearl, 1978 is no longer standing, though some flow from the hot springs is still coming out of a pipe from the building's foundation. All the facilities of the Hartsel Hot Springs are unused and in a state of decay and disrepair. The flow was difficult to measure but it appears to be greater than 300 liters per minute.

There is a popular opinion based upon rumor and general tourist literature that the geothermal water from the Hartsel Hot Springs is highly radioactive (Cahill, 1983). This opinion appears to based upon an article (Howland, 1936) which describes a barite occurrence in the Pennsylvanian-Permian Maroon Formation about 2 mi southwest of Hartsel Hot Springs. The author states that there is an unusual blue-colored barite at this locality and he conjectures that the blue coloration was caused by radiation damage. As further evidence for his thesis, Howland states without providing any data or analysis that the Hartsel Hot Springs are highly radioactive based upon analyses done by the Colorado Geological Survey (George et al., 1920). However, the mean of 60 hot springs analyzed in the 1920 CGS study is 0.139 picocuries radon per liter, ranging from a trace, 0.001, to 2.64 picocuries per liter. The value listed for the Hartsel Hot Springs is 0.154 picocuries radon per liter, only slightly above the mean.

A more recent study of the uranium concentration in natural waters of South Park (Sharp and Aamodt, 1976) indicates that the uranium concentration, as analyzed by fluorometric methods, in a filtered and acidified water sample from the Hartsel Hot Springs was 0.30 parts per billion (ppb) uranium. Two other analyses of the untreated sample were 0.98 and 0.10 ppb uranium. Samples from 16 springs in the South Platte drainage area within the South Park region which includes the Hartsel Hot Springs had values that ranged from 0.21 to 292 ppb uranium with an average of 22.6 ppb uranium. The average of 35 surface water samples in the same drainage area is 3.3 ppb uranium. The uranium concentration of 0.3 ppb at the Hartsel Hot Springs is well below the regional average of 22.6 ppb for the South Platte drainage in South Park.

It appears that the hot springs at Hartsel are associated with the South Park or Santa Maria Faults and/or the contact of the Morrison Formation and Precambrian crystalline rocks. Precambrian granites in the region around Hartsel are known to possess anomalously high geothermal gradients. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 55° to 85°C (George et al., 1920; Ettinger, 1964; Barrett and Pearl, 1976; Barrett and Pearl, 1978; McCarthy et al., 1982[b]).

HAYSTACK BUTTE WARM WATER WELL, BOULDER COUNTY

This well and surrounding area was visited in May, 1993. Warm water is still flowing from the wellhead into a 25-ft diameter pool which at the present time is used mostly by game birds as a watering and bathing pool. The pool is undeveloped and a significant amount of discarded machinery and other junk surround it. The temperature of the well has declined from 28°C in 1976 (Barrett and Pearl, 1976) to 20°C in May 1993. The source of the hot water is conjectural; however, the location of the well on the Haystack Mountain Anticline indicates that structures along the axis of the anticline probably helped in circulating waters through the underlying Pierre Shale to depths adequate enough for heating to the observed temperatures (Trimble, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

The estimate of the subsurface reservoir temperature made by Barrett and Pearl (1978) from a variety of geothermometers was 50°C. The surface temperature of the spring has declined almost 30% since 1978. It may be reasonable to expect a similar decline in the subsurface reservoir temperature estimate to approximately 35° to 40°C.

HOOPER AQUACULTURE WELL, ALAMOSA COUNTY

Access to the Hooper Aquaculture Well is south from Hooper on Colorado Highway 17 for 2.7 mi to the intersection with Nine Mile Lane. Turn left (east) on this road and proceed for 0.2 mi to the site.

The subject well was drilled as an irrigation well by E. F. Lambert in 1963. Total depth of the well was 2,063 ft. A 12 3/4 inch casing was run from surface to 922 ft and 9 3/8 inch casing was run from 922 to 2,063 ft. The well casing is perforated from 1,242 ft to total depth. The driller's log indicates the perforated section is an interbedded mixture of sand, gravel and brown clay. The well according to State of Colorado Division of Water Resources records initially flowed 8,955 liters per minute.

About ten years ago Mr. Erwin Young of Alamosa bought 80 acres of land comprising the north half of the northwest quarter of Section 22, T. 40 N., R. 10 E.. The Lambert (nee) Hooper Aquaculture well is located in the NW NW NW of this section was included in the purchase. After the purchase Mr. Young developed his acreage into a fish and alligator farm. The Hooper Aquaculture Well which now flows at about 2,600 liters per minute at a temperature between 30.2° to 31.3°C is about the perfect water temperature for the African perch or "Tilipia" that he is rearing at the site.

During our visit to the site in June of 1993, water leaking around the casing of the Hooper well was measured at 31.3°C. Currently, all the commercial fish growing ponds are out of doors. Mr. Young, however, is in the middle of a project to enclose a number of tanks inside a metal shed to increase production in winter months. He also is developing an additional Tilipia rearing unit near Alamosa whose ponds will be supplied from a couple of (unknown) geothermal wells of a temperature nearly matching the Hooper Well.

HOT SULPHUR SPRINGS, GRAND COUNTY

The Hot Sulphur Springs Resort is now only open during the summer and fall months. At the time of our visit in June 1993 the resort complex was for sale. The springs appear to be controlled by a north-south trending fault in the Dakota Formation and the Middle Park Formation.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 75° to 150°C (George et al., 1920; Izett, 1968; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

IDAHO HOT SPRINGS, CLEAR CREEK COUNTY

This site was not visited during this program. The chemistry of the geothermal waters in the Idaho Springs area is too complex for an accurate estimate of subsurface reservoir temperatures.

JUNIPER HOT SPRINGS, MOFFATT COUNTY

Juniper Hot Springs was visited in November, 1992. At that time the buildings and other facilities associated with the resort were run down and in a general state of disrepair. Hunters who were camped there informed me that the resort was closed in 1989, more or less permanently, by the elderly owner who lives in nearby Craig. The source springs are enclosed in a locked building. A one-inch pipe carries hot water from the building for a distance of about 8 ft and discharges into a pool. The sample for this study was taken at the discharge point.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 50° to 75°C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

LEMON HOT SPRINGS, SAN MIGUEL COUNTY

The Lemon Hot Springs consists of a 20-ft diameter pond at the mouth of an old adit. Several buildings having the appearance of private residences surround the pool and tunnel. The waters feeding the hot springs pool are draining from the tunnel. At the time of my visit in July 1993, the pool was choked with weeds and algae. The owners of the hot springs could not be contacted concerning the status of the pool and springs (George et al., 1920; Bush et al., 1959; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

MINERAL HOT SPRINGS, SAGUACHE COUNTY

An attempt to visit this site was made in June, 1993; however, we were denied access to the area. According to the guard at the site the owner is planning on developing the area and is very secretive about his plans. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 90°C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

MOUNT PRINCETON HOT SPRINGS, CHAFFEE COUNTY

Because of the presence of hot geothermal water, the area around Mount Princeton Hot Springs has been heavily developed since the turn of the century and has been the site of various resorts, hotels, homes, and youth camps. The springs around Mount Princeton are the hottest in the state. The Hortense Hot Spring which services the Silver Cliff Ranch, a Christian youth camp, has a temperature of 85°C. The water is used for bathing, domestic uses and drinking purposes. A resort, several residences, youth camps, and a greenhouse utilize the hot water from several springs and wells in the area. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 100° to 130°C.

The state Division of Wildlife has a trout rearing unit at the Chalk Cliffs hatchery some 2 mi east of the Mt. Princeton Hot Springs. This unit was purchased by the state in 1948 but has been in existence since the 1920s. The 18°C water in the Chalk Creek is used in the trout rearing unit to advantage. Growth times for rainbow trout from fingerlings to a stocking length of 10 inches are decreased from a normal 18 to 22 month period to 12 months because of the warm water (George et al., 1920; Scott et al., 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

MULLENVILLE WARM SPRING, PARK COUNTY

The area around this spring, also known as Rhodes Warm Spring in the earlier literature, has been developed as a subdivision called "Warm Springs Ranch". Below the springs the outflow has been channelized by a boulder and cobble drain. The warm water goes to some fishing ponds on the subdivision. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 25° to 35°C (Tweto, 1974; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

ORVIS HOT SPRINGS (RIDGEWAY), OURAY COUNTY

The Orvis Hot Springs resort utilizes geothermal water from a tufa mound just to the southeast of the resort buildings, from a well pit dug in 1991, and from springs which feed directly into a 35-ft diameter natural pool. The natural pool, used mostly for bathing in the 41°C water has a privacy fence and is surrounded with a wooden deck. The resort also has private rooms for bathing and massage and hydrotherapy sessions.

Part of the hot water from the tufa mound is being diverted to a greenhouse and aquaculture project about 1,000 ft to the south. The owner has ambitious plans to develop this project but at this writing, July 1993, it is still under construction (George et al., 1920; Luedke and Burbank, 1962; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

OURAY AREA, OURAY COUNTY

The City of Ouray has taken an active role in developing the geothermal resources of the immediate vicinity. In 1989, the City drilled two shallow wells, OX-2 and OX-6, in the City Park just to the south of the City Swimming Pool (Formerly known as the Radium Hot Springs Pool). These two wells are 90-ft deep and produce 48°C water which goes directly to the pool. At the time of my visit in July, 1993 one of the wells was temporarily shut-in. The pool still gets the bulk of its hot water via a pipeline from the Box Canyon Hot Springs.

Three motels in the City of Ouray are using geothermal waters from various sources for spas and space heating. The Twin Falls and Box Canyon motels are using geothermal waters from springs located at the motel sites, and the Manganese Mine at the mouth of Box Canyon, and from hot springs in Box Canyon. The Weisbaden Motel uses geothermal waters for its pool and space heating from a hot spring reservoir under the motel and from an underground Vapor Cave which has three natural hot springs issuing into it. The waste geothermal water from the Weisbaden Motel is used to heat the sidewalks and driveways of the City of Ouray municipal buildings about 200 ft down the hill.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 90°C (George et al., 1920; Luedke and Burbank, 1962; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

PAGOSA SPRINGS, ARCHULETA COUNTY

These springs were visited during June of 1993. The main spring, the Great Pagosa, situated a few hundred feet southwest of the Spring Inn is enclosed by a fence and posted with "No Trespassing" signs. The City of Pagosa Springs has recently built a viewing area on the east side of the spring which provides a good place to observe and photograph the spring. The city has placed four poster boards in the viewing area which describe the: (1) History of the Great Pagosa Hot Springs, (2) Geologic Requirements for a Hot Spring, (3) The Stratigraphic Section at Pagosa Springs, and (4) Distribution of the Pagosa Springs Geothermal Heating System. The poster boards are of good graphic quality and the historical and scientific information is accurate and well written for lay person understanding.

The Spring Inn is in the final phase of a major alteration of their pool area. When finished they will have a cluster of seven soaking pools of different sizes and water temperature ranging from about 35° to 45°C. Individual pools will be able to comfortably accommodate from 8 to 30 bathers.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 80° to 130°C (George et al., 1920; Hail, 1971; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

PARADISE HOT SPRING, DOLORES COUNTY

This hot spring is located 2.5 mi south of the Dunton Hot Springs along the West Dolores River. At the time of my visit in July 1993, the springs were not open to the public. The owner of the property uses the warm springs and bath house for his own purposes which is no change from the previous inventory in 1976 (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

PENNEY HOT SPRINGS, PITKIN COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 60° to 90°C (Barrett and Pearl, 1978).

PINKERTON HOT SPRINGS, LA PLATA COUNTY

The rerouting of the U.S. Highway 550 has destroyed two of the four hot springs that made up the Pinkerton Hot Springs. The two remaining springs, the Mound Spring and the Little Mound Spring, are located on the west side of the highway just a few feet from the pavement. The hot water from both springs is piped out to a drain along side of the highway and then to the natural drainage system. There has been some limonite-stained tufa build up at the site of the two remaining springs. The destruction of the two remaining springs has left the Colorado Timberline Academy (formerly the Golden Horseshoe Resort mentioned in Barrett and Pearl, 1978) without hot water for its pool.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 75° to 125°C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

PONCHA SPRINGS, CHAFFEE COUNTY

The Poncha Hot Springs were visited in May, 1993. The facilities around the springs are currently maintained by the City of Salida. Since 1938 most of the water from the springs is transported by pipeline to the municipal swimming pool in Salida. The inlet temperature at the pool is 47 to 50°C. Currently, the Boy Scouts of America use the facility in the summer months as a base camp. There is no longer any commercial usage of the facilities.

According to the caretaker at the site there are numerous springs which over the years have fallen into a state of disrepair. Currently, there are efforts to find and repair some of the old cisterns and pipelines in order to improve the quantity and temperature of the flow.

The Poncha Hot Springs area is marked by the presence of several fossil and a few active tufa mounds that are associated with the hot springs. There are significant aprons of travertine that occur downslope of the area of hot springs.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 115° to 145°C (George et al., 1920; Van Alstine, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

RAINBOW HOT SPRINGS, MINERAL COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50°C (Barrett and Pearl, 1978).

RANGER WARM SPRINGS, GUNNISON COUNTY

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60°C (Barrett and Pearl, 1978).

RICO, DOLORES COUNTY

Two of the four diamond drill holes noted by Barrett and Pearl, 1978 are still uncapped and flowing hot water. The Geyser Hot Water Well is flowing and bubbling with a slight geyser effect. It has built a substantial tufa mound, approximately 6-ft high, and an semi-circle shaped apron, approximately 25 ft in diameter, around the drill hole. Limonite staining is prominent in the tufa. The waters remain unused. The chemistry of the geothermal waters in the Rico area is too complex for an accurate estimate of subsurface reservoir temperatures (George et al., 1920; McKnight, 1974; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

ROUTT (STRAWBERRY) HOT SPRINGS, ROUTT COUNTY

The Strawberry Hot Springs is in the process of development as a commercial enterprise. Don Johnson of Steamboat Springs has owned the property since 1982. In the ten years since Johnson has owned the property he has deepened four of the pools and imported sand for the bottoms, built wooden decks and walkways, built four rustic cabins, and hired a gardener. At the time of my visit in November 1992, a massage house; a bath house with showers, toilets, and heat; and another cabin were under construction.

Recent geological mapping (Snyder, 1980) demonstrates that the Strawberry Hot Springs are hosted by an Proterozoic felsic gneiss and amphibolite. Younger granitic pegmatites are also found in the immediate area. A north-trending normal fault with an adjacent zone of pervasive epidote-chlorite alteration also occurs in the immediate area.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 125° to 175°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Snyder, 1980; Pearl et al., 1983).

SAND DUNES POOL HOT WATER WELL, SAGUACHE COUNTY

Hot water for the swimming pool comes from a 4,400-ft deep well located just to the south of the pool. The pool is no longer open to the public; however, it is in good shape and is used by the family living on the premises. An experimental project for growing catfish using the geothermal water has been abandoned for many years (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

SHAWS WARM SPRING, SAGUACHE COUNTY

The site was visited during June of 1993, however, access was not available. Sampling and measuring of water was achieved where the spring waters leave the swimming pool.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60°C (Barrett and Pearl, 1976; Lipman, 1976; Barrett and Pearl, 1978; Bond, 1981).

SOUTH CANYON HOT SPRINGS, GARFIELD COUNTY

These three undeveloped springs were visited in May, 1993. The hot springs have had several periods of usage and limited development followed by a closing of the primitive facilities by local governments. At the present time the hot springs are channeled into two pools dug into the dirt. There is obvious evidence of usage of the springs by bathers. The hot waters are associated with the Dakota Sandstone. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 130°C (Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

SPLASHLAND HOT WATER WELLS, ALAMOSA COUNTY

The Splashland Pool is served by two wells that are 40 ft apart and 2,800 ft deep just to the west of the pool. In the winter when the pool is closed, the flow of the wells is used for space heating and domestic hot water in the surrounding ranch buildings. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 100°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

STEAMBOAT SPRINGS AREA, ROUTT COUNTY

Although there are several springs in the vicinity of the town of Steamboat Springs, only the Heart Spring has been used as a commercial hot bathing spring. The other springs in this area, which include the famous Steamboat Spring, have temperatures which vary from 14° to 19°C, too low to be considered as a geothermal resource in this study.

The Heart Spring is currently used for bathing within the Steamboat Springs Health and Recreation Association facility, a modern well-appointed, health club which includes an olympic size lap pool, tennis courts, weight room and exercise areas. It is difficult to obtain an accurate temperature measurement at the spring outlet; however, the Heart Pool had an estimated temperature of 36.4°C at the time of my visit in November, 1992. According to the Office Manager, Linda Johnson, the flow rate varies from about 300 to 750 liters per minute. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 100° to 140°C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978; Snyder, 1980; McCarthy et al., 1982(a); Pearl et al., 1983).

STINKING SPRINGS, ARCHULETA COUNTY

Stinking Springs was visited in June of 1993. Warm water emerges in several places in a 1,500-ft stretch along the south bank of the Navajo River and north of the graded dirt road that parallels the river from Chromo to the springs and beyond. This area is very marshy and individual flows from points of emergence is very small.

The spring with the largest flow is south of the road. Barrett and Pearl (1976) sampled the water from this "main" Stinking Spring source in 1975 and found the temperature to be 27°C with a flow of 106 liters per minute. Our visit in 1993 found the temperature to be 25.4°C with a flow rate of 132 liters per minute.

The main spring bubbles up into a 20-ft diameter by 3-ft deep pool. This "soaking pool" seems to be a recent development or alteration to the spring. The spring is on property is owned by a newly (1992) formed recreational housing development called Crowley Ranch Reserve. It is assumed that they are responsible for the pool construction at this previously undeveloped and unused spring.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 60°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

SWISSVALE WARM SPRING, FREMONT COUNTY

This site was visited during June of 1993. Barrett and Pearl (1978) described the springs as being unused in 1978 and that is still the case. Sometime in the interim between the two site visits, a 25 ft x 15 ft x 4-ft deep soaking pool was dug about 50 ft from where Spring F issues at the surface. All the flow from this spring was diverted to the pool before running into the nearby Arkansas River. The pool is now filled with moss and algae. It would appear no one has used this pool for soaking recently. The spring is on private property and posted for no trespassing. No one currently resides on the property.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

TRIMBLE HOT SPRINGS, LA PLATA COUNTY

The Trimble Hot Springs lies within the well developed Trimble Hot Springs Resort complex. The actual springs now have only a meager flow of 8 to 12 liters per minute. The resort pools and spas are served by a well [mistakenly called the Tripp Hot Springs well in Barrett and Pearl (1978) and Barrett and Pearl (1976)] which is 150-ft deep and contains a submersible pump at 35 ft. The well is pumping at about 1,000 liters per minute. A new bath house complex was built in 1988. The grounds around the pools are well maintained. At the time of our visit in July, 1993 the resort had a good crowd.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 45° to 70°C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

TRIPP HOT SPRINGS, LA PLATA COUNTY

The Tripp Hot Spring was mistakenly located at a well site 200-ft north of the Trimble Hot Spring by Barrett and Pearl (1978). The actual Tripp Hot Spring is located about 3/4 mi north of Trimble, near the mouth of Tripp Gulch and consists of a small natural pool, 25 ft x 10 ft x 5 ft deep. It is in the backyard of a private residence and has not been used for many years. The water currently flows off the property into a culvert (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

VALLEY VIEW HOT SPRINGS, SAGUACHE COUNTY

This site was visited during June of 1993. The site characterization in Cahill (1983) essentially catches the ambiance of this site. The amenities are about as he described in 1982 with the added note that the shower and bathroom facilities are now completed and that the site now has telephone service. The springs serve five soaking pools and one swimming pool.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Cahill, 1983).

WAGON WHEEL GAP HOT SPRINGS, MINERAL COUNTY

Barrett and Pearl (1978) lists the location of the Wagon Wheel Gap Hot Springs as being in the SESE of Section 35, T. 41 N., R. 1 E.; Spar City 7.5 min. quadrangle map. In actuality, the Wagon Wheel Gap 4UR Hot Spring is in the NWNE of Section 2, T. 40 N., R. 1 E.; Lake Humphreys 7.5 min. quadrangle map. The Wagon Wheel Gap CFI Hot Spring is in the SWNE of Section 2, T. 40 N., R. 1 E.; Lake Humphreys 7.5 min. quadrangle map.

During a site visit on June of 1993, the 4UR Dude and Guest Ranch ownership was building a new deck and swimming pool north of the old bath house which will utilize waters from the 4UR Hot Springs.

The CFI Spring issues into an old bath tub that is by the spring which guests or employees of the ranch can fill with a bucket. The 65°C spring water must be mixed with the icy water from the adjacent Goose Creek to achieve the right temperature for a soak.

The chemistry of the geothermal waters in the Wagon Wheel Gap area is too complex for an accurate estimate of subsurface reservoir temperatures (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

WAUNITA HOT SPRINGS, GUNNISON COUNTY

The Waunita Hot Springs was visited in May 1993. The upper Waunita Hot Springs is a well-developed and appealing guest ranch. Waunita Hot Springs has been a popular tourist attraction since the turn of the century. The waters from the springs are used in the swimming pool for space heating the ranch and guest cabins, and for drinking purposes. The waters at

Waunita are among the hottest in the state with an immersed temperature of the spring "A" in the gazebo of 77°C. A sample of the water from the gazebo spring was taken for chemical analysis. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 140° to 150°C.

The lower Waunita Hot Springs are approximately a half mile from the upper Waunita Hot Springs. All the bath houses, gazebos, cisterns, and springs at the lower springs are unused and in a state of disrepair. There is only a foot path to the lower Waunita Hot Springs. The water temperature, apparent quality (conductivity), and flow are about the same as seen at the upper springs. The most reasonable estimate of the subsurface reservoir temperature of the lower Waunita Hot Springs is approximately 130°C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978; Zacharakis, 1981).

WELLSVILLE WARM SPRING, FREMONT COUNTY

This spring was visited during June of 1993. The concrete ponds supplied by the Wellsville Warm Spring were used for the raising of tropical fish starting some time around the middle 1960s. They are still in good condition and filled with warm spring water. However, the business was closed in 1987 because of the failing health of the owner who had run the fish farm for some 20 years.

The brother-in-law of the fish farmer now lives on the property. He indicated that the only use of the ponds supplied by the spring was for private bathing and swimming.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50°C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

SUMMARY

The 1992–1993 low-temperature geothermal assessment program added 10 new chemical analyses to the geochemical database of the state's geothermal waters. Other sources of geochemical data were reviewed and all good quality, that is less than 15% cation-anion balance error, geochemical analyses were entered into the long form geochemical database, Table 2. Certain areas with higher than 15% cation-anion balance were left in the database because they were the only analysis for an area or site. Usually the most significant errors in the cation-anion balance were found in the U.S. Geological Survey WATSTOR database and are due to a missing HCO_3 analysis.

Several corrections were made to locations and names of hot springs and wells described in the older literature. The Colorado Geological Survey Information Series 6 (1976) was updated during 1993 and the correct locations were entered into the revised publication and the database for this assessment. Corrections were also made to several location entries in the U.S. Geological Survey WATSTOR database.

A summary of the results of the 1992–1993 geothermal assessment and a comparison to the the 1976–1978 geothermal assessment are shown in the following table:

Table B. Summary of the results of the 1993 Low-Temperature Geothermal Assessment Program compared to the 1976–1978 goethermal assessment.

Item	1993 Assess.	1976–78 Assess.	% Change
Geothermal areas	93	56	+66
Geothermal sites	157	125	+26
Geochemical Analysis	382	236	+62
Sites of direct heat utilization	64	64	0
Sites of district heat use	20	?	
Sites of greenhouses, aquaculture	4	?	

RECOMMENDATIONS

The current assessment indicates that several areas in the state continue a long history of substantial utilization of their geothermal resources. The prime areas include Glenwood Springs, Idaho Springs, Steamboat Springs, Pagosa Springs, Mount Princeton, and Ouray. All of these areas, at the minimum, utilize the geothermal resources for swimming pools and spas. Some areas such as Ouray and Pagosa Springs utilize geothermal heat for space heating in municipal and other private buildings. There are other areas in the state that are collocated with or near population centers and are on the fringe of geothermal development. That is, they have had some development of their geothermal resources; however, there are indications that geological and geophysical studies may be used in a Second Phase geothermal assessment to increase the geothermal area and spur development in these areas. The geothermal areas that are candidates for a Second Phase are (not listed in any order of importance):

1) Trimble Hot Springs, La Plata County,
2) Orvis Hot Springs, Ouray County,
3) A large area southeast of Pagosa Springs along the Archuleta Antiform, Archuleta County,
4) Eastern San Luis Valley, Saguache and Alamosa Counties,
5) Rico and Dunton Hot Springs, Dolores County,
6) Cottonwood Hot Springs, Chaffee County.

Other areas that are geologically significant but far from a center of population are:

1) Deganahl well, Routt County,
2) Brands Ranch well, Jackson County,
3) Craig warm water well, Moffatt County,
4) Hartsel Hot Springs, Park County.

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APPENDIX

Table 1. Location of geothermal sources in Colorado.

ABBREVIATIONS: HS=Hot Spring; W=Well; Sec=Section; Qtr=Quarter; Twp=Township, Rge=Range, Merid=Meridian; Lat/LonD=Latitude/Longitude Degrees, M=Minutes, S=Seconds, Dec=Decimal Degrees; Utm=Universal Tranverse Mercator Coordinates; Rel=Reliability, 1=within 100 ft, 2=within 660 ft, 3=within 1,320 ft, 4=within 2,640 ft, 5=within 5,280 ft, 6=greater than 5,280 ft

DISCAIMER: Well and spring locations have been taken from many sources and not all locations have been field checked. There is no guarantee of the accuracy of any location.

ID	Site No.	Name	Type	Quadrangle	County	Sec, Qtr/Qtr	Twp, Rge	Merid.	Lat D	Lat M	Lat S	Lat Dec	Lon D	Lon M	Lon S	Lon Dec	X-Utm	Y-Utm	Rel
1	1	Antelope Warm Spring	HS	Workman Creek	Mineral	1, SWSE	40 N, 2 W	NMPM	37	44	36	37.7433	107	2	14	-107.0372	320502	4179086	1
2	1	Axial	W	Axial	Moffat	23, NESE	4 N, 93 W	6TH	40	18	1	40.3003	107	47	3	-107.7842	263367	4464596	2
3	1	Birdsie Warm Spring	HS	Workman Creek	Mineral	14, NWNE	40 N, 2 W	NMPM	37	43	42	37.7283	107	3	13	-107.0536	319021	4177454	3
4	1	Brands Ranch	W	Pitchpine Mountain	Jackson	31, SWSE	9 N, 81 W	6TH	40	42	16	40.7044	106	32	4	-106.5344	370371	4506869	1
5	1	Browns Canyon Warm Spring	HS	Nathrop	Chaffee	23, SESW	51 N, 8 E	NMPM	38	39	13	38.6536	106	3	11	-106.0531	408367	4278657	3
5	2	Browns Canyon (Chimney Hill)	W	Nathrop	Chaffee	28, SENE	51 N, 8 E	NMPM	38	38	40	38.6444	106	4	41	-106.0781	406180	4277665	2
5	3	Browns Grotto Warm Spring	HS	Nathrop	Chaffee	27, SWSW	51 N, 8 E	NMPM	38	38	13	38.6369	106	4	26	-106.0739	406533	4276829	3
6	1	Canon City Hot Springs	W	Royal Gorge	Fremont	31, SESW	18 S, 70 W	6TH	38	25	56	38.4322	105	15	41	-105.2614	477185	4253598	2
7	1	Carson #1 Well	W	Rules Hill	La Plata	36, NWSW	35 N, 8 W	NMPM	37	15	25	37.2569	107	41	57	-107.6992	260619	4126587	2
8	1	Cebolla "A", (Powderhorn)	HS	Powder Horn	Gunnison	4, NWNE	46 N, 2 W	NMPM	38	16	26	38.2739	107	5	54	-107.0983	316445	4238081	1
8	2	Cebolla "B", (Powderhorn)	HS	Powder Horn	Gunnison	4, NWNE	46 N, 2 W	NMPM	38	16	26	38.2739	107	5	54	-107.0983	316445	4238081	1
8	3	Cebolla "C", (Powderhorn)	HS	Powder Horn	Gunnison	4, NWNE	46 N, 2 W	NMPM	38	16	26	38.2739	107	5	54	-107.0983	316445	4238081	1
9	1	Cement Creek Warm Spring	HS	Cement Mountain	Gunnison	0, Unsurveyed	0, 0		38	50	6	38.8350	106	49	34	-106.8261	341498	4299843	1
10	1	Chinaman Canyon	HS	Madrid	Las Animas	30, NENW	32 S, 65 W	6TH	37	14	0	37.2333	104	43	0	-104.7167	525133	4120591	2
11	1	Clark Spring	W	Northeast Pueblo	Pueblo	1, NENE	21 S, 65 W	6TH	38	15	29	38.2581	104	36	35	-104.6097	534146	4234314	3
12	1	Cokedale	HS	Trinidad West	Las Animas	25, NESE	33 S, 65 W	6TH	37	8	23	37.1397	104	36	45	-104.6125	534416	4110239	1
13	1	Colonel Chinn	W	Hotchkiss	Delta	14, CNE	14 S, 92 W	6TH	38	50	22	38.8394	107	38	3	-107.6342	271365	4302049	3
14	1	Conundrum Hot Springs	HS	Maroon Bells	Pitkin	0, Unsurveyed	0, 0		39	0	43	39.0119	106	53	27	-106.8908	336287	4319594	1
15	1	Cottonwood Spring	HS	Good Point	Delta	20, NWSE	51 N, 13 W	NMPM	38	40	8	38.6689	108	20	38	-108.3439	209058	4285135	1
16	1	Cottonwood Hot Springs	HS	Buena Vista West	Chaffee	0, Unsurveyed	0, 0		38	48	46	38.8128	106	13	33	-106.2258	393570	4296507	2
16	2	Cottonwood (Jump Steady)	HS	Buena Vista West	Chaffee	0, Unsurveyed	0, 0		38	48	46	38.8128	106	13	21	-106.2225	393859	4296503	2
16	3	Cottonwood (Merrifield Well)	W	Buena Vista West	Chaffee	28, NENE	14 S, 79 W	6TH	38	48	35	38.8097	106	13	21	-106.2225	393854	4296164	2
17	1	Craig Warm Water Well	W	Castor Gulch	Moffat	9, SESE	6 N, 91 W	6TH	40	29	11	40.4864	107	36	3	-107.6008	279559	4484783	1
18	1	Crowley Ranch Reserve	W	Chromo	Archuleta	0, Unsurveyed	0, 0	NMPM	37	1	10	37.0194	106	48	10	-106.8028	339625	4098345	1
19	1	Dallas Creek	W	Ridgway	Ouray	7, SWNE	45 N, 8 W	NMPM	38	10	0	38.1667	107	47	0	-107.7833	256156	4227763	2
20	1	Deganahl (Yampa)	W	Yampa	Routt	18, SESE	2 N, 85 W	6TH	40	8	9	40.1358	106	57	43	-106.9619	332852	4444468	1
20	2	Deganahl-Watson Creek(Yampa)	W	Yampa	Routt	17, NWSW	2 N, 85 W	6TH	40	8	45	40.1458	106	57	20	-106.9556	333420	4445566	2
21	1	Desert Reef (Florence)	W	Florence SE	Fremont	30, SWNW	19 S, 68 W	6TH	38	22	9	38.3692	105	2	55	-105.0486	495754	4246571	1
22	1	Dexter Spring	W	Pikes Stockade	Conejos	8, NENE	35 N, 11 E	NMPM	37	17	41	37.2947	105	47	6	-105.7850	430422	4127652	1
23	1	Don K Ranch	W	Wetmore	Pueblo	5, NENE	22 S, 68 W	6TH	38	10	13	38.1703	105	0	48	-105.0133	498832	4224502	1
24	1	Dotsero	HS	Dotsero	Eagle	12, SWNW	5 S, 87 W	6TH	39	37	50	39.6306	107	6	5	-107.1014	319651	4388655	2
24	2	Dotsero South	HS	Dotsero	Eagle	12, SWSW	5 S, 87 W	6TH	39	37	31	39.6253	107	5	58	-107.0994	319804	4388065	4
25	1	Dry Creek Well	W	Bayfield	La Plata	28, SESE	34 N, 7 W	NMPM	37	9	24	37.1567	107	36	31	-107.6086	268346	4115235	2
26	1	Dunton	HS	Dolores Peak	Dolores	0, Unsurveyed	0, 0		37	46	17	37.7714	108	5	33	-108.0925	227606	4184751	4
27	1	Dutch Crowley	W	Monero	Archuleta	0, Unsurveyed	0, 0	NMPM	36	59	56	36.9989	106	46	19	-106.7719	342327	4096014	1
28	1	East Willow Creek	W	Bull Fork	Garfield	4, NWNW	5 S, 97 W	6TH	39	38	50	39.6472	108	17	22	-108.2894	217738	4393567	2
29	1	Eldorado Springs "A"	W	Eldorado	Boulder	0, Unsurveyed	0, 0		39	55	56	39.9322	105	16	47	-105.2797	476099	4420062	2
29	2	Eldorado Springs "B"	HS	Eldorado	Boulder	0, Unsurveyed	0, 0		39	55	56	39.9322	105	16	47	-105.2797	476099	4420062	2
30	1	Eoff	W	Serviceberry Mountain	Archuleta	7, SESW	34 N, 1 W	NMPM	37	11	28	37.1911	106	59	43	-106.9953	322899	4117734	1
31	1	Florence	W	Florence	Fremont	7, NENW	19 S, 68 W	6TH	38	24	53	38.4147	105	2	43	-105.0453	496047	4251625	2

Table 1. continued.

ID	Site No.	Name	Type	Quadrangle	County	Sec, Qtr/Qtr	Twp, Rge	Merid.	Lat D	Lat M	Lat S	Lat Dec	Lon D	Lon M	Lon S	Lon Dec	X-Utm	Y-Utm	Rel
32	1	Fremont Natatorium	W	Canon	Fremont	26, NWNW	18 S, 70 W	6TH	38	27	37	38.4603	105	11	45	-105.1958	482914	4256698	2
33	1	Geyser	HS	Rico	Dolores	0, Unsurveyed	0, 0		37	44	48	37.7467	108	7	1	-108.1169	225361	4182079	3
34	1	Glenwood Springs (Big Spring)	HS	Glenwood Springs	Garfield	9, SENE	6 S, 89 W	6TH	39	32	58	39.5494	107	19	18	-107.3217	300511	4380117	2
34	2	Glenwood Springs (Drinking Spring)	HS	Glenwood Springs	Garfield	9, SENE	6 S, 89 W	6TH	39	32	58	39.5494	107	19	18	-107.3217	300511	4380117	2
34	3	Glenwood Springs (Vapor Cave)	HS	Glenwood Springs	Garfield	9, SENE	6 S, 89 W	6TH	39	33	3	39.5508	107	19	11	-107.3197	300683	4380267	2
34	4	Glenwood Springs (Graves Springs)	HS	Glenwood Springs	Garfield	9, NWNW	6 S, 89 W	6TH	39	33	18	39.5550	107	20	7	-107.3353	299357	4380764	3
34	5	Glenwood Springs (Spring A)	HS	Glenwood Springs	Garfield	10, SWNW	6 S, 89 W	6TH	39	32	58	39.5494	107	19	10	-107.3194	300703	4380112	2
34	6	Glenwood Springs (Spring B)	HS	Glenwood Springs	Garfield	10, SWNW	6 S, 89 W	6TH	39	33	2	39.5506	107	19	4	-107.3178	300849	4380232	2
34	7	Glenwood Springs (Spring C)	HS	Glenwood Springs	Garfield	10, SWNW	6 S, 89 W	6TH	39	33	4	39.5511	107	19	0	-107.3167	300945	4380291	2
34	8	Glenwood Springs (Railroad Spring)	HS	Glenwood Springs	Garfield	10, NENW	6 S, 89 W	6TH	39	33	16	39.5544	107	18	51	-107.3142	301170	4380655	4
35	1	Grassy Creek (Hayden)	W	Mount Harris	Routt	27, SWSE	6 N, 87 W	6TH	40	26	33	40.4425	107	8	1	-107.1336	319045	4478848	2
36	1	Hartsel (Spring A)	HS	Hartsel	Park	8, NESE	12 S, 75 W	6TH	39	1	5	39.0181	105	47	40	-105.7944	431223	4318873	1
36	2	Hartsel (Spring B)	HS	Hartsel	Park	8, NESE	12 S, 75 W	6TH	39	1	5	39.0181	105	47	40	-105.7944	431223	4318873	1
37	1	Haystack Butte	W	Niwot	Boulder	33, NENW	2 N, 70 W	6TH	40	6	1	40.1003	105	14	20	-105.2389	479638	4438705	3
38	1	Hooper Aquaculture Well	W	Hooper East	Alamosa	22, NWNW	40 N, 10 E	NMPM	37	42	22	37.7061	105	52	20	-105.8722	423114	4173361	1
39	1	Horse Mountain Spring	HS	Battle Rock	Montezuma	24, SWSW	35 N, 18 W	NMPM	37	16	10	37.2694	108	47	22	-108.7894	163950	4131294	2
40	1	Hot Sulphur Springs (Spring A)	HS	Hot Sulphur Springs	Grand	3, SWSE	1 N, 78 W	6TH	40	4	29	40.0747	106	6	41	-106.1114	405232	4436432	2
40	2	Hot Sulphur Springs (Spring B)	HS	Hot Sulphur Springs	Grand	3, SWSE	1 N, 78 W	6TH	40	4	29	40.0747	106	6	41	-106.1114	405232	4436432	2
40	3	Hot Sulphur Springs (Spring C)	HS	Hot Sulphur Springs	Grand	3, SWSE	1 N, 78 W	6TH	40	4	29	40.0747	106	6	40	-106.1111	405256	4436432	2
40	4	Hot Sulphur Springs (Spring D)	HS	Hot Sulphur Springs	Grand	3, SWSE	1 N, 78 W	6TH	40	4	28	40.0744	106	6	40	-106.1111	405256	4436401	3
41	1	Idaho Springs (Spring A)	HS	Idaho Springs	Clear Creek	1, NENW	4 S, 73 W	6TH	39	44	20	39.7389	105	30	43	-105.5119	456134	4398693	2
41	2	Idaho Springs (Spring B)	HS	Idaho Springs	Clear Creek	0, Unsurveyed	0, 0		39	44	21	39.7392	105	30	43	-105.5119	456134	4398724	2
41	3	Idaho Springs (Spring C)	HS	Idaho Springs	Clear Creek	1, NENW	4 S, 73 W	6TH	39	44	19	39.7386	105	30	44	-105.5122	456110	4398662	2
41	4	Idaho Springs (Lodge Well)	W	Idaho Springs	Clear Creek	0, Unsurveyed	0, 0	6TH	39	44	22	39.7394	105	30	43	-105.5119	456134	4398754	2
42	1	Jacks Mine	HS	Madrid	Las Animas	6, SESW	33 S, 65 W	6TH	37	11	40	37.1944	104	42	52	-104.7144	525344	4116277	2
43	1	Juniper Hot Springs	HS	Juniper Hot Springs	Moffat	16, NESW	6 N, 94 W		40	28	1	40.4669	107	57	10	-107.9528	249653	4483563	1
44	1	Lake City Airstrip	W	Lake City	Hinsdale	11, SWSW	44 N, 4 W	6TH	38	4	35	38.0764	107	17	50	-107.2972	298502	4216577	2
45	1	Lake San Cristobal	W	Lake San Cristobal	Hinsdale	15, NESW	43 N, 4 W	6TH	37	59	0	37.9833	107	17	40	-107.2944	298491	4206244	2
46	1	Lemon	HS	Placerville	San Miguel	34, SESE	44 N, 11 W	NMPM	38	0	55	38.0153	108	3	11	-108.0531	231968	4211705	2
47	1	Lost Creek (Bennett)	W	Bennett	Adams	25, SESE	2 S, 64 W	6TH	39	50	25	39.8403	104	29	21	-104.4892	543707	4409945	2
48	1	Marigold	W	Cripple Creek South	Teller	10, SWSW	16 S, 70 W	6TH	38	39	47	38.6631	105	13	7	-105.2186	480980	4279203	2
49	1	Maurer Ranch	W	Sugar City	Crowley	14, SWNE	22 S, 56 W	6TH	38	8	8	38.1356	103	38	41	-103.6447	618776	4221517	2
50	1	McIntire Warm Spring	HS	Pikes Stockade	Conejos	18, NWNW	35 N, 11 E	NMPM	37	16	50	37.2806	105	49	6	-105.8183	427454	4126107	1
51	1	MGP Well	W	Weston	Las Animas	32, NWNW	33 S, 66 W	6TH	37	8	1	37.1336	104	48	31	-104.8086	517000	4109508	1
52	1	Mineral Hot Springs (Spring A)	W	Villa Grove	Saguache	7, SWNW	45 N, 10 E	NMPM	38	10	8	38.1689	105	55	5	-105.9181	419579	4224746	3
52	2	Mineral Hot Springs (Spring B)	HS	Villa Grove	Saguache	7, SWNW	45 N, 10 E	NMPM	38	10	8	38.1689	105	55	6	-105.9183	419556	4224746	3
52	3	Mineral Hot Springs (Spring C)	HS	Villa Grove	Saguache	12, SENE	45 N, 9 E	NMPM	38	10	6	38.1683	105	55	11	-105.9197	419433	4224685	3
52	4	Mineral Hot Springs (Spring D)	HS	Villa Grove	Saguache	12, SENE	45 N, 9 E	NMPM	38	10	4	38.1678	105	55	20	-105.9222	419214	4224627	3
53	1	Moffat	W	Moffat South	Saguache	8, NWSW	43 N, 10 E	6TH	37	59	2	37.9839	105	54	5	-105.9014	420840	4204205	2
54	1	Mosca West	W	Hooper West	Alamosa	6, NWNW	39 N, 10 W	6TH	37	39	41	37.6614	105	55	38	-105.9272	418217	4168446	2
55	1	Mt. Princeton Hot Springs (Spring A)	HS	Mount Antero	Chaffee	19, SWNW	15 S, 78 W	6TH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
55	2	Mt. Princeton Hot Springs (Spring B)	HS	Mount Antero	Chaffee	19, SWNW	15 S, 78 W	6TH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
55	3	Mt. Princeton Hot Springs (Spring D)	HS	Mount Antero	Chaffee	19, SWNW	15 S, 78 W	6TH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
55	4	Mt. Princeton Hot Springs (Spring E)	HS	Mount Antero	Chaffee	19, SWNW	15 S, 78 W	6TH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2
55	5	Mt. Princeton Hot Springs (Spring F)	HS	Mount Antero	Chaffee	19, SWNW	15 S, 78 W	6TH	38	43	58	38.7328	106	9	41	-106.1614	399052	4287556	2

Table 1. continued.

ID	Site No.	Name	Type	Quadrangle	County	Sec, Qtr/Qtr	Twp, Rge	Merid.	Lat D	Lat M	Lat S	Lat Dec	Lon D	Lon M	Lon S	Lon Dec	X-Utm	Y-Utm	Rel
55	6	Mt. Princeton Hot Springs (Hortense)	HS	Mount Antero	Chaffee	24, SENW	15 S, 79 W	6TH	38	43	57	38.7325	106	10	30	-106.1750	397869	4287540	1
55	7	Mt. Princeton Hot Springs (Hortense Well)	W	Mount Antero	Chaffee	24, SENW	15 S, 79 W	6TH	38	43	58	38.7328	106	10	27	-106.1742	397941	4287571	3
55	8	Mt. Princeton Hot Springs (Woolmington Well)	W	Mount Antero	Chaffee	24, SESW	15 S, 79 W	6TH	38	43	24	38.7233	106	10	38	-106.1772	397663	4286525	3
55	9	Mt. Princeton Hot Springs (Wright Well, east)	W	Mount Antero	Chaffee	24, SENE	15 S, 79 W	6TH	38	43	56	38.7322	106	9	58	-106.1661	398641	4287500	3
55	10	Mt. Princeton Hot Springs (Wright Well, west)	W	Mount Antero	Chaffee	24, SENW	15 S, 79 W	6TH	38	43	56	38.7322	106	10	30	-106.1750	397868	4287509	3
55	11	Mt. Princeton Hot Springs (Young Life Well)	W	Mount Antero	Chaffee	24, SENW	15 S, 79 W	6TH	38	43	56	38.7322	106	10	32	-106.1756	397820	4287510	3
56	1	Mullenville (Rhodes) Warm Spings	HS	Fairplay West	Park	24, NWSW	10 S, 78 W	6TH	39	9	49	39.1636	106	3	58	-106.0661	407893	4335266	1
57	1	Orchard Mesa (Grand Junction)	W	Grand Junction	Mesa	19, SWSE	1 S, 1 E	UTE	39	2	55	39.0486	108	31	12	-108.5200	195358	4327862	2
58	1	Orvis Hot Spring	HS	Dallas	Ouray	22, CSW	45 N, 8 W	NMPM	38	8	0	38.1333	107	44	2	-107.7339	260379	4223934	1
59	1	Ouray (Wiesbaden & Motel Spring A)	HS	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	16	38.0211	107	40	3	-107.6675	265841	4211310	2
59	2	Ouray (Wiesbaden & Motel Spring B)	HS	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	16	38.0211	107	40	3	-107.6675	265841	4211310	2
59	3	Ouray (Wiesbaden & Motel Spring C)	HS	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	16	38.0211	107	40	3	-107.6675	265841	4211310	2
59	4	Ouray (Pool or Box Canyon Spring)	HS	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	6	38.0183	107	40	41	-107.6781	264905	4211028	3
59	5	Ouray (Fellin Spring)	HS	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	22	38.0228	107	39	57	-107.6658	265993	4211491	1
59	6	Ouray (Vinegar Hill Spring)	HS	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	14	38.0206	107	40	4	-107.6678	265815	4211250	1
59	7	Ouray (Manganese Mine)	HS	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	9	38.0192	107	40	31	-107.6753	265152	4211115	1
59	8	Ouray (Uncompahgre Spring)	HS	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	25	38.0236	107	40	27	-107.6742	265264	4211605	4
59	9	Ouray City Park OX-2	W	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	40	38.0278	107	40	15	-107.6708	265570	4212059	1
59	10	Ouray City Park OX-6	W	Ouray	Ouray	0, Unsurveyed	0, 0		38	1	43	38.0286	107	40	15	-107.6708	265573	4212151	1
60	1	Oxford Well	W	Gem Village	La Plata	26, NESE	34 N, 8 W	NMPM	37	9	33	37.1592	107	40	41	-107.6781	262185	4115685	2
61	1	Pagosa Springs (Big Spring)	HS	PagosaSprings	Archuleta	13, SESW	35 N, 2 W	NMPM	37	15	52	37.2644	107	0	37	-107.0103	321740	4125898	1
61	2	Pagosa Springs (Courthouse well)	W	Pagosa Springs	Archuleta	13, SWNE	35 N, 2 W	NMPM	37	15	58	37.2661	107	0	38	-107.0106	321719	4126084	3
61	3	Pagosa Springs (Spa Motel well)	W	Pagosa Springs	Archuleta	13, NWSE	35 N, 2 W	NMPM	37	15	55	37.2653	107	0	35	-107.0097	321792	4125991	4
62	1	Papeton well (Colorado Springs)	W	Pikeview	El Paso	32, NENE	13 S, 66 W	6TH	38	52	44	38.8789	104	47	46	-104.7961	517686	4303149	2
63	1	Paradise Hot Spring	W	Groundhog Mountain	Dolores	0, Unsurveyed	0, 0		37	45	15	37.7542	108	7	54	-108.1317	224091	4182955	1
64	1	Penny Hot Springs	W	Redstone	Pitkin	4, NENW	10 S, 88 W	6TH	39	13	33	39.2258	107	13	29	-107.2247	307957	4343988	1
64	1	Penny Hot Springs (Granges Spring)	W	Redstone	Pitkin	33, SESW	9 S, 88 W	6TH	39	13	50	39.2306	107	13	34	-107.2261	307850	4344516	2
65	1	Pinkerton (Spring A)	HS	Hermosa	La Plata	25, SWNE	37 N, 9 W	NMPM	37	26	50	37.4472	107	48	17	-107.8047	251884	4147976	3
65	2	Pinkerton (Spring B)	HS	Hermosa	La Plata	25, NWNE	37 N, 9 W	NMPM	37	26	54	37.4483	107	48	18	-107.8050	251863	4148100	4
65	3	Pinkerton (Mound Spring)	HS	Hermosa	La Plata	25, NWNE	37 N, 9 W	NMPM	37	27	7	37.4519	107	48	20	-107.8056	251825	4148502	3
65	4	Pinkerton (Little Mound Spring)	HS	Hermosa	La Plata	25, NWNE	37 N, 9 W	NMPM	37	27	9	37.4525	107	48	21	-107.8058	251803	4148565	3
66	1	Poncha Springs (Spring A)	HS	Poncha Pass	Chaffee	15, NWSW	38 N, 8 E	NMPM	38	29	49	38.4969	106	4	37	-106.0769	406086	4261297	1
66	2	Poncha Springs (Spring B)	HS	Poncha Pass	Chaffee	15, NWSW	38 N, 8 E	NMPM	38	29	49	38.4969	106	4	37	-106.0769	406086	4261297	1
66	3	Poncha Springs (Spring C)	HS	Poncha Pass	Chaffee	15, NWSW	38 N, 8 E	NMPM	38	29	53	38.4981	106	4	34	-106.0761	406159	4261420	2
66	4	Poncha Springs (Spring D)	HS	Poncha Pass	Chaffee	15, NWSW	38 N, 8 E	NMPM	38	29	53	38.4981	106	4	34	-106.0761	406159	4261420	2
66	5	Poncha Springs (Spring E)	HS	Poncha Pass	Chaffee	15, NWSW	38 N, 8 E	NMPM	38	29	53	38.4981	106	4	34	-106.0761	406159	4261420	2
67	1	Rainbow	HS	South River Peak	Mineral	0, Unsurveyed	0, 0		37	30	33	37.5092	106	52	28	-106.8744	334327	4152805	1
68	1	Ranger	HS	Cement Mountain	Gunnison	22, SWSE	14 S, 85 W	6TH	38	48	47	38.8131	106	52	28	-106.8744	337252	4297493	1
69	1	Rico (Diamond drill hole)	W	Rico	Dolores	0, Unsurveyed	0, 0		37	42	5	37.7014	108	1	45	-108.0292	232934	4176799	3
69	2	Rico (Big Geyser Warm Spring)	W	Rico	Dolores	0, Unsurveyed	0, 0		37	42	0	37.7000	108	1	44	-108.0289	232954	4176644	3
69	3	Rico (Geyser Warm Spring)	W	Rico	Dolores	0, Unsurveyed	0, 0		37	42	2	37.7006	108	1	44	-108.0289	232956	4176706	3

Table 1. continued.

ID	Site No.	Name	Type	Quadrangle	County	Sec, Qtr/Qtr	Twp, Rge	Merid.	Lat D	Lat M	Lat S	Lat Dec	Lon D	Lon M	Lon S	Lon Dec	X-Utm	Y-Utm	Rel
69	4	Rico (Little Spring)	W	Rico	Dolores	0, Unsurveyed	0, 0		37	42	4	37.7011	108	1	44	-108.0289	232958	4176767	3
70	1	Roatcap Creek	W	Gray Reservoir	Delta	15, NESE	13 S, 92 W	6TH	38	55	7	38.9186	107	38	57	-107.6492	270318	4310874	2
70	2	Roatcap Creek (Stevens Gulch)	W	Gray Reservoir	Delta	14, NENE	13 S, 92 W	6TH	38	55	39	38.9275	107	37	50	-107.6306	271960	4311814	2
71	1	Routt [aka Strawberry] (Spring A)	HS	Rocky Peak	Routt	18, SWSE	7 N, 84 W	6TH	40	33	34	40.5594	106	51	0	-106.8500	343372	4491286	1
71	2	Routt [aka Strawberry] (Spring B)	HS	Rocky Peak	Routt	18, SWSE	7 N, 84 W	6TH	40	33	34	40.5594	106	51	0	-106.8500	343372	4491286	1
71	3	Routt [aka Strawberry] (Spring C)	HS	Rocky Peak	Routt	18, SWSE	7 N, 84 W	6TH	40	33	34	40.5594	106	51	0	-106.8500	343372	4491286	1
71	4	Routt [aka Strawberry] (Spring D)	HS	Rocky Peak	Routt	18, SWSE	7 N, 84 W	6TH	40	33	34	40.5594	106	51	0	-106.8500	343372	4491286	1
72	1	Sand Dune Pool	W	Deadman Camp	Saguache	27, NENE	41 N, 10 E	NMPM	37	46	42	37.7783	105	51	20	-105.8556	424656	4181360	1
73	1	Sarcillo Canyon Well	W	Weston	Las Animas	21, NWNE	33 S, 66 W	NMPM	37	9	40	37.1611	104	46	56	-104.7822	519337	4112564	2
74	1	Shaws	HS	TwinMountain SE	Saguache	33, SESE	41 N, 6 E	NMPM	37	45	1	37.7503	106	19	1	-106.3169	383980	4178720	1
75	1	Smith Canyon Spring	HS	Weston	Las Animas	14, SENW	33 S, 66 W	6TH	37	10	20	37.1722	104	45	7	-104.7519	522022	4113803	2
76	1	South Canyon Hot Springs (Spring A)	HS	Storm King Mountain	Garfield	2, SESW	6 S, 90 W	6TH	39	33	11	39.5531	107	24	40	-107.4111	292836	4380721	3
76	2	South Canyon Hot Springs (Spring B)	HS	Storm King Mountain	Garfield	2, SESW	6 S, 90 W	6TH	39	33	11	39.5531	107	24	40	-107.4111	292836	4380721	3
77	1	Splashland	W	Alamosa East	Alamosa	34, SESE	38 N, 10 E	NMPM	37	29	19	37.4886	105	51	31	-105.8586	424093	4149219	3
78	1	Steamboat Springs (Heart Spring)	HS	Steamboat Springs	Routt	17, SENE	6 N, 84 W	6TH	40	28	58	40.4828	106	49	37	-106.8269	345149	4482735	1
78	2	Steamboat Springs (Sulphur Cave Spring)	HS	Steamboat Springs	Routt	17, NWNW	6 N, 84 W	6TH	40	29	3	40.4842	106	50	22	-106.8394	344092	4482912	1
78	3	Steamboat Springs (Steamboat Spring)	HS	Steamboat Springs	Routt	8, SWSW	6 N, 84 W	6TH	40	29	20	40.4889	106	50	26	-106.8406	344008	4483438	1
79	1	Stinking Springs	HS	Chromo	Archuleta	0, Unsurveyed	0, 0		37	2	6	37.0350	106	48	28	-106.8078	339213	4100080	1
80	1	Swissvale (Spring A)	HS	Wellsville	Fremont	20, SESW	49 N, 10 E	NMPM	38	28	50	38.4806	105	53	26	-105.8906	422322	4259305	2
80	2	Swissvale (Spring F)	HS	Wellsville	Fremont	20, SESW	49 N, 10 E	NMPM	38	28	50	38.4806	105	53	26	-105.8906	422322	4259305	2
81	1	Sylvester Gulch Warm Spring	HS	Somerset	Gunnison	15, SESE	13 S, 90 W	6TH	38	54	48	38.9133	107	26	22	-107.4394	288488	4309780	2
82	1	Texas Camp (Rangely)	W	Rangely	Rio Blanco	32, NWNW	2 N, 102 W	6TH	40	6	14	40.1039	108	52	27	-108.8742	169752	4446276	2
83	1	Trimble Hot Springs	HS	Hermosa	La Plata	15, NWNW	36 N, 9 W	NMPM	37	23	27	37.3908	107	50	52	-107.8478	247885	4141832	3
84	1	Tripp	HS	Hermosa	La Plata	10, SWNW	36 N, 9 W	NMPM	37	24	10	37.4028	107	50	44	-107.8456	248121	4143152	3
85	1	Towaoc Spring	HS	Towaoc	Montezuma	18, SESE	33.5 N, 17 W	NMPM	37	11	7	37.1853	108	43	38	-108.7272	169102	4121733	2
86	1	Two Mile Road	W	Hooper SE	Alamosa	11, SWSE	38 N, 10 E	6TH	37	32	47	37.5464	105	50	53	-105.8481	425084	4155621	2
87	1	Uravan Well	W	Uravan	Montrose	34, NWNW	48 N, 17 W	NMPM	38	22	29	38.3747	108	44	21	-108.7392	173327	4253809	2
88	1	Valley View (Orient) Hot Springs (Spring A)	HS	Valley View Hot Springs	Saguache	36, NWSE	46 N, 10 E	NMPM	38	11	32	38.1922	105	48	49	-105.8136	428752	4227249	1
88	2	Valley View (Orient) Hot Springs (Spring B)	HS	Valley View Hot Springs	Saguache	36, NWSE	46 N, 10 E	NMPM	38	11	31	38.1919	105	48	50	-105.8139	428727	4227218	1
88	3	Valley View (Orient) Hot Springs (Spring D)	HS	Valley View Hot Springs	Saguache	36, NWSE	46 N, 10 E	NMPM	38	11	28	38.1911	105	48	33	-105.8092	429140	4227123	3
89	1	Wagon Wheel Gap (4UR Ranch Spring)	HS	Lake Humphreys	Mineral	2, NWNE	40 N, 1 E	NMPM	37	44	55	37.7486	106	49	52	-106.8311	338675	4179297	4
89	2	Wagon Wheel Gap (CFI Spring)	HS	Lake Humphreys	Mineral	2, NWNE	40 N, 1 E	NMPM	37	44	54	37.7483	106	49	50	-106.8306	338723	4179265	4
90	1	Waunita Hot Springs (Spring C)	HS	Pitkin	Gunnison	11, SWSW	49 N, 4 E	NMPM	38	30	50	38.5139	106	30	27	-106.5075	368568	4263705	2
90	2	Waunita Hot Springs (Spring D)	HS	Pitkin	Gunnison	11, SWSW	49 N, 4 E	NMPM	38	30	50	38.5139	106	30	27	-106.5075	368568	4263705	2
90	3	Waunita Hot Springs (Spring A)	HS	Pitkin	Gunnison	11, SWSW	49 N, 4 E	NMPM	38	30	50	38.5139	106	30	27	-106.5075	368568	4263705	2
90	4	Waunita Hot Springs (Spring B)	HS	Pitkin	Gunnison	11, SWSW	49 N, 4 E	NMPM	38	30	50	38.5139	106	30	27	-106.5075	368568	4263705	2
91	1	Lower Waunita Hot Springs (Spring A)	HS	Pitkin	Gunnison	10, SWSE	49 N, 4 E	NMPM	38	30	57	38.5158	106	30	56	-106.5156	367869	4263932	3
91	2	Lower Waunita Hot Springs (Spring C)	HS	Pitkin	Gunnison	10, SWSE	49 N, 4 E	NMPM	38	30	57	38.5158	106	30	58	-106.5161	367821	4263932	3
91	3	Lower Waunita Hot Springs (Spring B)	HS	Pitkin	Gunnison	10, SWSE	49 N, 4 E	NMPM	38	30	57	38.5158	106	30	56	-106.5156	367869	4263932	3

Table 1. continued.

ID	Site No.	Name	Type	Quadrangle	County	Sec, Qtr/Qtr	Twp, Rge	Merid.	Lat D	Lat M	Lat S	Lat Dec	Lon D	Lon M	Lon S	Lon Dec	X-Utm	Y-Utm	Rel
91	4	Lower Waunita Hot Springs (Spring D)	HS	Pitkin	Gunnison	10, SWSE	49 N, 4 E	NMPM	38	30	59	38.5164	106	31	0	-106.5167	367773	4263995	3
92	1	Wellsville	HS	Wellsville	Fremont	18, SWNW	49 N, 10 E	NMPM	38	29	10	38.4861	105	54	45	-105.9125	420414	4259940	1
93	1	Wet Canyon	HS	Vigil	Las Animas	28, NWNE	32 S, 67 W	6TH	37	14	5	37.2347	104	53	31	-104.8919	509585	4120713	2

Table 3: Geochemical analysis of geothermal sources in Colorado (short list) (milligrams/liter).

ABBREVIATIONS: HS= Hot Spring; W= Well; ND= Not Detected; Brackets ([ ]) in the TDS column indicate Conductivity measurements; Conductivity is a good regional indicator of TDS

DISCLAIMER: Geochemical analyses come from a variety of sources of variable quality. There is no guarantee of the accuracy of any analysis. Engineering decisions should be based upon complete new analyses.

ID	Site	Name	Type	pH	TDS	Na	K	Ca	Mg	Fe	SiO_2	B	Li	HCO_3	SO_4	Cl	F	Cation-Anion Balance, %
1	1	Antelope Warm Spring	HS		151	44.0	0.1	4.0	0.3	0.02	41		0.01	110	2	3	2.0	5.1
2	1	Axial	W	7.1	1,250	71.0	14.0	140.0	140.0	0.11	18			630	530	17	0.6	0.4
3	1	Birdsie Warm Spring	HS	9.2	[209]													
4	1	Brands Ranch	W	6.4	[465]													
5	1	Browns Canyon Warm Spring	HS	8.0	[775]	170.0	2.4	9.0			28							
5	2	Browns Canyon(Chimney Hill)	W			170.0	2.7	7.0			47							
5	3	Browns GrottoWarm Spring	HS	7.0	494	180.0	3.4	18.0			46							
6	1	Canon City Hot Springs	HS	6.2	1,220	180.2	19.8	179.9	57.9	0.03	23	0.20	0.23	867	123	186	1.5	0.1
7	1	Carson #1 Well	W	8.2	789	310.0	2.8	2.7	0.3	0.07	23	0.19			1	14	1.5	96.4
8	1	Cebolla "A", (Powderhorn)	HS	6.7	1,453	309.9	65.7	122.7	49.3	0.03	79	1.10	0.49	1,178	125	121	4.3	-0.5
8	2	Cebolla "B", (Powderhorn)	HS		1,460	310.0	64.0	120.0	50.0	0.05	77	1.10	0.72	1,180	130	120	5.8	-1.6
8	3	Cebolla "C", (Powderhorn)	HS		1,460	300.0	63.0	130.0	51.0	0.04	79	1.10	0.71	1,170	130	120	4.6	-0.3
9	1	Cement Creek Warm Spring	HS	7.1	393	38.3	6.1	71.3	19.5	0.01	18	0.07	0.09	305	76	11	1.7	0.2
10	1	Chinaman Canyon	HS	8.5	342	41.0	1.6	66.0	16.0	1.60	11	0.02			64	7	0.3	76.1
11	1	Clark Spring	W	6.8	1,210	250.0	18.0	75.0	45.0	2.70	11	0.10	0.22	323	620	28	1.4	-0.9
12	1	Cokedale	HS	8.4	884	190.0	7.1	68.0	29.0	0.62	12	0.06			390	16	0.5	39.6
13	1	Colonel Chinn	W	6.5	2,050	615.0	40.0	120.0	34.5	0.11	25	1.80		1,530	84	375	2.5	-2.6
14	1	Conundrum Hot Springs	HS		1,910	42.2	6.2	563.4	5.0	0.05	41	0.03	0.01	18	1,411	8	2.3	1.7
15	1	Cottonwood Spring	HS	9.0	166	6.4	1.7	35.0	13.0	ND	15			180	4	2	0.1	1.8
16	1	Cottonwood Hot Springs	HS	7.6	358	102.8	8.9	6.1	0.9	0.02	58	0.07	0.13	63	107	28	14.3	6.0
16	2	Cottonwood (Jump Steady)	HS	7.6	348	107.5	2.7	5.9	0.3	0.01	46	0.09	0.16	70	110	30	10.7	4.8
16	3	Cottonwood (Merrifield Well)	W	8.8	301	81.0	2.5	9.5	0.8	0.01	48	0.08	0.11	71	87	23	12.0	-2.7
17	1	Craig Warm Water Well	W	8.2	878	353.5	3.9	5.1	0.7	0.03	50	0.23	0.08	997	3	5	3.1	-5.7
18	1	Crowley Ranch Reserve	W	6.8	[1,789]													
19	1	Dallas Creek	W	7.7	3,210	350.0	20.0	600.0	44.0	2.10	29				1,900	100		14.1
20	1	Deganahl (Yampa)	W	7.2	263	28.4	2.1	51.5	13.8	0.01	17	0.03		257	27	7	0.1	0.4
20	2	Deganahl-Watson Creek (Yampa)	W	8.2	241	27.0	2.8	51.0	14.0	0.03					22	10		85.0
21	1	Desert Reef (Florence)	W	6.5	1,398	281.4	30.4	159.4	70.3	0.06	33	0.17	0.22	1,155	228	128	1.1	-2.1
22	1	Dexter Spring	HS	7.9														
23	1	Don K Ranch	W	6.5	1,710	400.0	50.0	160.0	66.0	1.10	40	0.56	0.52	1,580	64	150	1.9	2.0
24	1	Dotsero Warm Springs	HS	7.1	10,170	3,451.3	160.8	252.3	68.3	0.02	16	0.21	0.10	452	449	5,544	0.6	-0.4
24	2	Dotsero Warm Springs, South	HS	6.9	8,950	3,064.0	35.5	251.5	54.7	0.01	12	0.19	0.08	398	480	4,806	0.3	-0.6
25	1	Dry Creek Well	W	8.5	369	140.0	0.5	6.0	0.9	0.06	8	0.06		310	41	14	1.1	1.4
26	1	Dunton Hot Spring	HS	6.5	1,300	34.3	20.3	343.3	44.3	1.41	33	0.10	0.10	969	333	7	0.6	-0.8
27	1	Dutch Crowley	W	6.9	1,270	21.0	9.3	310.0	24.0	0.08	33	0.90		170	780	8	0.5	-3.6
28	1	East Willow Creek	W	7.9	972	390.0	1.1	5.0	6.3	0.05	11	3.30	0.33	880	9	100	11.0	-1.1
29	1	Eldorado Springs "A"	W	6.9	101	6.9	3.2	15.0	4.8	0.01	16	0.02	0.01	63	20	1	0.2	2.6

Table 3. continued.

ID	Site	Name	Type	pH	TDS	Na	K	Ca	Mg	Fe	SiO_2	B	Li	HCO_3	SO_4	Cl	F	Cation-Anion Balance, %
29	2	Eldorado Springs "B"	HS	6.6	86	9.3	2.7	11.1	3.4	0.01	15	0.02	0.01	45	24	2	0.3	-0.7
30	1	Eoff	W	7.0	[2,500]													
31	1	Florence	W	6.3	1,480	270.0	32.0	180.0	78.0	0.50	21	0.16	0.24	1,200	210	98	1.1	4.1
32	1	Fremont Natatorium	W	6.8	1,333	203.0	29.4	145.3	67.3	0.95	22	0.09	0.06	615	546	33	0.5	0.1
33	1	Geyser	HS		1,620	400.0	29.0	170.0	40.0	0.02	37	0.12	0.28	1,770	68	2	0.4	-1.9
34	1	Glenwood Springs (BigSpring)	HS	6.3	20,400	7,083.3	263.3	456.7	92.0	0.05	33	0.89	0.40	657	1,131	11,008	2.3	0.1
34	2	Glenwood Springs (Drinking Spring)	HS	6.4	19,950	6,596.0	619.4	505.4	72.6	0.05	31	0.90	0.34	767	1,116	10,658	2.3	-0.8
34	3	Glenwood Springs (Vapor Cave)	HS	6.8	18,200	6,450.0	154.5	426.5	68.0	0.41	28	0.78	0.67	744	1,450	9,300	1.7	2.1
34	4	Glenwood Springs (Graves Springs)	HS	7.0	21,500	7,000.0	180.0	770.0	150.0	0.07	32	1.00	0.69	744	2,000	11,000	2.9	-1.2
34	5	Glenwood Springs (Spring A)	HS	6.3	17,600	6,000.0	160.0	410.0	88.0	0.04	30	0.80	0.73	736	980	9,600	2.2	-3.6
34	6	Glenwood Springs (Spring B)	HS	6.8	18,050	6,375.0	172.5	447.5	81.8	0.03	28	0.82	0.83	749	1,023	9,675	2.2	1.4
34	8	Glenwood Springs (Railroad Spring)	HS	6.8	18,300	6,150.0	190.0	460.0	83.0	0.03	29	0.87		770	990	10,000	2.3	-4.4
35	1	Grassy Creek (Hayden)	W	7.5	1,050	31.0	4.1	200.0	77.0	0.09	14			560	420	21	0.3	-4.3
36	1	Hartsel (Spring A)	HS		2,280	680.0	33.0	120.0	20.0	0.17	41	0.56	1.00	479	320	820	2.1	1.2
36	2	Hartsel (Spring B)	HS	6.7	2,260	662.6	31.2	113.8	21.8	0.49	38	0.50	0.67	458	323	808	2.0	0.2
37	1	Haystack Butte	W	8.0	1,200	510.0	1.3	2.5	0.7	0.05	29	0.74	0.24	1,250	8	30	4.4	3.1
38	1	Hooper Aquaculture well	W	8.8	[463]													
39	1	Horse Mountain Spring	HS	8.2	932	31.0	1.2	160.0	62.0	ND	10				540	6	0.4	20.9
40	1	Hot Sulphur Springs (Spring A)	HS	6.9	1,198	424.0	34.2	15.0	3.3	0.04	32	0.54	0.87	817	130	137	11.6	-0.7
40	2	Hot Sulphur Springs (Spring B)	HS	6.7	1,200	430.0	24.0	15.0	3.1	0.10	35	0.57	1.10	817	140	140	12.0	-2.0
40	3	Hot Sulphur Springs (Spring C)	HS	7.0	1,200	435.0	23.5	15.0	3.4	0.09	33	0.55	1.30	821	135	140	10.8	-0.2
40	4	Hot Sulphur Springs (Spring D)	HS	7.1	1,190	430.0	23.0	16.0	3.0	0.20	30	0.57	1.50	790	150	140	9.1	0.3
41	1	Idaho Springs (Spring A)	HS	6.8	2,005	518.6	62.2	139.0	37.1	0.05	66	0.37	0.51	1,465	397	67	4.2	-0.5
41	2	Idaho Springs (Spring B)	HS		2,070	520.0	82.0	130.0	50.0	0.02	68	0.37	0.66	1,520	400	69	4.8	-0.1
41	3	Idaho Springs (Spring C)	HS		1,070	260.0	44.0	77.0	23.0	0.04	45	0.17	0.34	759	210	36	2.9	1.3
41	4	Idaho Springs (Lodge Well)	W	6.9	2,070	520.0	82.0	150.0	38.0	1.00	58	0.36	0.87	1,490	420	66	3.5	0.8
42	1	Jacks Mine	HS	9.2	1,870	720.0	7.0	7.6	9.8	8.00	3	1.50			390	21	1.4	73.3
43	1	Juniper Hot Springs	HS	8.0	1,120	430.8	10.2	3.6	1.2	0.02	39	0.54	0.10	1,025	16	87	3.3	-2.4
44	1	Lake City Airstrip	W	7.6	1,810	300.0	29.0	290.0	33.0	2.80	34				720	76		44.9
45	1	Lake San Cristobal	W	7.7	1,950	360.0	36.0	180.0	36.0	6.20	32				970	87		21.2
46	1	Lemon	HS	6.6	2,776	745.2	89.7	150.2	11.0	0.59	98	1.86	3.75	1,084	859	267	4.7	0.5
47	1	Lost Creek (Bennett)	W	7.8	329	110.0	1.6	8.3	1.4	0.02	10				84	9	1.4	61.4
48	1	Marigold	W	7.0	2,070	120.0	5.2	500.0	30.0	0.05	61				1,200	55		19.0
49	1	Maurer Ranch	W	7.2	1,430	430.0	10.0	25.0	18.0	0.05	12			310	750	32	1.5	0.0
50	1	McIntire Warm Springs	HS	8.2	159	11.0	4.1	20.0	2.7									
51	1	MGP Well	W	7.6	1,160	480.0	1.5	3.6	0.1	0.55	17	0.10			1	21	4.3	96.0
52	1	Mineral Hot Springs (Spring A)	W	6.8	651	137.5	14.3	58.3	13.3	0.22	47	0.38	0.31	343	168	39	4.0	-0.3
52	3	Mineral Hot Springs (Spring C)	HS		723	150.0	14.0	60.0	14.0	0.02	50	0.37	0.33	341	190	43	4.2	0.9
52	4	Mineral Hot Springs (Spring D)	HS	6.8	665	142.5	14.0	57.0	13.0	0.07	47	0.37	0.33	352	173	39	3.9	-1.4
53	1	Mosca West	W	8.8	238	62.0	2.1	2.8	0.2	0.12	70	0.38		110	36	8	2.5	0.2
54	1	Moffat	W	8.2	175	55.0	0.5	5.9	0.1	0.03	27	0.11		120	18	4	3.0	3.7

Table 3. continued.

ID	Site	Name	Type	pH	TDS	Na	K	Ca	Mg	Fe	SiO_2	B	Li	HCO_3	SO_4	Cl	F	Cation-Anion Balance, %
55	1	Mt. Princeton Hot Springs (Spring A)	HS	7.5	246	57.8	2.1	10.6	0.6	0.01	58	0.02	0.09	72	66	5	9.4	-0.7
55	5	Mt. Princeton Hot Springs (Spring F)	HS		229	50.0	1.9	12.0	0.5	0.01	57	0.01	0.08	73	58	4	8.3	-2.6
55	6	Mt. Princeton Hot Springs (Hortense)	HS	7.8	344	96.2	2.6	4.5	0.1	0.02	76	0.04	0.07	89	99	12	17.3	-6.1
55	7	Mt. Princeton Hot Springs (Hortense Well)	W		318	84.0	2.8	6.4	0.1	0.04	72	0.03	0.12	75	92	8	14.0	-1.1
55	8	Mt. Princeton Hot Springs (Woolmington)	W		143	40.0	1.7	11.0	0.6	0.03	1	0.02	0.06	75	47	4	0.1	2.8
55	9	Mt. Princeton Hot Springs (Wright Well,east)	W		234	61.0	2.1	8.3	0.3	0.05	53	0.02	0.10	68	60	5	10.0	4.2
55	11	Mt. Princeton Hot Springs (Young Life)	W		259	60.0	2.3	8.5	0.3	0.03	71	0.02	0.09	72	67	4	9.2	-1.2
56	1	Mullenville (Rhodes) Warm Springs	HS	7.6	190	8.5	3.1	34.4	21.5	0.03	12	0.02	0.01	181	16	24	0.2	-1.2
57	1	Orchard Mesa (Grand Junction)	W	9.0	480	190.0	1.1	2.0	0.3	0.03	14	0.24			43	7	0.5	86.8
58	1	Orvis Hot Springs-Pool (Ridgway)	HS	6.6	2,370	423.8	45.6	277.0	20.3	0.70	54	0.84	0.77	349	1,277	90	3.5	0.5
59	1	Ouray (Wiesbaden & Motel Spring A)	HS		1,580	120.0	11.0	350.0	8.0	0.09	40	0.15	2.40	213	910	31	2.7	2.1
59	2	Ouray (Wiesbaden & Motel Spring B)	HS		695	53.0	5.0	150.0	8.3	0.02	29	0.06	1.20	189	340	14	1.1	1.3
59	3	Ouray (Wiesbaden Well & Motel Spring C)	W	6.9	1,433	112.8	9.3	326.3	10.1	0.01	43	0.24	3.20	191	836	35	3.0	4.5
59	4	Ouray (Pool or Box Canyon Spring)	HS	6.8	1,640	100.8	9.4	372.6	8.9	0.03	49	0.21	1.76	129	975	42	3.2	1.8
59	5	Ouray (Fellin Spring)	HS	7.4	269	24.0	1.9	43.0	10.0	ND	21	0.24		185	12	6	0.1	14.8
59	6	Ouray (Vinegar Hill)	HS	7.0	331	14.0	1.9	70.0	5.0	ND	11	0.24		136	93	11	0.6	1.2
59	7	Ouray (Manganese Mine)	HS	7.2	1,463	138.0	9.2	381.5	11.5	0.16	52	0.33		122	1,069	50	3.0	1.6
59	8	Ouray (Uncompahgre Spring)	HS	7.7	2,040	110.0	9.4	350.0	9.2	0.01	44	0.20		138	930	42	3.0	1.2
59	9	Ouray City Park (OX-2)	W	6.7	1,350	89.0	8.9	309.5	13.5	0.02	56	0.22		172	849	38	2.5	-5.0
60	1	Oxford Well	W	7.9	818	320.0	4.3	22.0	1.2	ND		0.05		660	26	2	2.4	24.2
61	1	Pagosa Springs (Big Spring)	HS	6.6	3,206	699.8	131.0	255.9	22.2	0.09	65	2.17	2.64	807	1,462	181	4.6	-0.5
61	2	Pagosa Springs (Courthouse Well)	W	6.5	3,300	780.0	89.0	250.0	25.0	0.02	52	1.80	2.80	858	1,500	170	4.5	1.6
61	3	Pagosa Springs (Spa Motel Well)	W	6.5	3,320	780.0	91.0	230.0	24.0	0.21	51	1.90	2.90	753	1,600	160	4.4	-0.6
62	1	Papeton	W	6.7	684	55.0	2.0	140.0	21.0	0.30	19	0.05		280	290	18	0.3	0.1
63	1	Paradise Hot Spring	HS	6.8	6,260	1,867.0	370.0	190.0	28.3	0.14	167	4.90	9.60	670	130	3,167	3.8	0.6
64	1	Penny Hot Springs (Granges Spring)	HS	7.2	3,698	759.3	120.5	360.0	46.8	1.19	118	1.72	9.60	607	1,008	979	3.3	1.1
65	1	Pinkerton (Spring A)	HS	6.3	3,880	720.0	116.7	533.3	73.3	4.30	28	2.93	2.50	1,590	613	1,000	2.6	0.4
65	2	Pinkerton (Spring B)	HS		[6,000]	720.0	120.0	530.0	71.0	4.40		3.00	2.80	1,640	610	990		-0.4
65	3	Pinkerton (Mound Spring)	HS	6.5	3,887	716.7	120.0	550.0	71.3	4.20	28	2.97	2.80	1,620	623	1,000	2.3	0.4
65	4	Pinkerton (Little Mound Spring)	HS	7.0	[5,500]													
66	1	Poncha Springs (Spring A)	HS	7.7	674	195.0	8.3	17.8	0.4	0.01	82	0.07	0.19	214	203	50	12.0	-1.3
66	2	Poncha Springs (Spring B)	HS	7.5	655	190.0	7.8	18.0	0.5	0.05	83	0.07	0.18	214	190	48	12.0	-0.2

Table 3. continued.

ID	Site	Name	Type	pH	TDS	Na	K	Ca	Mg	Fe	SiO_2	B	Li	HCO_3	SO_4	Cl	F	Cation-Anion Balance, %
66	3	Poncha Springs (Spring C)	HS	7.7	668	192.5	8.3	18.8	0.5	0.02	80	0.09	0.19	216	193	50	11.2	0.4
67	1	Rainbow	HS		161	45.0	0.2	2.1	0.2	0.08	39	0.05	0.01	85	30	1	2.2	-3.1
68	1	Ranger	HS	7.0	467	61.3	7.8	71.5	21.3	0.01	19	0.08	0.15	351	92	18	1.4	-0.7
69	1	Rico (Diamond drill hole)	W	7.0	2,250	66.0	28.0	590.0	82.0	0.03	120	0.07	ND	1,120	810	2	1.4	11.1
69	2	Rico (Big Geyser Warm Spring)	W	6.8	2,745	72.5	30.5	685.0	95.5	8.40	125	0.08	0.25	1,675	910	4	1.8	-0.7
69	3	Rico (Geyser Warm Spring)	W	6.3	2,790	80.0	32.0	680.0	100.0	8.50	110	0.08	0.25	1,730	920	4	2.1	-2.0
69	4	Rico (Little Spring)	HS	7.0	2,745	76.5	18.8	655.0	101.0	6.10	120	0.08	0.21	1,580	980	3	3.2	-3.3
70	1	Roatcap Creek	W	7.5	3,190	1,300.0	13.0	9.0	3.2	5.40	16	2.00			11	180	1.9	90.6
70	2	Roatcap Creek (StevensGulch)	W	8.3	1,690	650.0	23.0	12.0	3.1	24.00	9	1.00			43	130	1.4	84.8
71	1	Routt [aka Strawberry] (Spring A)	HS	7.8	513	158.0	8.9	8.3	0.1	0.03	151	0.22	0.25	135	47	129	16.3	-1.4
71	2	Routt [aka Strawberry] (Spring B)	HS	7.1	539	160.0	9.1	7.8	0.5	0.08	98	0.28	0.31	135	49	130	17.0	-1.6
72	1	Sand Dunes Pool Well	W	8.3	334	81.0	8.6	3.2	0.4	0.01	120	0.51	0.01	176	23	5	5.9	3.3
73	1	Sarcillo Canyon Well	W	8.0	393	1.7	2.1	55.0	18.0	ND	11	0.01			100	9	0.5	45.6
74	1	Shaws	HS	9.0	424	130.0	1.5	2.7	0.7	0.01	100	0.12		211	46	7	3.0	18.8
75	1	Smith Canyon Spring	HS	7.5	320	33.0	1.9	54.0	20.0	0.06	10	0.02			37	13	0.3	80.2
76	1	South Canyon Hot Springs (Spring A)	HS	7.3	787	275.0	8.2	7.6	1.4	0.02	42	0.26	0.15	304	101	198	3.7	-1.3
76	2	South Canyon Hot Springs (Spring B)	HS	7.1	757	260.0	7.8	7.1	0.9	0.04	43	0.23	0.15	291	100	190	4.0	-3.9
77	1	Splashland	W	8.3	311	72.0	9.9	4.1	0.4	0.02	110	0.34	0.01	151	29	6	4.2	4.0
78	1	Steamboat Springs (Heart Spring)	HS	8.1	888	292.7	11.3	18.3	0.5	0.04	74	0.74	0.22	103	144	319	5.3	0.3
78	2	Steamboat Springs (Sulphur CaveSpring)	HS	6.5	4,530	1,600.0	110.0	90.0	24.0	0.06	18	2.90	3.00	2,420	490	1,000	3.0	1.3
78	3	Steamboat Springs (Steamboat Spring)	HS	6.7	6,170	2,200.0	140.0	110.0	31.0	0.01	21	3.20	3.70	3,390	590	1,400	2.9	0.3
79	1	Stinking Springs	HS	7.0	899	20.0	12.0	210.0	27.0	0.14	24	0.06	0.09	258	470	7	0.6	-2.6
80	1	Swissvale (Spring A)	HS	7.0	[820]													
80	2	Swissvale (Spring F)	HS	7.0	[726]													
81	1	Sylvester Gulch Warm Spring	HS	7.1	374	66.0	1.9	48.0	20.0	0.04	9	0.05		350	50	3	0.2	1.3
82	1	Texas Camp (Rangely)	W	7.4	31,200	11,000.0	330.0	900.0	120.0	0.52	33	9.10		440	590	18,000	1.1	2.7
83	1	Trimble Hot Springs	W	6.4	3,290	349.0	35.3	437.3	37.0	0.03	56	1.45	1.07	859	1,137	147	2.7	-2.3
84	1	Tripp	HS	6.2	[1,498]	396.0	165.0	558.0	42.0		97		1.60	1,121	1,312	254		0.2
85	1	Towaoc Spring	HS		737	110.0		78.0	42.0		19			340	300	20	0.2	-2.2
86	1	Two Mile Road	W	7.5	[540]	130.0	3.7	6.2	0.6									
87	1	Uravan Well	W	7.6	254	46.0	22.0	22.0	13.0	0.06	4	0.21		230	13	18	1.1	2.7
88	1	Valley View Hot Springs (Spring A)	HS	7.2	245	3.6	2.7	50.3	14.3	0.01	20	0.08	0.01	123	90	1	0.5	-1.1
88	2	Valley View Hot Springs (Spring B)	HS	7.1	232	3.5	2.3	47.5	13.0	0.02	18	0.01	0.01	125	82	2	0.4	-5.2
88	3	Valley View Hot Springs (Spring D)	HS	7.3	235	3.5	2.7	50.5	13.0	0.04	18	0.12		125	83	2	0.3	-0.5
89	1	Wagon Wheel Gap (4UR Ranch Spring)	HS	6.9	1,583	476.7	49.0	62.3	14.7	0.01	85	2.13	2.20	1,023	180	200	7.0	0.3
89	2	Wagon Wheel Gap (CFI Spring)	HS	6.5	1,510	447.5	46.8	67.3	15.3	0.19	74	2.25	1.90	1,023	145	198	7.2	-0.7
90	1	Waunita Hot Springs (Spring C)	HS	8.3	581	155.0	10.0	8.4	2.0	0.02	120	0.06	0.21	125	185	15	18.5	4.0

Table 3. continued.

ID	Site	Name	Type	pH	TDS	Na	K	Ca	Mg	Fe	SiO_2	B	Li	HCO_3	SO_4	Cl	F	Cation-Anion Balance, %
90	2	Waunita Hot Springs (Spring D)	HS	8.3	594	160.0	10.0	6.0	ND	0.01	130	0.07	0.21	132	190	15	18.0	0.7
90	3	Waunita Hot Springs (Spring A)	HS	8.3	604	155.5	9.3	6.3	ND	ND	130	ND	0.17	131	180	31	17.0	-4.5
91	1	Lower Waunita Hot Springs (Spring A)	HS	7.8	[1,029]													
91	2	Lower Waunita Hot Springs (Spring C)	HS	7.8	[880]													
91	3	Lower Waunita Hot Springs (Spring B)	HS	7.9	540	153.3	10.0	8.3	0.7	0.07	84	0.06	0.20	161	173	15	16.0	-1.2
91	4	Lower Waunita Hot Springs (Spring D)	HS	7.8	535	150.0	10.0	6.9	0.5	0.17	86	0.07	0.20	153	170	15	20.0	-4.5
92	1	Wellsville	HS	7.2	480	70.4	5.7	64.8	20.9	0.04	27	0.10	0.07	289	89	54	0.7	0.4
93	1	Wet Canyon	HS	8.2	543	52.0	2.2	99.0	23.0	2.80	11	0.03			200	12	0.5	51.0

Table 4: General information of geothermal sources in Colorado.

ABBREVIATIONS: Type: HS=Hot Spring; W=well; Use: Bnd= bathing, not developed; Bd=bathing, developed; N=no use; MW=mineral water; AC=Aquaculture; ACs=Aquaculture, stock tank; A=Agricultural rrigation; SH=Space Heating; GH=Greenhouse; ?=Not Known; E=Estimated

DISCLAIMER: Information on the hot springs and wells comes from a variety of sources. There is no guarantee of the accuracy of any of the data in this table.

ID	Site	Name	Type	Use	Temp °C	Flow l/m	Well depth, m
1	1	Antelope Warm Spring	HS	N	32	11 to 46	
2	1	Axial	W	?	22		3.6
3	1	Birdsie Warm Spring	HS	N	30	53	
4	1	Brands Ranch	W	Bnd	34	304E	
5	1	Browns Canyon Warm Spring	HS	N	25	4	
5	2	Browns Canyon (Chimney Hill)	W	N	27		
5	3	Browns Grotto Warm Spring	HS	N	23	19	
6	1	Canon City Hot Springs	HS	N	39	4 to 19	
7	1	Carson #1 Well	W	?	38		744.8
8	1	Cebolla "A", (Powderhorn)	HS	Bd	38	11	
8	2	Cebolla "B", (Powderhorn)	HS	Bd	38		
8	3	Cebolla "C", (Powderhorn)	HS	Bd	40		
9	1	Cement Creek Warm Spring	HS	Bd	26	253	
10	1	Chinaman Canyon	HS	?	26	68	
11	1	Clark Spring	W	MW	25	46	432.0
12	1	Cokedale	HS	?	29	85	
13	1	Colonel Chinn	W	ACs	42	45	20.0
14	1	Conundrum Hot Springs	HS	Bnd	38	145	
15	1	Cottonwood Spring	HS	N	25	5,100	
16	1	Cottonwood Hot Springs	HS	Bd	54	475	
16	2	Cottonwood (Jump Steady)	HS	Bd	53	240	
16	3	Cottonwood (Merrifield Well)	W	SH,GH	54	990	34.8
17	1	Craig Warm Water Well	W	N	38	84	424.0
18	1	Crowley Ranch Reserve	W	N	44	380	
19	1	Dallas Creek	W	S	35		14.8
20	1	Deganahl (Yampa)	W	N	41	10,260	757.6
20	2	Deganahl-Watson Creek (Yampa)	W	N	37		666.6
21	1	Desert Reef (Florence)	W	Bd	55	330	332.1
22	1	Dexter Spring	HS	N	20	190E	
23	1	Don K Ranch	W	?	28	95	
24	1	Dotsero Warm Springs	HS	N	31	2,160	
24	2	Dotsero Warm Springs, South	HS	N	32	3,200	
25	1	Dry Creek Well	W	?	23		46.6
26	1	Dunton Hot Spring	HS	Bnd	42	96	

Table 4. continued.

ID	Site	Name	Type	Use	Temp °C	Flow l/m	Well depth, m
27	1	Dutch Crowley	W	A	60	350	521.2
28	1	East Willow Creek	W	?	22	23	6.6
29	1	Eldorado Springs "A"	W	Bd	24		
29	2	Eldorado Springs "B" (Pool spring)	HS	Bd	25	45	
30	1	Eoff	W	N	39	190E	908.0
31	1	Florence	W	N	28	494	?
32	1	Fremont Natatorium	W	Bnd,A	36	183	545.0
33	1	Geyser	HS	N	28	428E	
34	1	Glenwood Springs (Big Spring)	HS	Bd	51	5,060	
34	2	Glenwood Springs (Drinking Springs)	HS	Bd	51	445	
34	3	Glenwood Springs (Vapor Cave)	HS	Bd	50	19E	
34	4	Glenwood Springs (Graves Springs)	HS	N	46	19	
34	5	Glenwood Springs (Spring A)	HS	N	44	10E	
34	6	Glenwood Springs (Spring B)	HS	N	51	342	
34	7	Glenwood Springs (Spring C)	HS	N	46	10	
34	8	Glenwood Springs (Railroad Spring)	HS	Bnd	51	285	
35	1	Grassy Creek (Hayden)	W	?	20		3.3
36	1	Hartsel (Spring A)	HS	Bnd	52		
36	2	Hartsel (Spring B)	HS	Bnd	48	181	
37	1	Haystack Butte	W	N	24	15E	888.5
38	1	Hooper Aquaculture Well	W	AC	31		625.2
39	1	Horse Mountain Spring	HS	N	23		
40	1	Hot Sulphur Springs (Spring A)	HS	Bd	44	42	
40	2	Hot Sulphur Springs (Spring B)	HS	Bd	42	6	
40	3	Hot Sulphur Springs (Spring C)	HS	Bd	40	36	
40	4	Hot Sulphur Springs (Spring D)	HS	Bd	38	57	
41	1	Idaho Springs (Spring A)	HS	Bd	45	80	
41	2	Idaho Springs (Spring B)	HS	Bd	24		
41	3	Idaho Springs (Spring C)	HS	Bd	20	4	
41	4	Idaho Springs (Lodge Well)	W	Bd	46	114	
42	1	Jacks Mine	HS	N	27		
43	1	Juniper Hot Springs	HS	Bd	36	63	
44	1	Lake City Airstrip	W	?	24		5.1
45	1	Lake San Cristobal	W	?	24		8.2
46	1	Lemon (Geyser)	HS	N	33	36	
47	1	Lost Creek (Bennett)	W	?	27		60.6
48	1	Marigold	W	?	24		17.9
49	1	Maurer Ranch	W	?	23		424.2
50	1	McIntire Warm Springs	HS	N	21		
51	1	MGP Well	W	N	26	3,060	439.1

Table 4. continued.

ID	Site	Name	Type	Use	Temp °C	Flow l/m	Well depth, m
52	1	Mineral Hot Springs (Spring A)	W	N	60	410	?
52	2	Mineral Hot Springs (Spring B)	HS	N	51	Small	
52	3	Mineral Hot Springs (Spring C)	HS	N	60		
52	4	Mineral Hot Springs (Spring D)	HS	N	60	19	
53	1	Mosca West	W	?	30		603.3
54	1	Moffat	W	?	20		75.8
55	1	Mt. Princeton Hot Springs (Spring A)	HS	Bd,SH	54	77	
55	2	Mt. Princeton Hot Springs (Spring B)	HS	Bd,SH	54	Large	
55	3	Mt. Princeton Hot Springs (Spring D)	HS	Bd,SH	44		
55	4	Mt. Princeton Hot Springs (Spring E)	HS	Bd,SH	50		
55	5	Mt. Princeton Hot Springs (Spring F)	HS	Bd,SH	49	46	
55	6	Mt. Princeton Hot Springs (Hortense)	HS	Bd,SH	83	74	
55	7	Mt. Princeton Hot Springs (Hortense Well)	W	Bd,SH	82		54.5
55	8	Mt. Princeton Hot Springs (Woolmington)	W	N	39		
55	9	Mt. Princeton Hot Springs (Wright Well, east)	W	Bd,SH,GH	67		
55	11	Mt. Princeton Hot Springs (Young Life)	W	Bd,SH	66		
56	1	Mullenville (Rhodes) Warm Springs	HS	N	26	880	
57	1	Orchard Mesa (Grand Junction)	W	?	26		418.2
58	1	Orvis Hot Springs, (Ridgway)	HS	Bd	50	60 to 2,100	
59	1	Ouray (Wiesbaden & Motel Spring A)	HS	Bd,SH	53		
59	2	Ouray (Wiesbaden & Motel Spring B)	HS	Bd,SH	30	7E	
59	3	Ouray (Wiesbaden & Motel Spring C)	HS	Bd,SH	47	4 to 114	
59	4	Ouray (Pool or Box Canyon Spring)	HS	Bd	66	375	
59	5	Ouray (Fellin Spring)	HS	N	29	25	
59	6	Ouray (Vinegar Hill)	HS	N	25	2,272	
59	7	Ouray (Manganese Mine)	HS	Bd	67	205	
59	8	Ouray (Uncompahgre Spring)	HS	Bd	49	19	
59	9	Ouray City Park (OX-2)	W	Bd	49	1500	27.3
60	1	Oxford Well	W	?	27		35.2
61	1	Pagosa Springs (Big Spring)	HS	Bd,SH	57	1,286	
61	2	Pagosa Springs (Courthouse Well)	W	SH	56	114	
61	3	Pagosa Springs (Spa Motel Well)	W	Bd,SH	53		151.5
62	1	Papeton	W	?	22		13.9
63	1	Paradise Hot Spring	HS	Bnd	43	114	
64	1	Penny Hot Springs	HS	Bnd	47	40	
65	1	Pinkerton (Spring A)	HS	N	32	205	
65	2	Pinkerton (Spring B)	HS	N	33	76	
65	3	Pinkerton (Mound Spring)	HS	N	29	23	
65	4	Pinkerton (Little Mound Spring)	HS	N	26	8E	
66	1	Poncha Springs (Spring A)	HS	Bd	70	760	

Table 4. continued.

ID	Site	Name	Type	Use	Temp °C	Flow l/m	Well depth, m
66	2	Poncha Springs (Spring B)	HS	Bd	65	87	
66	3	Poncha Springs (Spring C)	HS	Bd	62	8	
66	4	Poncha Springs (Spring D)	HS	Bd	56	7E	
66	5	Poncha Springs (Spring E)	HS	Bd	60	2E	
67	1	Rainbow	HS	N	40	171	
68	1	Ranger	HS	?	27	743	
69	1	Rico (Diamond drill hole)	W	N	44	57	
69	2	Rico (Big Geyser Warm Spring)	W	N	35	38	
69	3	Rico (Geyser Warm Spring)	W	N	40	46	
69	4	Rico (Little Spring)	HS	N	38	53	
70	1	Roatcap Creek	W	N	22		279.4
70	2	Roatcap Creek (Stevens Gulch)	W	N	27		407.6
71	1	Routt [aka Strawberry] (Spring A)	HS	Bd	64	154	
71	2	Routt [aka Strawberry] (Spring B)	HS	Bd	62	114	
71	3	Routt [aka Strawberry] (Spring C)	HS	Bd	54	8E	
71	4	Routt [aka Strawberry] (Spring D)	HS	Bd	51	8E	
72	1	Sand Dunes Pool Well	W	Bnd	44		1333.3
73	1	Sarcillo Canyon Well	W	?	20		8.5
74	1	Shaws	HS	Bnd	29	198	
75	1	Smith Canyon Spring	HS	?	20	0	
76	1	South Canyon Hot Springs (Spring A)	HS	Bnd	48	49	
76	2	South Canyon Hot Springs (Spring B)	HS	Bnd	46	40	
77	1	Splashland	W	Bd,SH	40	2,500	606.0
78	1	Steamboat Springs (Heart Spring)	HS	Bd	39	657	
78	2	Steamboat Springs (Sulphur Cave Spring)	HS	N	20	38	
78	3	Steamboat Springs (Steamboat Spring)	HS	N	26	76	
79	1	Stinking Springs	HS	N	26	100	
80	1	Swissvale (Spring A)	HS	N	27	295	
80	2	Swissvale (Spring F)	HS	N	23	76E	
81	1	Sylvester Gulch Warm Spring	HS	?	25		
82	1	Texas Camp (Rangely)	W	?	48		2272.7
83	1	Trimble Hot Springs	HS, W	Bd	43	775	45.4
84	1	Tripp	HS	N	31	195	
85	1	Towaoc Spring	HS	?	22		
86	1	Two Mile Road	W	?	21		454.5
87	1	Uravan Well	W	?	25	500	35.4
88	1	Valley View Hot Springs (Spring A)	HS	Bd	36	210	
88	2	Valley View Hot Springs (Spring B)	HS	Bd	34	350	
88	3	Valley View Hot Springs (Spring D)	HS	Bd	34	315	
89	1	Wagon Wheel Gap (4UR Ranch Spring)	HS	Bd	55	120	

Table 4. continued.

ID	Site	Name	Type	Use	Temp °C	Flow l/m	Well depth, m
89	2	Wagon Wheel Gap (CFI Spring)	HS	Bd	49	135	
90	1	Waunita Hot Springs (Spring C)	HS	Bd,SH	78	171	
90	2	Waunita Hot Springs (Spring D)	HS	Bd,SH	57		
90	3	Waunita Hot Springs (Spring A)	HS	Bd,SH	77	1,000	
90	4	Waunita Hot Springs (Spring B)	HS	Bd,SH	78		
91	1	Lower Waunita Hot Springs (Spring A)	HS	N	70	285E	
91	2	Lower Waunita Hot Springs (Spring C)	HS	N	70	300	
91	3	Lower Waunita Hot Springs (Spring B)	HS	N	68	156	
91	4	Lower Waunita Hot Springs (Spring D)	HS	N	63		
92	1	Wellsville	HS	N	35	460	
93	1	Wet Canyon	HS	?	26	270	

STATE OF COLORADO

COLORADO GEOLOGICAL SURVEY
Division of Minerals and Geology

Department of Natural Resources
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DEPARTMENT OF NATURAL RESOURCES

Howard Ross
University of Utah Research Institute
391 Chipeta Way, Suite C
Salt Lake City, UT 84108-1295

March 2, 1994

Re: Low Temperature Geothermal Project

Dear Howard:

I have made some minor corrections to the geothermometer estimates in the discussion part of the text after applying Mike Adam's geothermometer reliability test methods. A diskette containing the four tables of geochemical, location, and general data on the geothermal sites is also included. The submission of these files and report fulfills the contract obligations concerning deliverables. If you need any thing else, like more maps, let me know. It has been a pleasure working with you and I hope that we can continue our geothermal efforts in the future.

Sincerely,

James A. Cappa
Chief, Minerals and Mineral Fuels

encl.

1992-1993 LOW-TEMPERATURE GEOTHERMAL ASSESSMENT PROGRAM, COLORADO

James A. Cappa
Colorado Geological Survey
1313 Sherman Street, Suite 715
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(303) 866-2611
December 30, 1993

Acknowledgements

This low-temperature geothermal assessment program was funded by the U. S. Department of Energy-Geothermal Division. The Colorado Geological Survey serves as a subcontractor to the Oregon Institute of Technology-Geo Heat Center for the purposes of fulfilling the terms of this contract within the State of Colorado.

Abstract

Previous assessments of Colorado's low-temperature geothermal resources were completed by the Colorado Geological Survey in 1920 and in the mid- to late- 1970's. The purpose of the 1992-1993 low-temperature geothermal resource assessment is to update the earlier physical, geochemical, and utilization data and compile computerized databases of the location, chemistry, and general information of the low-temperature geothermal resources in Colorado. The main sources of the data included published data from the Colorado Geological Survey, the U. S. Geological Survey WATSTOR database, and the files of the State Division of Water Resources.

The staff of the Colorado Geological Survey in 1992 and 1993 visited most of the known geothermal sources that were recorded as having temperatures greater than 30° C. Physical measurements of the conductivity, pH, temperature, flow rate, and notes on the current geothermal source utilization were taken. Ten new geochemical analyses were completed on selected geothermal sites. The results of the compilation and field investigations are compiled into the four enclosed Quattro Pro 4 databases.

For the purposes of this report a geothermal area is defined as a broad area, usually less than three square miles in size, that may have several wells or springs. A geothermal site is an individual well or spring within a geothermal area. The 1992-1993 assessment reports that there are 93 geothermal areas in the Colorado, up from the 56 reported in 1978; there are 157 geothermal sites up from the 125 reported in 1978; and a total of 382 geochemical analyses are compiled, up from the 236 reported in 1978.

Six geothermal areas are recommended for further investigation: Trimble Hot

Springs, Orvis Hot Springs, an area southeast of Pagosa Springs, the eastern San Luis Valley, Rico and Dunton area, and Cottonwood Hot Springs.

1. Introduction

The first assessment of the geothermal resources of the State of Colorado was completed in 1920 by the Colorado Geological Survey with the publication of Colorado Geological Survey Bulletin 11, Mineral Waters of Colorado. Bulletin 11 contains chemical analyses of the state's mineral waters including the known geothermal waters and, also, has a section describing the utilization of the mineral waters.

Low-temperature geothermal resources are defined as those having a surface temperature of 20° to 100° C. The first modern low-temperature geothermal assessment for the state of Colorado was completed during a period of time from about 1976 to 1983. That assessment was carried out by the Colorado Geological Survey through a funding program with the U. S. Department of Energy and the U. S. Geological Survey. The 1976 survey involved a sampling program conducted over an approximate 12 month period of 125 geothermal sources from 56 geothermal areas and resulted in the 1976 publication of Colorado Geological Survey Information Series 6, Hydrogeochemical Data of Thermal Springs and Wells in Colorado (revised 1993).

In 1978, the Colorado Geological Survey published Bulletin 39, An Appraisal of Colorado's Geothermal Resources, which contained descriptive information on the sites, including location, current usage, geological setting and an analysis of various geothermometers for each of the 56 geothermal areas of the state. Bulletin 39 utilized the analytical geochemical information presented in Information Series 6.

Several other site-specific geological and geophysical studies were performed by the Colorado Geological Survey up to 1983. Economic evaluations regarding the utilization of geothermal heat and energy for various sites were also completed during this time. The U. S. Department of Energy was the primary funding agency. All the pertinent publications are listed in the Reference chapter of this report.

The need for a new geothermal assessment is evidenced by the results of the current 1992-1993 low-temperature geothermal assessment. In Bulletin 39 which was published in 1978, there are 56 geothermal areas and 125 geothermal sites. The 1992-1993 survey lists 93 geothermal areas and 157 geothermal sites throughout the state. Over 380 chemical analyses were compiled from various sources in the construction of the database. Utilization of geothermal resources has changed over years. In some cases flow rates and temperature of the geothermal sources have changed since prior assessments. Several errors in location and description of geothermal springs from both the above described Colorado Geological Survey publications and the U. S. Geological Survey WATSTOR database were corrected.

The data collected and compiled for this survey are recorded in four computer databases. A 1:1,000,000 scale map of the state (Plate 1) shows the location and ID number of each of the geothermal areas.

The 1992-1993 low-temperature geothermal assessment for Colorado was initiated in the fall of 1992 by the Colorado Geological Survey. The scheduled completion date is December, 1993. Funding for this survey was provided by the U. S. Department of Energy.

The program was administered by the University of Utah Research Institute in Salt Lake City, Utah and the Geo Heat Center at the Oregon Institute of Technology, Klamath Falls, Oregon.

2. Data Sources

Data were compiled from a variety of sources including unpublished materials. The most important unpublished sources were the Colorado Department of Water Resources well permit files, the U. S. Geological Survey WATSTOR database, and analytical reports from private laboratories given to the principal investigator by geothermal source owners and operators.

The most important published source material includes: George et al., 1920, Colorado Geological Survey Bulletin 11; Barrett and Pearl, 1976, Colorado Geological Survey Information Series 6; and Barrett and Pearl, 1978, Colorado Geological Survey Bulletin 39.

The University of Utah Research Institute provided 10 new water analyses for each state for the current low-temperature geothermal assessment program. All 10 new analyses were completed for the Colorado portion of the program.

All geochemical data which maintained a cation-anion charge balance of ± 15% were entered into the databases. Geothermal sources with only one analysis were entered regardless of the charge balance. All data entries, especially those with significant cation-anion charge balance errors, were checked by two separate operators. References for each analysis are recorded in the GTHCHM1 database.

3. Data Format

The data collected during this assessment has been distributed into four Quattro Pro 4 spread sheets on the enclosed diskette. For purposes of this program a geothermal area is defined as a geologically cohesive land area that may or may not contain several geothermal wells or hot springs. Generally an area is less than approximately three square miles. A site is defined as an individual geothermal well or hot spring within an area.

Each geothermal area within the database has a unique ID number. Different sites within a geothermal area have unique area-site numbers. All the tables list the ID number, Site number, and Geothermal Source (Name).

Table 1 is a location database (GTHLOC); it describes the county, quadrangle map, section, township, range, latitude and longitude, and Universal Transverse Mercator grid references.

Table 2 contains the long form of the geochemical database(GTHCHEM1). All the geochemical and sample data collected during this survey is stored in this Table. There can be multiple entries of geochemical data for each site.

Table 3 is the short form of the geochemical database(GTHCHEM2). It contains an abbreviated element list and has only one entry per site. Where multiple chemical analyses were available all the results were averaged to make just a single entry.

Table 4 contains the general information database (GTHGEN). It has information such as temperature, flow rate, type, references, and current usage for each geothermal site.

All the data in the project databases were entered by hand. Much of the data resided in Colorado Geological Survey Bulletins and Information Series and had never been entered into a computerized database before. The only other computerized database used in this project was the WATSTOR database compiled by the U. S. Geological Survey; however, all of this data was entered manually.

The enclosed diskette contains all the database files in a Quattro Pro 4 format. These files can easily be transformed into Lotus 1-2-3 or other database manager files. The following table lists all the important computer database information for the databases.

TABLE	DATABASE NAME	INFORMATION	NO. OF FIELDS	NO. OF BYTES
Table 1	GTHLOC	Location	24	84,936
Table 2	GTHCHEM1	Chemistry, long list	59	385,444
Table 3	GTHCHEM2	Chemistry, short list	22	84,670
Table 4	GTHGEN	General information	8	29,316

Table A: List of pertinent computer file data for the low-temperature geothermal assessment databases. All databases are in Quattro Pro 4 format (WQ1 suffix).

4. Fluid Chemistry

The University of Utah Research Institute (UURI) provided 10 new water analyses for each state as part of the low-temperature geothermal assessment program. Because of time constraints a lower limit of 30° C was set on any geothermal spring or well to be visited in the field. Almost all of the geothermal sources greater than 30° C were visited. A few that would have required a full day to walk in to were not visited. The temperature, pH, conductivity, flow rate and current usage for each site were recorded. Sites for a complete water analysis were selected on a subjective criteria of developmental significance and lack of recent or quality geochemical data. The 10 sites selected for new water analyses in Colorado are:

Craig Warm Water Well
Desert Reef (Florence)
Dotsero, South
Mt. Princeton (Hortense Well)
Ouray (Pool or Box Canyon Spring)
Routt (aka Strawberry)
Steamboat Springs (Heart Spring)
Waunita Hot Springs
Juniper Hot Springs

Pagosa Hot Springs (Big Spring)

The results of the new samples are included in Table 2 and have a reference number of 3. There were no new results that had serious implications for the prior known geochemistry of the geothermal areas.

Other sources of geochemical information were utilized in compiling the database. The most significant source of geochemical data was the DOE supported studies performed by the CGS in the late 1970's. The reference for each analysis is listed in Table 2. Any geochemical analysis that had a cation-anion balance error greater than 15% was discarded except for the case described below.

Geochemical data derived from the U. S. Geological Survey WATSTOR database was entered into the current database; unfortunately, most of those reports do not have an analysis for HCO_3^- or CO_3^{-2} which causes severe errors in the cation-anion balance. As most of these analyses are the only one for that particular site they have been retained in the database even though they do not balance within the specified limits.

5. Discussion

The location of all the geothermal sites compiled during this assessment program is shown on Figure 1. The accompanying Plate 1 shows the location and geothermal area ID number. A frequency plot of all the geothermal temperatures from each site is shown in Figure 2. The greatest number of temperature measurements fall in the 25° to 40° C categories. There is another peak in the 51° to 55° C range.

The following section contains a brief discussion of the sites that were visited during the 1992-1993 geothermal assessment program. All the geothermometer estimates in the following section are derived from discussions and tables in Barrett and Pearl (1978). Some modification of suspect geothermometer estimates was made using the methods described by Michael Adams of UURI (personal communication, 1993).

Antelope Warm Spring, Mineral County

The Antelope Warm Spring was visited in June of 1993. The spring issues into a concrete-lined cistern approximately 6 feet by 4 feet at ground level and 5 feet deep. The spring is 20 feet north of wooden building shaped like a quonset hut. Inside this building is a 20 foot by 30 foot swimming pool. Water from the spring was used to fill the pool.

Mr. Larry (Sonny) Dickerson, longtime owner of the property around the spring, indicated the pool had not been used for several years. The pool was used by family and friends, never commercially. Currently, the swimming pool building is used for storage by Mr. Dickerson. The pool is covered by a tarp and is nearly empty. Water from the Antelope Warm Spring is diverted into the pasture surrounding the spring. A valve and pipe system (in an advanced state of disrepair) can still divert most of the spring flow into the swimming pool if desired.

Flow from the spring was measured at 50 liters per minute which was four (4) times the rate measured by Barrett and Pearl (1976) in 1975. Mr. Dickerson is of the opinion that

Colorado Geothermal Springs and Wells - Figure 1

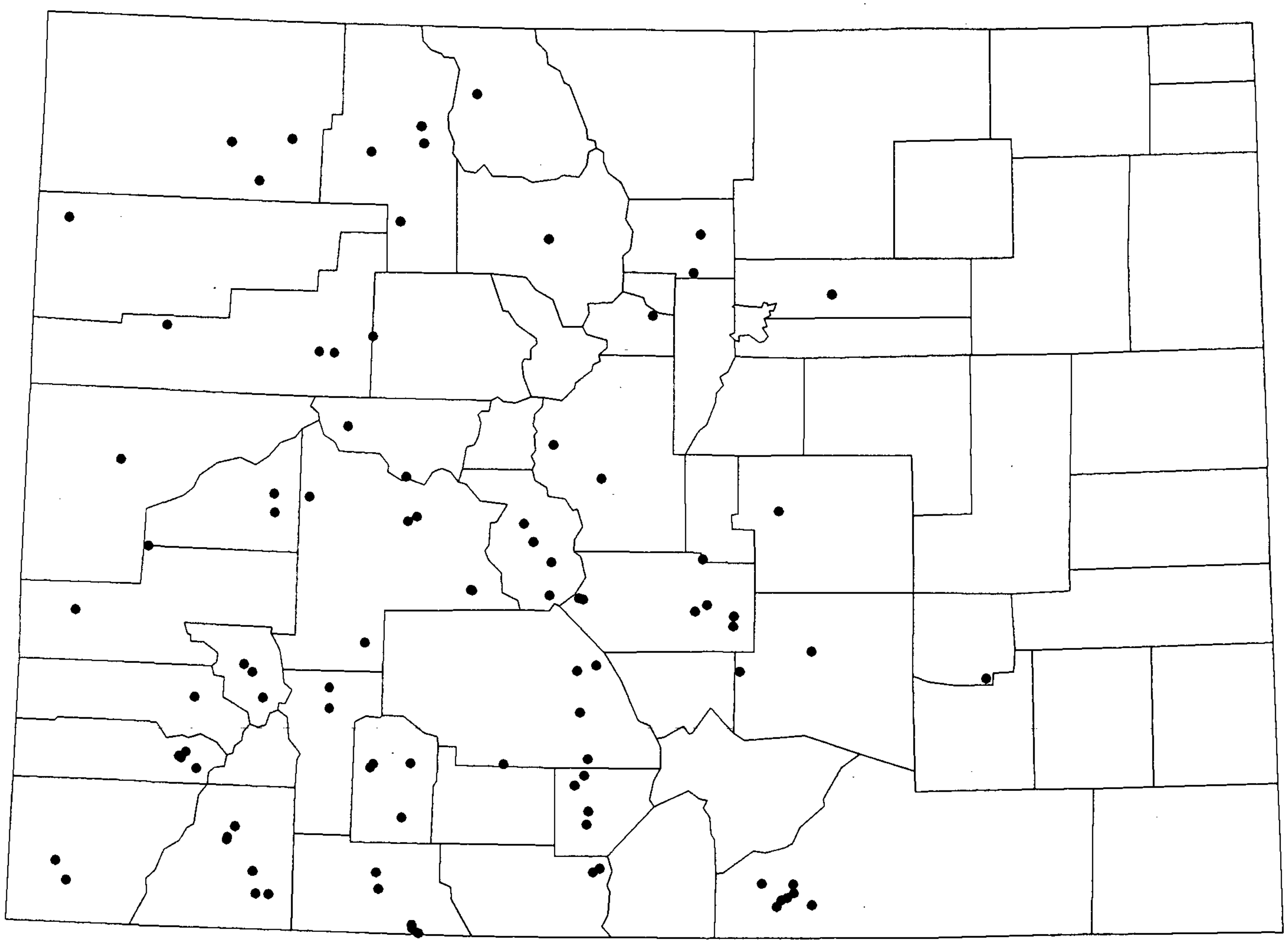
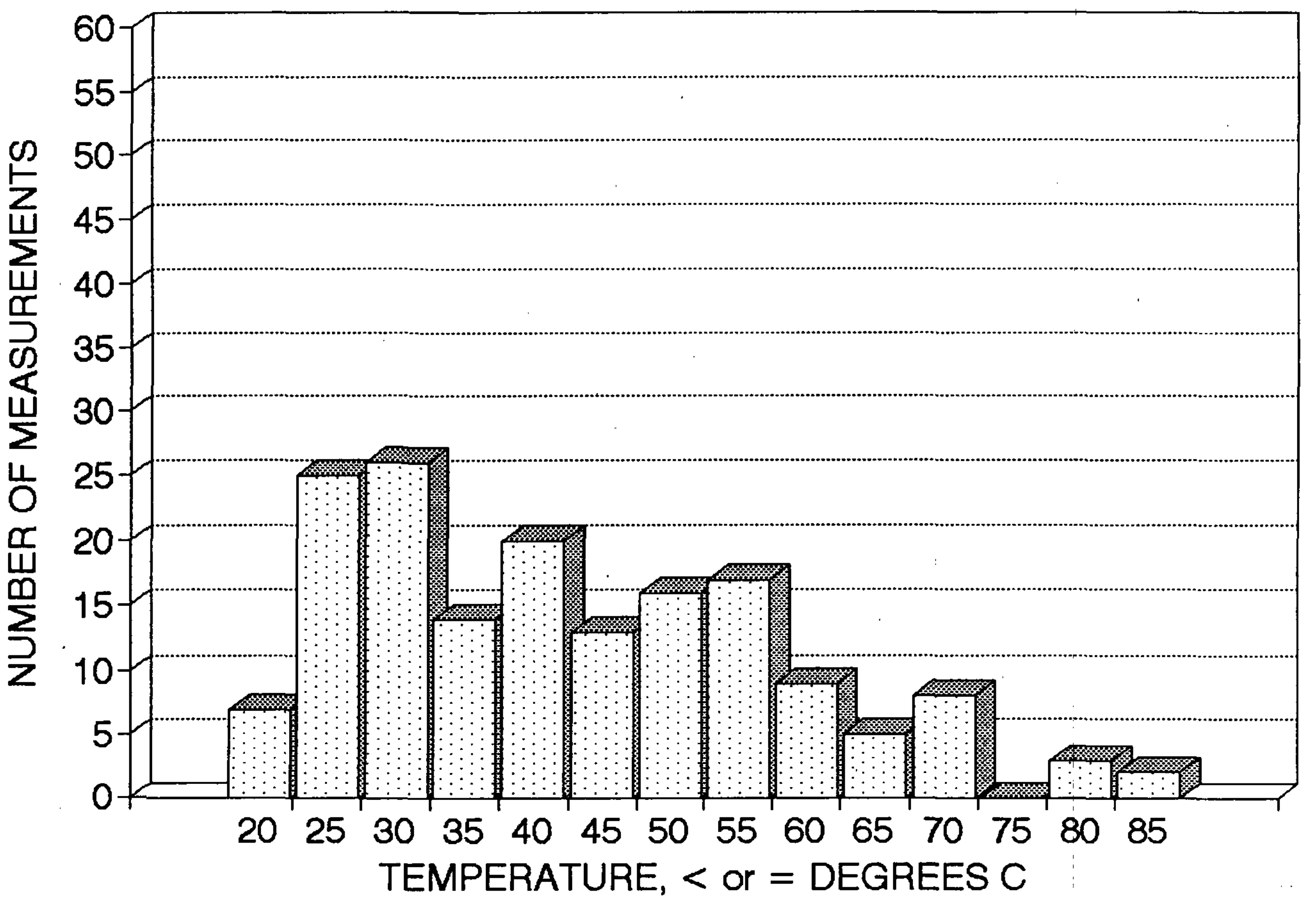


Figure 2: FREQUENCY DISTRIBUTION COLORADO GEOTHERMAL SOURCES



during the last five years flow from the spring has noticeably increased.

The most reasonable estimate of the subsurface reservoir temperature from a combination of geothermometers is 35° to 52° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Steven and Ratte, 1973).

Birdsie Warm Spring, Mineral County

There are five springs that issue from the toe of the slope just north of the road. All the flow enters a culvert and flows out to the Rio Grande. The most reasonable estimate of the subsurface reservoir temperature from a combination of geothermometers is 35° to 52° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Steven and Ratte, 1973).

Brands Ranch Artesian Well, Jackson County

The Brands Ranch Artesian Well was visited in May, 1993. There is no longer any physical evidence of the well mentioned in Barrett and Pearl, 1978. The spring bubbles up into a 15 feet diameter, 2.5 foot deep pool. There are no facilities in this somewhat remote area. The pool appears to get some occasional use from hunters, campers, fisherman and local people.

The collapsed well that makes the hot spring is the Horton 2 Brands well drilled in 1953 to a total depth of 1,075 feet. The lowest formation penetrated is the Morrison Formation. The hot waters probably come from the Dakota Sandstone. The most reasonable estimate of the subsurface reservoir temperature from a combination of geothermometers is 42° to 55° C (Hail, 1965; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Browns Canyon Warm Springs, Chaffee County

An attempt to visit this site was made in July, 1993. Several minor seeps were noted in the area described by Dick (1976) and Barrett and Pearl (1978); however, these seeps had a temperature less than 20° C (Scott et al., 1975; Barrett and Pearl, 1976; Dick, 1976; Barrett and Pearl, 1978).

Canon City Hot Springs, Fremont County

Canon City Hot Springs emerges from a corroded casing in the northeast corner of the front yard of a house that faces the nearby Arkansas River. Nothing remains of the "classy" thirty-eight room Royal Gorge Hotel and Spa built adjacent to the Spring in the 1870's. Fifteen years ago the current owner of the property filled in the swimming pool supplied by the spring.

Water from the spring is now used to irrigate some of the owner's and a neighbor's front yard landscape shrubs. When the spring was visited in June of 1993 the temperature of the spring was 40° C. The flow varied from 9 to 142 liters per minute (George et al., 1920; Taylor et al., 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Cebolla Hot Springs, Gunnison County

The Cebolla Hot Springs near the village of Powderhorn was visited in May, 1993. The cabins and bath houses appeared to be still in useable and working condition; however, there was no one around to give us any information about present day usage. There are still two bath houses (George et al., 1920; Hedlund and Olson, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Cement Creek Warm Springs, Gunnison County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60° C (Barrett and Pearl, 1978).

Clark Artesian Well, Pueblo County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 25° to 60° C (Barrett and Pearl, 1978).

Colonel Chinn Hot Water Well, Delta County

This well was visited in November, 1992. The well water is piped through a closed wellhead to a manifold and then to stock tanks about 200 feet away. An accurate indication of the temperature could not be obtained; however, the property owner indicated that the water flows all the year without freezing (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Hail, 1972).

Conundrum Hot Springs, Pitkin County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50° C (Barrett and Pearl, 1978)

Cottonwood Hot Springs, Chaffee County

At the time of our visit in May, 1993, the Jump Steady Resort was renamed to the Cottonwood Hot Springs Inn. The Inn has guest cabins and hot spring spas in a somewhat rustic environment. Hot water which is used for bathing, domestic heating, and drinking purposes comes from an enclosed cistern.

Another set of nearby springs and a well are used by the Merrifield family for a greenhouse complex, domestic heating and bathing, and drinking.

The Cottonwood Hot Springs is located at the contact of the Tertiary Mount Princeton Quartz Monzonite and Precambrian migmatitic gneisses to the south. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 100° to 110° C (George et al., 1920; Scott, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Craig Warm Water Well, Moffat County

The Craig Warm Water Well is mislocated in Colorado Geological Survey Bulletin 39. The correct location is shown in Table 1 of the current reinvestigation of the geothermal resources of Colorado. The Craig Warm Water Well was visited in November, 1992. At that time the wellhead was in poor condition with hot water leaking from various places. There was no evidence of any activity or recent use of the well. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is approximately 100° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Crowley Ranch Reserve Well, Archuleta County

The Crowley Ranch Reserve Well was drilled as an oil and gas test by the Phillips Oil Company in 1943. The well intersected the Dakota Formation at 240 feet, Morrison Formation at 520 feet, Todilto Limestone at 1,200 feet, Wingate Sandstone at 1,308 feet, Chinle Formation at 1,508 feet and Precambrian quartzite at 1,515 feet. The well is reported to have begin flowing hot water at 1,558 feet. The well was abandoned at 1,625 feet and deeded to the Crowley's for irrigation purposes.

There is no longer any physical evidence of the well. Water bubbles up into 8 foot in diameter, 5 foot deep pool. During a visit to the site by CGS personnel in June, 1993, all the water from the well was diverted to the east into an irrigation ditch. Three hundred feet from the well some of the water is taken from the ditch to fill a just constructed hot tub. The remainder of the water in the ditch is allowed to flow into the Jaw Bone Canyon.

From 1943 until within the last year the 48° C well water was used for pasture irrigation. Now, 534 acres of the Crowley family holdings around the well are in a just developed recreational community called the Crowley Ranch Reserve. The Reserve is made up of 19 one to three acre parcels on the 534 acres. Property owners are given common ownership of a great amount of the Reserve's land. One of the amenities touted by the developers of the property is the geothermal hot tub referred to in the above paragraph. Just on the market, only two lots have been sold and as yet no homes have been built.

Deganahl Warm Water Well, Routt County

The Deganahl warm water well was drilled as an oil test in Cretaceous rocks by Fullerton Leasing Company of California in October, 1967. Because the well encountered only warm water, the company turned the well over to the land owner, Mr. Deganahl. He completed the well at a total depth of 2,500 feet in January, 1968 as a warm water well. The original flow of the well was some 11,900 liters per minute at the time of drilling . Caving problems while installing the casing reduced the well flow to 4,800 liters per minute. The temperature of the water is 43° C and the well had a shut in pressure of 200 psi.

In 1981, the Colorado Division of Wildlife applied for a permit to drill a geothermal well at their Finger Rocks Trout Hatchery facility three miles east of the Deganahl well. The permit application was denied by the State Water Engineer. The analyses of the Deganahl well water included in Table 2 were performed as part of the Division of Wildlife's feasability study on the proposed project.

The Deganahl well was visited in May, 1993. The owners of the well make only occasional use of the well for bathing purposes. The hot water is flowing at approximately 1,500 liters per minute out of the wellhead and into Watson Creek. A second well is located at a bearing of S33E and a distance of 225 feet from the original well. The conductivity, pH, and temperature of the water from the second well are similar to the original well. There is no record of the depth or history of the second well, according to a member of the Deganahl family. The flow rate of the second well is only about 100 liters per minute.

The geothermal waters are accounted for by a normal geothermal gradient and probably issue from either the Dakota Sandstone or sandstones within the Frontier Formation. The well was spudded into The Mancos Shale (Kucera, 1962).

Desert Reef (Florence), Fremont County

The Desert Reef Beach Club is a "Natural Outdoor Hot Springs". The facilities consist of a changing house and a 20 foot by 30 foot bathing pool fed by an old oil test well, the Conoco Huffman No. 1 well drilled in 1966. The well was drilled into Precambrian granite at 3,948 feet and has a total depth of 4,240 feet. Later the well was plugged back to 1,096 feet and produces 54° C water at a permitted flow of 1,100 liters per minute from the Morrison and Dakota sandstones.

Dexter Warm Springs, Conejos County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 20° to 50° C (Barrett and Pearl, 1978).

Dotsero Warm Springs, Eagle County

The Dotsero Warm Springs were visited in May, 1993. The springs and adjacent buildings described and pictured by Barrett and Pearl, 1978 on the northwest side of the Colorado River are no more. Construction activities on Interstate Highway 70 have destroyed the old buildings and the hot springs have been covered over by fill material for the new highway. There are some monitor wells in the area of the old springs at the river's edge; however, there was no sign of flow from these springs.

The springs on the south-east side of the river are still intact and flowing directly into the Colorado River at the base of a fill for the railroad tracks. The outflow quantity is impossible to measure; however, the waters were very saline to the taste. A sample of the water was taken for chemical analysis. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is approximately 100° C (George et al., 1920; Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Dunton Hot Springs, Dolores County

Dunton Hot Springs is near the old mining town of Dunton. There are several old cabins around the Dunton Hot Springs. In the past few years a private group has tried to run a primitive resort around the Hot Springs. Unfortunately, they are no longer in business and all the cabins, lodge, and bathhouse are falling into disrepair. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 50° to 70° C (Bush and Bromfield, 1966; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Dutch Crowley Artesian Well, Archuleta County

The Dutch Crowley Artesian well was visited during June of 1993. The site's 70° C water is flowing from the top of surface casing which extends about 2 feet above ground level.

The well was spudded as an oil and gas test in July 1951 by a J. R. Butler from Houston Texas. The wildcat encountered two gas-and-water zones at approximately 800 and 1,200 feet in the Morrison Formation. The gas rate from the 800 foot sand and/or sands was estimated by the well-site geologist (Mr. Walt Osterhoudt) to be about 300,000 cubic feet per day. The well intersected the Entrada Sandstone at 1,500 feet and flowed fresh water with a temperature of 48° C. The well was bottomed at 1,741 feet. The hole was deeded by the operator to the Crowleys for a water well.

Barrett and Pearl's narrative on how to get to the well in their 1978 CGS Bulletin 39 is not accurate. The correct instructions are to read; proceed 3.8 miles southeast from the Chromo Post Office on US Highway 49 to where a dirt road leads east. Turn left on this road and drive about 1/8 of a mile. The well is about 3/4 of a mile due east of this parking spot on the south side of a boggy meadow.

Mr. Donny Shayhan, a Crowley family son-in-law who lead this investigator (H. T. Hemborg) to the well, indicated that he is considering piping water from the well to his ranch house located 1 1/4 miles west of the well. Up to now this well has only been used for pasture irrigation.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 80° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Osterhoudt, 1978).

Eldorado Springs, Boulder County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 26° to 40° C (Barrett and Pearl, 1978).

Eoff Artesian Well, Archuleta County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 60° C (Barrett and Pearl, 1978).

Florence Artesian Well, Fremont County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 34° to 50° C (Barrett and Pearl, 1978).

Fremont Natatorium Well, Fremont County

The 70 by 150 foot swimming pool supplied by the warm water well is now used only by the owners. The pool and concrete decking is in disrepair. The owner indicated that he and his wife closed the pool for public bathing 30 years ago because they could not afford to be in compliance with newly enacted public swimming pool water standards for chlorination. When this site was visited during June of 1993 the owner was using a portion of the warm well water to irrigate a sizeable vegetable and berry garden.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50° C (Barrett and Pearl, 1976; Scott, 1977; Barrett and Pearl, 1978).

Geyser Warm Springs, Dolores County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 60° to 120° C (Barrett and Pearl, 1978).

Glenwood Springs area, Garfield County

The Glenwood Springs area is the state's premier bathing spa area. There are several hot springs in the area around Glenwood Springs but only those on the north side of the Colorado River have been developed. No new analyses were taken from the Glenwood Springs area during this study. The Vapor Caves Spa donated a copy of a private laboratory report on the chemistry of their waters (George et al., 1920; Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

The chemistry of the geothermal waters in the Glenwood Springs area is too complex for an accurate estimate of subsurface reservoir temperatures. The subsurface temperature is, probably, not much higher than the surface temperature of the hot springs, approximately 45° to 50° C (Barrett and Pearl, 1978).

Hartsel Hot Springs, Park County

The remains of the Hartsel Hot Springs were visited in May, 1993. The bath house that is pictured in Barrett and Pearl, 1978 is no longer standing, though some flow from the hot springs is still coming out of a pipe from the building's foundation. All the facilities of the Hartsel Hot Springs are unused and in a state of decay and disrepair. The flow was difficult to measure but it appears to be greater than 300 liters per minute.

There is a popular opinion based upon rumor and general tourist literature that the geothermal water from the Hartsel Hot Springs is highly radioactive (Cahill, 1983). This opinion appears to based upon an article (Howland, 1936) which describes a barite occurrence in the Pennsylvanian-Permian Maroon Formation about two miles southwest of Hartsel Hot Springs. The author states that there is an unusual blue-colored barite at this locality and he conjectures that the blue coloration was caused by radiation damage. As further evidence for his thesis, Howland states without providing any data or analysis that the Hartsel Hot Springs are highly radioactive based upon analyses done by the Colorado Geological Survey (George et al., 1920). The mean of 60 hot springs (>20° C) analyzed in the 1920 CGS study is 0.139 picocuries Ra per liter. The values range from a trace, 0.001, to 2.64 picocuries Ra per liter. The value for the Hartsel Hot Springs is 0.154 picocuries Ra per liter, only slightly above the mean.

A more recent study of the uranium concentration in natural waters of South Park (Sharp and Aamodt, 1976) indicates that the uranium concentration, as analyzed by fluorometric methods, in a filtered and acidified water sample from the Hartsel Hot Springs was 0.30 parts per billion (ppb) uranium. Two other analyses of the untreated sample were 0.98 and 0.10 ppb uranium. Samples from 16 springs in the South Platte drainage area within the South Park region which includes the Hartsel Hot Springs had values that ranged from 0.21 to 292 ppb uranium with an average of 22.6 ppb uranium. The average of 35 surface water samples in the same drainage area is 3.3 ppb uranium. The uranium concentrations of 0.3 ppb at the Hartsel Hot Springs is well below the regional average, 22.6 ppb, for the South Platte drainage in South Park.

It appears that the hot springs at Hartsel are associated with the South Park or Santa Maria Faults and\or the contact of the Morrison Formation and Precambrian crystalline rocks. Precambrian granites in the region around Hartsel are known to possess anomalously high geothermal gradients. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 55° to 85° C (George et al., 1920; Ettinger, 1964; Barrett and Pearl, 1976; Barrett and Pearl, 1978; McCarthy et al., 1982[b]).

Haystack Butte Warm Water Well, Boulder County

This well and surrounding area was visited in May, 1993. Warm water is still flowing from the wellhead into a 25 foot diameter pool which at the present time is used mostly by game birds as a watering and bathing pool. The pool is undeveloped and a significant amount of discarded machinery and other junk surround it. The temperature of the well has declined from 28° C in 1976 (Barrett and Pearl, 1976) to 20° C in May, 1993. The source of the hot water is conjectural; however, the location of the well on the Haystack Mountain Anticline indicates that structures along the axis of the anticline probably helped in circulating waters through the underlying Pierre Shale to depths adequate enough for heating to the observed temperatures (Trimble, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

The estimate of the subsurface reservoir temperature made by Barrett and Pearl (1978) from a variety of geothermometers was 50° C. The surface temperature of the spring has declined almost 30% since 1978. It may be reasonable to expect a similar decline in the subsurface reservoir temperature estimate to approximately 35° to 40° C.

Hooper Aquaculture Well, Alamosa County

Access to the Hooper Aquaculture Well is south from Hooper on Colorado Highway 17 for 2.7 miles to the intersection with Nine Mile Lane. Turn left (east) on this road and proceed for 0.2 miles to the site.

The subject well was drilled as an irrigation well by E. F. Lambert in 1963. Total depth of the well was 2,063 feet. A 12 3/4 inch casing was run from surface to 922 feet and 9 5/8 inch casing was run from 922 to 2,063 feet. The well casing is perforated from 1,242 feet to total depth. The driller's log indicates the perforated section is an interbedded mixture of sand, gravel and brown clay. The well according to State of Colorado Division of Water Resources records initially flowed 8,955 liters per minute.

About ten years ago Mr. Erwin Young of Alamosa bought 80 acres of land comprising the north half of the northwest quarter of Section 22, T40N, R10E. The Lambert (nee) Hooper Aquaculture well is located in the NW NW NW of this section was included in the purchase. After the purchase Mr. Young developed his acreage into a fish and alligator farm. The "geothermal" Hooper Aquaculture Well which now flows at about 2,600 liters per minute at a temperature between 30.2° to 31.3° C is about the perfect water temperature for the African perch or "Tilipia" that he is rearing at the site.

During our visit to the site in June of 1993, water leaking around the casing of the Hooper well was measured at 31.3° C. Currently, all the commercial fish growing ponds are out of doors. Mr. Young, however, is in the middle of a project to enclose a number of tanks inside a metal shed to increase production in winter months. He also is developing an additional Tilipia rearing unit near Alamosa whose ponds will be supplied from a couple of (unknown) geothermal wells of a temperature nearly matching the Hooper Well.

Hot Sulphur Springs, Grand County

The Hot Sulphur Springs Resort is now only open during the summer and fall months. At the time of our visit in June, 1993 the resort complex was for sale. The springs appear to be controlled by a north-south trending fault in the Dakota Formation and the Middle Park Formation.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 75° to 150° C (George et al., 1920; Izett, 1968; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Idaho Hot Springs, Clear Creek County

This site was not visited during this program. The chemistry of the geothermal waters in the Idaho Springs area is too complex for an accurate estimate of subsurface reservoir temperatures.

Juniper Hot Springs, Moffatt County

Juniper Hot Springs was visited in November, 1992. At that time the buildings and other facilities associated with the resort were severely run down and in a general state of disrepair. Hunters who were camped there informed me that the resort was closed in 1989, more or less permanently, by the elderly owner who lives in nearby Craig. The source springs are enclosed in a locked building. A one-inch pipe carries hot water from the building for a distance of about eight feet and discharges into a pool. The sample for this study was taken at the discharge point.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 50° to 75° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Lemon Hot Springs, San Miguel County

The Lemon Hot Springs consists of a small, 20 foot diameter, pond at the mouth of an old adit. Several buildings having the appearance of private residences surround the pool and tunnel. The waters feeding the hot springs pool are draining from the tunnel. At the time of my visit in July, 1993, the pool was choked with weeds and algae. The owners of the hot springs could not be contacted concerning the status of the pool and springs (George et al., 1920; Bush et al., 1959; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Mineral Hot Springs, Saguache County

An attempt to visit this site was made in June, 1993; however, we were denied access to the area. According to the guard at the site the owner is planning on developing the area and is very secretive about his plans. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 90° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Mount Princeton Hot Springs, Chaffee County

Because of the presence of hot geothermal water, the area around Mount Princeton Hot Springs has been heavily developed since the turn of the century and has been the site of various resorts, hotels, homes, and youth camps. The springs around Mount Princeton are the hottest in the state. The Hortense Hot Spring which services the Silver Cliff Ranch, a Christian youth camp, has a temperature of 85° C. The water is used for bathing, domestic uses and drinking purposes. A resort, several residences, youth camps, and a greenhouse utilize the hot water from several springs and wells in the area. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 100° to 130° C.

The state Division of Wildlife has a trout rearing unit at the Chalk Cliffs hatchery some two miles east of the Mt. Princeton Hot Springs. This unit was purchased by the state in 1948 but has been in existence since the 1920's. The 18° C water in the Chalk Creek is used in the trout rearing unit to advantage. Growth times for rainbow trout from fingerlings to a stocking length of 10 inches are decreased from a normal 18 to 22 month period to 12 months because of the warm water (George et al., 1920; Scott et al., 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Mullenville Warm Spring, Park County

The area around this spring, also known as Rhodes Warm Spring in the earlier literature, has been developed as a subdivision called "Warm Springs Ranch". Below the springs the outflow has been channelized by a boulder and cobble drain. The warm water goes to some fishing ponds on the subdivision. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 25° to 35° C (Tweto, 1974; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Orvis Hot Springs (Ridgeway), Ouray County

The Orvis Hot Springs resort utilizes geothermal water from a tufa mound just to the southeast of the resort buildings, from a well pit dug in 1991, and from springs which feed directly into a 35 foot diameter natural pool. The natural pool, used mostly for bathing in the 41° C water has a privacy fence and is surrounded with a wooden deck. The resort also has private rooms for bathing and massage and hydrotherapy sessions.

Part of the hot water from the tufa mound is being diverted to a greenhouse and aquaculture project about 1,000 feet to the south. The owner has ambitious plans to develop this project but at this writing, July, 1993, it is still under construction (George et al., 1920; Luedke and Burbank, 1962; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Ouray, Ouray County

The City of Ouray has taken an active role in developing the geothermal resources of the immediate vicinity. In 1989, the City drilled two shallow wells, OX-2 and OX-6, in the City Park just to the south of the City Swimming Pool (Formerly known as the Radium Hot Springs Pool). These two wells are 90 feet deep and produce 48° C water which goes directly to the pool. At the time of my visit in July, 1993 one of the wells was temporarily shut-in. The pool still gets the bulk of its hot water via a pipeline from the Box Canyon Hot Springs.

Three motels in the City of Ouray are using geothermal waters from various sources for spas and space heating. The Twin Falls and Box Canyon motels are using geothermal waters from springs located at the motel sites, and the Manganese Mine at the mouth of Box Canyon, and from hot springs in Box Canyon. The Weisbaden Motel uses geothermal waters for its pool and space heating from a hot spring reservoir under the motel and from an underground Vapor Cave which has three natural hot springs issuing into it. The waste geothermal water from the Weisbaden Motel is used to heat the sidewalks and driveways of the City of Ouray municipal buildings about 200 feet down the hill.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 90° C (George et al., 1920; Luedke and Burbank, 1962; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

<u>Pagosa Springs, Archuleta County</u>

These springs were visited during June of 1993. The main spring, Great Pagosa, situated a few hundred feet southwest of the Spring Inn is enclosed by a fence and posted with "No Trespassing" signs. The City of Pagosa Springs has recently built a viewing area on the east side of the spring which provides a good place to observe and photograph the spring. The city has placed four poster boards in the viewing area which describe the: (1) History of the Great Pagosa Hot Springs, (2) Geologic Requirements for a Hot Spring, (3) The Stratigraphic Section at Pagosa Springs, and (4) Distribution of the Pagosa Springs Geothermal Heating System. The poster boards are of good graphic quality and the historical and scientific information is accurate and well written for lay person understanding.

The Spring Inn is in the final phase of a major alteration of their pool area. When finished they will have a cluster of seven soaking pools of different sizes and water temperature ranging from about 35° to 45° C. Individual pools will be able to comfortably accommodate from 8 to 30 bathers.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 80° to 130° C (George et al., 1920; Hail, 1971; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

<u>Paradise Hot Spring, Dolores County</u>

This hot spring is located 2.5 miles south of the Dunton Hot Springs along the West Dolores River. At the time of my visit in July, 1993, the springs were not open to the public. The owner of the property uses the warm springs and bath house for his own purposes which is no change from the previous inventory in 1976 (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

<u>Penney Hot Springs, Pitkin County</u>

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 60° to 90° C (Barrett and Pearl, 1978).

Pinkerton Hot Springs, La Plata County

The rerouting of the U. S. Highway 550 has destroyed two of the four hot springs that made up the Pinkerton Hot Springs. The two remaining springs, the Mound Spring and the Little Mound Spring, are located on the west side of the highway just a few feet from the pavement. The hot water from both springs is piped out to a drain along side of the highway and then to the natural drainage system. There has been some limonite-stained tufa build up at the site of the two remaining springs. The destruction of the two remaining springs has left the Colorado Timberline Academy (formerly the Golden Horseshoe Resort mentioned in Barrett and Pearl, 1978) without hot water for its pool.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 75° to 125°C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Poncha Springs, Chaffee County

The Poncha Hot Springs were visited in May, 1993. The facilities around the springs are currently maintained by the City of Salida. Since 1938 most of the water from the springs is transported by pipeline to the municipal swimming pool in Salida. The inlet temperature of the pool is approximately 47 to 50° C. Currently, the Boy Scouts of America use the facility heavily in the summer months as a base camp. There is no longer any commercial usage of the facilities.

According to the caretaker at the site there are numerous springs which over the years have fallen into a state of disrepair. Currently, there are efforts to find and repair some of the old cisterns and pipelines in order to improve the quantity and temperature of the flow.

The Poncha Hot Springs area is marked by the presence of several fossil and a few active tufa mounds that are associated with the hot springs. There are significant aprons of travertine that occur downslope of the area of hot springs.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 115° to 145° C (George et al., 1920; Van Alstine, 1975; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Rainbow Hot Springs, Mineral County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50° C (Barrett and Pearl, 1978).

Ranger Warm Springs, Gunnison County

This site was not visited during this program. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60° C (Barrett and Pearl, 1978).

Rico, Dolores County

Two of the four diamond drill holes noted by Barrett and Pearl, 1978 are still uncapped and flowing hot water. The Geyser Hot Water Well is flowing and bubbling with a slight geyser effect. It has built a substantial tufa mound, approximately 6 feet high, and an semi-circle shaped apron, approximately 25 feet in diameter, around the drill hole. Limonite staining is prominent in the tufa. The waters remain unused. The chemistry of the geothermal waters in the Rico area is too complex for an accurate estimate of subsurface reservoir temperatures (George et al., 1920; McKnight, 1974; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Routt [aka Strawberry] Hot Springs, Routt County

The Strawberry Hot Springs is in the process of development as a commercial enterprise. Don Johnson of Steamboat Springs has owned the property since 1982. In the ten years since Johnson has owned the property he has deepened four of the pools and imported sand for the bottoms, built wooden decks and walkways, built four rustic cabins, and hired a gardener. At the time of my visit in November, 1992, a massage house; a bath house with showers, toilets, and heat; and another cabin were under construction.

Recent geological mapping (Snyder, 1980) demonstrates that the Strawberry Hot Springs are hosted by an Proterozoic felsic gneiss and amphibolite. Younger granitic pegmatites are also found in the immediate area. A north-trending normal fault with an adjacent zone of pervasive epidote-chlorite alteration also occurs in the immediate area.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 125° to 175° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Snyder, 1980; Pearl et al., 1983).

Sand Dunes Pool Hot Water Well, Saguache County

Hot water for the swimming pool comes from a 4,400 foot deep well located just to the south of the pool. The pool is no longer open to the public; however, it is in good shape and is used by the family living on the premises. An experimental project for growing catfish using the geothermal water has been abandoned for many years (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Shaws Warm Spring, Saguache County

The site was visited during June of 1993. I could not gain access to spring. Sampling and measuring of water was achieved where the spring waters leave swimming pool.
The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 30° to 60° C (Barrett and Pearl, 1976; Lipman, 1976; Barrett and Pearl, 1978; Bond, 1981).

South Canyon Hot Springs, Garfield County

These three undeveloped springs were visited in May, 1993. The hot springs have had several periods of usage and limited development followed by a closing of the primitive facilities by local governments. At the present time the hot springs are channeled into two pools dug into the dirt. There is obvious evidence of usage of the springs by bathers. The hot waters are associated with the Dakota Sandstone. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 70° to 130° C (Bass and Northrop, 1963; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Splashland Hot Water Wells, Alamosa County

The Splashland Pool is served by two wells that are 40 feet apart and 2,800 feet deep just to the west of the pool. In the winter when the pool is closed, the flow of the wells is used for space heating and domestic hot water in the surrounding ranch buildings. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 100° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Steamboat Springs, Routt County

Although there are several springs in the vicinity of the town of Steamboat Springs, only the Heart Spring has been used as a commercial hot bathing spring. The other springs in this area, which include the famous Steamboat Spring, have temperatures which vary from 14° to 19° C, too low to be considered as a geothermal resource in this study.

The Heart Spring is currently used for bathing within the larger Steamboat Springs Health and Recreation Association facility, a modern well appointed health club which includes an olympic size lap pool, tennis courts, weight room and exercise areas. It is impossible to obtain a good temperature measurement at the spring outlet; however, the Heart Pool had a temperature of 36.4° C at the time of my visit in November, 1992. According to the Office Manager, Linda Johnson, the flow rate varies from about 300 to 750 liters per minute. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 100° to 140° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978; Snyder, 1980; McCarthy et al., 1982(a); Pearl et al., 1983).

Stinking Springs, Archuleta County

Stinking Springs was visited in June of 1993. Warm water emerges in several places in a 1,500 foot stretch along the south bank of the Navajo River and north of the graded dirt road that parallels the river from Chromo to the springs and beyond. This area is very marshy and individual flows from points of emergence is very small.

The spring with the largest flow is south of the road. Barrett and Pearl (1976) sampled the water from this "main" Stinking Spring source in 1975 and found the temperature to be 27° C with a flow of 106 liters per minute. Our visit in 1993 found the temperature to be 25.4° C with a flow rate of 132 liters per minute.

The main spring bubbles up into a 20 foot diameter by 3 foot deep pool. This "soaking pool" seems to be a recent development or alteration to the spring. The spring is on property is owned by a newly (1992) formed recreational housing development called Crowley Ranch Reserve. It is assumed that they are responsible for the pool construction at this previously undeveloped and unused spring. Based on the lack of trash and foot prints around this newly dug out soaking pool, usage so far is judged to minimal.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 60° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Swissvale Warm Spring, Fremont County

This site was visited during June of 1993. Barrett and Pearl (1978) described the springs as being unused in 1978 and that is still the case. Sometime in the interim between the two site visits a 25 foot x 15 foot x 4 foot deep soaking pool was dug about 50 feet from where Spring F issues at the surface. All the flow from this spring was diverted to the pool before running into the nearby Arkansas River. The pool is now filled with moss and algae. It would appear no one has used this pool for soaking recently. The spring is on private property and posted for no trespassing. No one currently resides on the property.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Trimble Hot Springs, La Plata County

The Trimble Hot Springs lies within the well developed Trimble Hot Springs resort complex. The actual springs now have only a meager flow of 8 to 12 liters per minute. The resort pools and spas are served by a well [mistakenly called the Tripp Hot Springs well in Barrett and Pearl (1978) and Barrett and Pearl (1976)] which is 150 feet deep and contains a submersible pump at 35 feet. The well is pumping at about 1,000 liters per minute. A new bath house complex was built in 1988. The grounds around the pools are well maintained. At the time of our visit in July, 1993 the resort had a good crowd.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 45° to 70° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Tripp Hot Springs, La Plata County

The Tripp Hot Spring was mistakenly located at a well site 200 feet north of the Trimble Hot Spring by Barrett and Pearl (1978). The actual Tripp Hot Spring is located about 3/4 mile north of Trimble, near the mouth of Tripp Gulch and consists of a small natural pool, 25 feet x 10 feet x 5 feet deep. It is in the backyard of a private residence and has not been used for many years. The water currently flows off the property into a culvert (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Valley View Hot Springs, Saguache County

This site was visited during June of 1993. The site characterization in Cahill (1983) essentially catches the ambiance of this site. The amenities are about as he described in 1982 with the added note that the shower and bathroom facilities are now completed and that the site now has telephone service. The springs serve five soaking pools and one swimming pool.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 40° to 50° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978; Cahill, 1983).

Wagon Wheel Gap Hot Springs, Mineral County

Barrett and Pearl (1978) lists the location of the Wagon Wheel Gap Hot Springs as being in the SESE of Section 35, T41N, R1E; Spar City 7.5' quadrangle map. In actuality, the Wagon Wheel Gap 4UR Hot Spring is in the NWNE of Section 2, T40, R1E; Lake Humphreys 7.5' quadrangle map. The Wagon Wheel Gap CFI Hot Spring is in the SWNE of Section 2, T40, R1E; Lake Humphreys 7.5' quadrangle map.

During a site visit on June of 1993, the 4UR Dude and Guest Ranch ownership was building a new deck and swimming pool north of the old bath house which will utilize waters from the 4UR Hot Springs.

The CFI Spring is unused unless you count the old bath tub that is by the spring which guests or employees of the ranch can fill with a bucket. The 65° C spring water must be mixed with the icy water from the adjacent Goose Creek to achieve the right temperature for a soak.

The chemistry of the geothermal waters in the Wagon Wheel Gap area is too complex for an accurate estimate of subsurface reservoir temperatures (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

Waunita Hot Springs, Gunnison County

The Waunita Hot Springs was visited in May, 1993. The upper Waunita Hot Springs is a well-developed and appealing guest ranch. Waunita Hot Springs has been a popular tourist attraction since the turn of the century and still is even to this day. The waters from the springs are used in the swimming pool, space heating for the ranch and guest cabins, and for drinking purposes. The waters at Waunita are among the hottest in the state with an immersed temperature of the spring "A" in the gazebo of 77° C. A sample of the water from the gazebo spring was taken for chemical analysis. The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 140° to 150° C.

The lower Waunita Hot Springs are approximately a half mile from the upper Waunita Hot Springs. All the bath houses, gazebos, cisterns, and springs at the lower springs are unused and in a bad state of disrepair. There is only a foot path to the lower Waunita Hot Springs. The water temperature, apparent quality (conductivity), and flow are about the same as seen at the upper springs. The most reasonable estimate of the subsurface reservoir temperature of the lower Waunita Hot Springs is approximately 130° C (George et al., 1920; Barrett and Pearl, 1976; Barrett and Pearl, 1978; Zacharakis, 1981).

Wellsville Warm Spring, Fremont County

This spring was visited during June of 1993. The concrete ponds supplied by the Wellsville Warm Spring were used for the raising of tropical fish starting some time around the middle 60's. They are still in good condition and filled with warm spring water. However, the business was closed six years ago because of the failing health of the owner who had run the fish farm for some 20 years. This gentleman passed away about 5 years ago.

An elderly brother-in-law of the fish farmer now lives on the property. He indicated the only use now of ponds supplied by the spring was for bathing and swimming by his grandchildren and his sister's grandchildren.

The most reasonable estimate of the subsurface reservoir temperature from a variety of geothermometers is 35° to 50° C (Barrett and Pearl, 1976; Barrett and Pearl, 1978).

6. Summary

The 1992-1993 low-temperature geothermal assessment program added 10 new chemical analyses to the geochemical database of the state's geothermal waters. Other sources of geochemical data were reviewed and all good quality, that is less than 15% cation-anion balance error, geochemical analyses were entered into the long form geochemical database, Table 2. Certain areas with higher than 15% cation-anion balance were left in the database because they were the only analysis for an area or site. Usually the most significant errors in the cation-anion balance were found in the U. S. Geological Survey WATSTOR database and are due to a missing HCO_3 analysis.

Several corrections were made to locations and names of hot springs and wells described in the older literature. The Colorado Geological Survey Information Series 6 (1976) was updated during 1993 and the correct locations were entered into the revised publication and the database for this assessment. Corrections were also made to several location entries in the U. S. Geological Survey WATSTOR database.

A summary of the results of the 1992-1993 geothermal assessment and a comparison to the the 1976-1978 geothermal assessment are shown in the following table:

ITEM	1993 ASSESSMENT	1976-78 ASSESSMENT	% CHANGE
GEOTHERMAL AREAS	93	56	+66%
GEOTHERMAL SITES	157	125	+26%
GEOCHEMICAL ANALYSES	382	236	+62%
SITES OF DIRECT HEAT UTILIZATION	64	64	0
SITES OF DISTRICT HEAT USE	20	?	
SITES OF GREENHOUSES, AQUACULTURE	4	?	

Table B: Summary of the results of the 1993 Low-Temperature Geothermal Assessment Program compared to the 1976-1978 geothermal assessment.

7. Recommendations

The current assessment indicates that several areas in the state continue a long history of substantial utilization of their geothermal resources. The prime areas include Glenwood Springs, Idaho Springs, Steamboat Springs, Pagosa Springs, Mount Princeton, and Ouray. All of these areas, at the minimum, utilize the geothermal resources for swimming pools and spas. Some areas such as Ouray and Pagosa Springs utilize geothermal heat for space heating in municipal and other private buildings.

There are other areas in the state that are collocated with or near population centers and are on the fringe of geothermal development. That is, they have had some development of their geothermal resources; however, there are indications that geological and geophysical studies may be used in a Second Phase geothermal assessment to increase the geothermal area and spur development in these areas. The geothermal areas that are candidates for a Second Phase are (not listed in any order of importance):

1) Trimble Hot Springs, La Plata County.
2) Orvis Hot Springs, Ouray County.
3) A large area southeast of Pagosa Springs along the Archuleta Antiform, Archuleta County.
4) Eastern San Luis Valley, Saguache and Alamosa Counties.
5) Rico and Dunton Hot Springs, Dolores County.
6) Cottonwood Hot Springs, Chaffee County.

Other areas that are geologically significant but far from a center of population are:

1) Deganahl well, Routt County.
2) Brands Ranch well, Jackson County.
3) Craig warm water well, Moffatt County.
4) Hartsel Hot Springs, Park County.

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